FERTILITY CHANGE IN INDIA

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FERTILITY CHANGE IN INDIA

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PREFACE

This report on fertility change in India is one of the results of a project on integrated population modelling initiated by the National Institute of Public Health and Environmental Protection (RIVM) and the Population Research Centre (PRC) of the University of Groningen, both based in The Netherlands. The RIVM, a government-funded independent advisory agency, is making its modelling expertise available to support national and international policy making processes related to the environment and health. The PRC offers training and research in population issues. The centre has an international orientation, conducting research projects in several developed and developing countries.

The project is part of an interdisciplinary programme of the RIVM to develop comprehensive global modelling methodologies to examine various development pathways towards balanced growth. The resulting modelling framework is called TARGETS (Tools to Access Regional and Global Environmental and health Targets for Sustainability) and is part of the research programme 'Global Dynamics and Sustainable Development'. The framework focuses on the assessment of the interactions between environmental change and human activities. The programme results are part of RIVM's contributions to the integrated environmental assessment reports of the United Nations Environmental Program (UNEP). It is the development policy of UNEP and RIVM, as well as the PRC, to make the methodologies developed readily accessible and also available to regional and national centres of excellence throughout the world. In this way, an inter-regional network of collaborating centres is being established to assess regional and local priority issues within an integrated context.

Previously, as part of the TARGETS population model, a generic fertility module has been designed that describes the dynamics of fertility change at the aggregated global level. The structure of the model is validated against its applications at less aggregated levels, both regional and national, describing populations in different stages of the fertility transition. At the same time, the modified regional and national versions account for the diversity of historical and future fertility change among populations throughout the world. The first three case studies include India and China, because their populations form a large part of the world population and also because of their specific pattern of fertility change. In addition, Mexico is being studied to include a Latin American case.

The present report presents the results of the Indian case study. A draft report was prepared by the authors and was discussed in a three-day workshop organized by the Population Research Centre of the University of Kerala in Thiruvananthapuram, India and the Population Research Centre of the University of Groningen. Leading Indian demographers participated in the meeting. During the workshop fertility change in India was discussed, with an emphasis on the main patterns and causes of the fertility transition in the past, present and future. The model structure, its equations and the parameters values were discussed in detail and the conclusions have been implemented in the present version. The model description is given in the report and the computer listing is included in the appendices.

This report, the generic model, the all-Indian application, as well as the possible applications for individual Indian states are publicly available. They should be of interest to international and national researchers as well as to policy makers and programme executives active in the field of population and reproduction.
ACKNOWLEDGEMENTS

The National Institute, the Population Research Centre and the project team most cordially wish to acknowledge the contributions of their Indian fellow researchers without whom the thoroughness of this report and the development of the model would have been impossible:

Prof. Dr. Ashish Bose,
Emeritus Professor, Institute of Economic Growth, New Delhi

Prof. Dr. T.K. Roy
Professor, International Institute for Population Sciences, Bombay

Dr. K.S. Natarajan
Deputy Registrar General, Office of the Registrar General, New Delhi

Dr. P.N. Mari Bhat
Director, Population Research Centre, Dharwad

Prof. Dr. P.S. Nair
Professor and Director, Population Research Centre, University of Kerala, Thiruvananthapuram.
1. INTRODUCTION

The physical environment, as the ultimate source of life-sustaining materials and energy, the sink for the waste products of human activity, and the origin of climatic and seismic hazards, affects human populations in countless ways. Human activities modify the physical environment, and the number and distribution of people affect the scale and nature of their activities. Man’s impact is often described as the product of three variables: population, consumption and technology. Insight in the mutual relationships between the human and the environmental system is needed in order to operationalize the concept of sustainable development (Van Vianen et al. 1994), which is the aim of the Netherlands National Institute of Public Health and Environmental Protection (RIVM) research programme ‘Global Dynamics and Sustainable development’.

Concern for the population factor is expressed in most prospective world studies. With regard to the models used in such studies, two broad approaches can be distinguished. First, in most models population change is included as an exogenous part (e.g. Interfutures (1979), Global 2000 (1982) and EPA (Environmental Protection Agency 1990). Population data are taken from the well known United Nations (e.g. United Nations 1993a) or World Bank (e.g. Bos et al. 1992) projections. These are purely demographic projections, where change in demographic parameters is exogenously postulated, based on observed time paths, research findings and expert opinions. The high, medium and low fertility variants are thought to provide reasonable and plausible future trends in fertility that bracket the probable range of future fertility (UN 1993a, p.84). Second, in the WorldII (Forrester 1971) and WorldIII (Meadows et al. 1972) models that were used for the first ‘Limits to Growth’ studies of the Club of Rome population was treated endogenously. Especially in World III an attempt was made to relate fertility to other variables in the model, in particular life expectancy, production per capita (‘income’) and services per capita (‘family planning allocations’). The relations were partly based on the model of intermediate fertility variables by Davis and Blake (1956) and reflect the state of the art at the beginning of the seventies. Bongaarts (1982) proposed a quantifiable formulation of the procreation process, only after the publication of the WorldIII model. The findings of large scale surveys in the developing world (World Fertility Surveys, WFS) and the studies of the European fertility decline led to better insights into the dominant factors (Van Vianen et al. 1994, p. 7).

The model presented in this report adopts a systems dynamics view of fertility change. In the systems perspective, fertility change is embedded in a broader context consisting of several sociobiological factors or elements that directly or indirectly affect fertility; some are themselves affected by fertility. The systems view adopted in this report is consistent with TARGETS (Tools to Assess Regional and Global Environmental and health Targets for Sustainability), a Global Change model that is being developed by the RIVM. The proposed fertility model, which is described elsewhere (Van Vianen et al. 1994), is a module of TARGETS.

The level of fertility is measured as the number of children a woman has during her lifetime, on average (Total Fertility Rate, TFR). Some of the factors, such as contraceptive use and abortion, have an immediate and direct impact on the number of children. These factors, together with the TFR, represent the main characteristics of fertility at a given point in time. They are referred to as state variables since they describe the state of fertility. In TARGETS, the set of variables is referred to as the State Subsystem. The state variables, i.e. the TFR and the factors that have an immediate and direct impact on the TFR, are closely related to the procreation process, as described by Bongaarts. In Bongaarts’ formulation, the factors that affect fertility directly are known as proximate determinants or intermediate fertility variables. The systems approach to fertility encompasses the Bongaarts model relating fertility to the intermediate variables.

The main reason why Davis and Blake, Bongaarts and others distinguish intermediate variables is that they mediate the effect of social, economic and cultural conditions on fertility, i.e. contextual variables do not affect fertility directly, but rather indirectly through the intermediate variables. The social, economic and cultural factors affecting fertility represent a subsystem, which in TARGETS
is called the *Pressure Subsystem*. In the present fertility model, the indirect effects on fertility are summarized in a single index, the Human Development Index (HDI), which has been developed by UNDP. However, the three components of the HDI (GNP, literacy and life expectancy) are treated separately.

The main consequences of fertility change are population growth and changes in the age structure of the population. Population growth is expressed by two variables: the number of births and the population momentum, which represents the long-term consequence of current fertility. The changing age structure is expressed in terms of the proportion of the elderly population. A declining fertility is associated with an increasing proportion of elderly (even if mortality remains the same) and hence with an aging population. The consequences of fertility change constitute another subsystem of the context in which fertility is embedded. In TARGETS, the subsystem is known as the *Impact Subsystem*.

Fertility dynamics may have some undesirable consequences. For instance, when fertility is high, population growth and economic growth may get out of balance, which is the case when economic growth is inadequate to provide food, jobs, housing, educational and health facilities to people, even if one takes account of technological processes. When economic growth cannot be accelerated, population growth should be reduced to maintain the same standard of living. A growing discrepancy between population growth and economic growth may result in an increased awareness by government and the public that population growth and hence fertility must be curbed. The need for fertility control may also be felt at the micro-level in that families try to improve their standard of living by having fewer children. When families want to limit and/or space the children that are born but have no knowledge of or no access to the means to do so, an unmet need is said to exist. In that case, families may call on the governments (or NGOs) to provide the information and means to control fertility. The instruments available to the government to influence the intermediate fertility variables, and hence fertility, are called steering variables. In TARGETS, the set of steering variables constitutes the *Steering or Response Subsystem*. The Pressure, State, Impact and Response Subsystems (P-S-I-R) characterize the systems dynamics perspective of TARGETS, which is adopted in his report.

The generic model has been used to describe fertility change at the global level (Van Vianen et al. 1994). For the model to be truly generic, it should describe fertility dynamics in varying contexts. In order to validate the model, it was applied to countries with different fertility dynamics. Case studies were organized in India, China and Mexico. A secondary objective of the case studies was to contribute to the regionalisation of TARGETS to different regions of the world. The case studies will be used to evaluate, modify and improve the generic model. This report deals with the case study of India.

In this report we follow the outline presented in Van Vianen et al. (1994). The demographic transition of India’s population, the determinants of the mortality and fertility transition and the history of the family planning programme in India are discussed in Section 2. The time path of proximate determinants of fertility and of the socio-economic factors explaining variation in fertility are described in Section 3.

Of course, one can hardly speak about the Indian fertility pattern. Huge differences in fertility behaviour and related socio-economic and cultural circumstances exist within the subcontinent. Broadly, two demographic regimes can be distinguished in India: the northern states and southern states (based on Dyson and Moore 1983). Compared to the northern states, the southern states are characterized by relatively lower overall fertility, lower marital fertility, later age at marriage, lower infant and child mortality, and relatively higher sex ratios (defined as number of females per 1,000 males). The division between the two regimes broadly coincides with the division between areas of northern kinship/low female autonomy and southern kinship/higher female autonomy (Dyson and Moore 1983, p. 42-43). To illustrate these two demographic regimes, we present two case studies and describe the fertility transition, proximate determinants and related socio-economic factors for the southern state of Kerala and the northern state of Uttar Pradesh (Section 4).

The objective of Section 4 is just to illustrate the huge variation existing in India: a separate fertility model of Kerala and Uttar Pradesh is beyond the scope of this report, but might be developed in a later phase.

Based on the information presented in Section 3, we estimate the parameters of the variables to be included in the India fertility model (Section 5). Some of the equations of the generic model are adapted to the Indian situation. A major improvement
is that, while in the generic model only the age group of 15-44 years was distinguished (as TARGETS was limited to broad age groups; see Van Vianen et al. 1994), five year age groups are discerned in the Impact Subsystem of the Indian model. Different scenarios are presented in Section 6.
2. THE DEMOGRAPHIC TRANSITION IN INDIA

In this section we discuss the growth of the Indian population during the 20th century, the demographic transition, the components of mortality and fertility transition, and the history of the Indian family planning programme.

2.1 The population of India

At this moment India's population is the second largest in the world, next to China. According to the census taken on 1 March 1991, India's population consisted of 846.3 million people, including Jammu and Kashmir where no census has been conducted: their population was projected to be 7.72 million (Natarajan 1991, p.29) (see Table 2.1). With this, India's share of the world population increased to 16 per cent, implying that every sixth person in the world is an Indian. At the end of March 1994, the population was almost certainly close to 900 million (Visaria and Visaria 1994).

Most Indian people (74 per cent) live in the rural areas. Children in the age group of 0-14 years make up 37 per cent of the population. Most people (82.6 per cent) belong to the Hindu religion, 11.4 per cent are Muslim, 2.4 per cent Christian, 2.0 per cent Sikhs, 0.7 per cent Buddhist and 0.5 per cent Jain (census 1981).

It is expected that in the year 2001 India's population will exceed 1 billion people (see Table 2.2). The Standing Committee of Experts on Population Projections (1988), appointed by the Planning Commission to work out the projections for formulation of the 8th Five Year Plan, and projecting India's population on the basis of fertility and mortality estimates released by the Sample Registration System (SRS) of the Office of the Registrar General, estimated that the population will be around 1,003 million in 2001 and around 1,082 million in 2006. The Committee did not project India's population beyond 2006 (Natarajan 1991).

Natarajan (1993) using census data and vital rates of the SRS, projected that in the year 2001, India's population will be around 1020 million and in 2021 will amount to 1313 million. The author concludes, however, that the possibility that the population will go up to 1400 million by 2021 cannot be ruled out.

<table>
<thead>
<tr>
<th>Year</th>
<th>Population (millions)</th>
<th>Absolute growth (millions)</th>
<th>Decadal growth (%)</th>
<th>Average annual exponential growth rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1891</td>
<td>235.9</td>
<td></td>
<td>1.1</td>
<td>0.11</td>
</tr>
<tr>
<td>1901</td>
<td>238.4</td>
<td>2.5</td>
<td>1.1</td>
<td>0.56</td>
</tr>
<tr>
<td>1911</td>
<td>252.1</td>
<td>13.7</td>
<td>5.7</td>
<td>1.04</td>
</tr>
<tr>
<td>1921</td>
<td>251.3</td>
<td>-0.8</td>
<td>0.3</td>
<td>-0.03</td>
</tr>
<tr>
<td>1931</td>
<td>279.0</td>
<td>27.7</td>
<td>11.0</td>
<td>1.33</td>
</tr>
<tr>
<td>1941</td>
<td>318.7</td>
<td>39.7</td>
<td>14.2</td>
<td>1.25</td>
</tr>
<tr>
<td>1951</td>
<td>361.1</td>
<td>42.4</td>
<td>13.3</td>
<td>1.96</td>
</tr>
<tr>
<td>1961</td>
<td>439.2</td>
<td>78.1</td>
<td>21.5</td>
<td>2.20</td>
</tr>
<tr>
<td>1971</td>
<td>548.2</td>
<td>109.0</td>
<td>24.8</td>
<td>2.20</td>
</tr>
<tr>
<td>1981*</td>
<td>683.3</td>
<td>135.1</td>
<td>24.7</td>
<td>2.20</td>
</tr>
<tr>
<td>1991**</td>
<td>846.3</td>
<td>163.0</td>
<td>23.6</td>
<td>2.14</td>
</tr>
</tbody>
</table>

Source: Registrar General of India, Census.

*Including Assam: population estimated to be 18.04 million
**Including Jammu and Kashmir: population estimated to be 7.72 million
Table 2.2: Projected population (millions) of India, according to different sources

<table>
<thead>
<tr>
<th>Year</th>
<th>Population (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>1,003</td>
</tr>
<tr>
<td>2006</td>
<td>1,082</td>
</tr>
</tbody>
</table>

Source: Standing Committee, Government of India 1988

<table>
<thead>
<tr>
<th>Year</th>
<th>Population (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>846,302</td>
</tr>
<tr>
<td>1996</td>
<td>933,150</td>
</tr>
<tr>
<td>2001</td>
<td>1,020,069</td>
</tr>
<tr>
<td>2006</td>
<td>1,104,345</td>
</tr>
<tr>
<td>2011</td>
<td>1,183,124</td>
</tr>
<tr>
<td>2016</td>
<td>1,253,662</td>
</tr>
<tr>
<td>2021</td>
<td>1,313,813</td>
</tr>
<tr>
<td>2041*</td>
<td>&gt; 1,500</td>
</tr>
</tbody>
</table>

Source: Natarajan 1993
* Registrar General of India 1991

Figure 2.1: Population of India (millions), 1891-1991
Source: Registrar General of India, Census

One of the demographic goals set by the Indian government in successive Five Year Plans (see Section 2.4) is to reach a net reproduction rate (NRR)\(^1\) of 1. In 1980, the Working Group on Population Policy (1980), Planning Commission of the Government of India, projected that if an NRR of 1 was to be reached in the year 2001, the population of India could be stabilised around 1250 million people in the year 2040 (Government of India 1980). However, it is evident now that the goal of NRR=1 will not be reached in the year 2001 and in the Eighth Five Year Plan (1992-1997) the achievement of the demographic goal has been postponed to the year 2011-2016 (see further in Section 2.4).

Natarajan (1991) made a rough projection assuming that an NRR of 1 will be reached in the period 2011-2016 and will remain at that level beyond that period, which indicates that India’s population is likely to exceed 1500 million by the year 2041. Even then, the population will be growing at a rate of 0.5 per cent per annum. This also means that India is likely to outstrip China in the size of its population. Based on the World Bank projections of China’s population, Natarajan expects this to happen in the year 2030 (Natarajan 1991, p.31). Visaria (1991) estimates it will occur in 2050.

United Nations estimates project that India’s population will exceed 1.44 billion by the year 2025 (UN 1993a).

The growth of India’s population since the end of the 19th century is depicted in Table 2.1 and Figure 2.1. At the end of the last century, in 1881, India’s population amounted to about 230 million people. It took about 80 years for India’s population to double (439.2 millions in 1961). It took only 30 years to (almost) double again (Narayana 1990).

At the end of the last century and the beginning of the present one, population growth was low. The period 1911-1921 even showed a negative growth rate due to an influenza epidemic. After 1921 the growth rate increased. The highest annual growth, i.e. 2.2 per cent, took place in the period 1961-1981. Between 1961-1971, 109 million people were added

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\(^1\) The NRR represents the average number of (surviving) daughters which would replace their mothers, assuming that the age and sex-specific fertility and mortality rates for the current period were to continue indefinitely. If the calculated value of NRR is more than 1, the population is increasing in absolute numbers. If it equals 1, the population is stationary and if it is less than 1, the population will ultimately decline.
to the Indian population, and 130 million people between 1971-1981. The latest census indicated that 163 million people were added to the Indian population between 1981-1991, but the growth rate had declined. Recent data from the SRS indicate a further decline in annual growth rate, i.e. 1.9 per cent in 1992.

The growth rate of the population is the difference between the crude birth rate (CBR: number of births per 1,000 population) and the crude death rate (CDR: number of deaths per 1,000 population). The CBR and CDR for India, from 1891 to 1991, are depicted in Table 2.3. The changes in both rates are discussed in the following section on the demographic transition.

### 2.2 The demographic transition in India

In general, the familiar picture presents the demographic transition as tripartite. In the pretransitional stage, both mortality and fertility are high and in approximate equilibrium, thereby generating extremely slow population growth in the long run. Mortality is more irregular and trends are interrupted by ‘mortality crises’. Total fertility can vary appreciably, due to changes in proportions marrying and age at marriage. In the second stage, the time of transition, mortality starts falling while fertility remains high, or even goes up, due to the erosion of old systems of control (Wrigley and Schofield 1981), generating a period of rapid population growth, until after some lag fertility starts declining too. In the third and final stage, the post-transitional stage, the populations that have completed the transition are depicted with low and approximately equal levels of both mortality and fertility and no or little population growth in the long run. Fertility is more irregular, displaying ‘baby booms’ and ‘busts’ while mortality remains more or less unchanged (Van Vianen et al.1994).

These observed empirical regularities constitute the demographic transition. However, the transition did not occur in the same way in every country or

---

**Table 2.3: Crude Birth Rate (CBR) and Crude Death Rate (CDR) in India, 1891-1981**

<table>
<thead>
<tr>
<th>Year</th>
<th>CBR: Births / 1,000 population</th>
<th>CDR: Deaths / 1,000 population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1891-1901</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>1901-11</td>
<td>49</td>
<td>43</td>
</tr>
<tr>
<td>1911-21</td>
<td>49</td>
<td>49</td>
</tr>
<tr>
<td>1921-31</td>
<td>47</td>
<td>37</td>
</tr>
<tr>
<td>1931-41</td>
<td>45</td>
<td>33</td>
</tr>
<tr>
<td>1941-51</td>
<td>43</td>
<td>31</td>
</tr>
<tr>
<td>1951-61</td>
<td>44</td>
<td>26</td>
</tr>
<tr>
<td>1961-71</td>
<td>42</td>
<td>20</td>
</tr>
<tr>
<td>1971-81</td>
<td>37</td>
<td>15</td>
</tr>
</tbody>
</table>

Source: Registrar General of India, Census

**Table 2.3 continued: Crude Birth Rate (CBR) and Crude Death Rate (CDR) for rural and urban areas in India, 1980-1992**

<table>
<thead>
<tr>
<th>Year</th>
<th>CBR Rural</th>
<th>Urban</th>
<th>CDR Combined</th>
<th>Rural</th>
<th>Urban</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980-82</td>
<td>35.4</td>
<td>27.6</td>
<td>33.8</td>
<td>13.6</td>
<td>7.7</td>
<td>12.3</td>
</tr>
<tr>
<td>1981-83</td>
<td>35.4</td>
<td>27.8</td>
<td>33.8</td>
<td>13.3</td>
<td>7.7</td>
<td>12.1</td>
</tr>
<tr>
<td>1982-84</td>
<td>35.3</td>
<td>28.6</td>
<td>33.8</td>
<td>13.3</td>
<td>8.0</td>
<td>12.4</td>
</tr>
<tr>
<td>1983-85</td>
<td>35.0</td>
<td>28.6</td>
<td>33.6</td>
<td>13.3</td>
<td>8.1</td>
<td>12.1</td>
</tr>
<tr>
<td>1984-86</td>
<td>34.6</td>
<td>28.2</td>
<td>33.2</td>
<td>13.0</td>
<td>8.0</td>
<td>11.8</td>
</tr>
<tr>
<td>1985-87</td>
<td>34.1</td>
<td>27.5</td>
<td>32.6</td>
<td>12.4</td>
<td>7.6</td>
<td>11.3</td>
</tr>
<tr>
<td>1986-88</td>
<td>33.6</td>
<td>26.9</td>
<td>32.1</td>
<td>12.0</td>
<td>7.6</td>
<td>11.0</td>
</tr>
<tr>
<td>1987-89</td>
<td>33.0</td>
<td>26.3</td>
<td>31.5</td>
<td>11.7</td>
<td>7.4</td>
<td>10.7</td>
</tr>
<tr>
<td>1988-90</td>
<td>32.3</td>
<td>25.4</td>
<td>30.8</td>
<td>11.2</td>
<td>7.2</td>
<td>10.3</td>
</tr>
<tr>
<td>1989-91</td>
<td>31.6</td>
<td>24.7</td>
<td>30.1</td>
<td>10.7</td>
<td>7.1</td>
<td>9.9</td>
</tr>
<tr>
<td>1992</td>
<td>30.7</td>
<td>23.1</td>
<td>29.0</td>
<td>10.8</td>
<td>7.0</td>
<td>10.0</td>
</tr>
</tbody>
</table>

Source: Registrar General of India, Sample Registration System (SRS)
region. India is commonly classified as one of the ‘late initiators’ of the demographic transition (Roy 1993). Natarajan (1991, p.32) expects that in India “the entire demographic transition starting from 1921 onwards will take about 120 years to complete”, resulting in a total population of more than 1500 million people in the year 2041.

In India, at the end of the last century birth and death rates were both at a high level, around 50 per 1,000. This first stage of the transition lasted until the early 1920s. Irregularities in mortality occurred in the period 1911-1921, when a severe influenza epidemic among the Indian population induced an increase in mortality: between 16 to 20 million people died (Mills 1989). In this first stage of the transition, a purely agrarian economy with hardly any industrial activity existed (Premi 1991, p. 24-26).

The second stage of the transition, i.e. a decline in mortality with fertility remaining high, started from 1921 onwards. Between 1921 and 1931, death rates declined from 49 deaths per 1,000 population to 37 deaths per 1,000 population, while the level of the birth rates remained around 45 births per 1,000 population, thereby inducing higher growth rates. Industrialization took off in this second stage of the transition (Premi 1991, p.26).

From 1951 onwards, mortality declined rapidly, reaching a level of 10 per 1,000 in 1992 (SRS). The birth rates remained high and no decline in CBR occurred up to the mid-1960s. Fertility decline started around 1970 and India entered the third stage of demographic transition (Premi 1991; Natarajan 1991; Chesnais 1992).

While CBR amounted to 42 births per 1,000 population in 1961-1971, it declined to 37 births per 1,000 population in 1971-1981. However, although fertility fell significantly in the early 1970s, from the mid-1970s up to the mid-1980s CBR remained almost unchanged, around 33-34 births per 1,000 population (Chaudhry 1989; Srikantan and Balasubramanian 1989). In the period 1986-92, CBR declined and reached a level of 29.0 births per 1,000 population in 1992 (SRS).

2.3 Components of the demographic transition

We draw a distinction between the components of mortality decline and those regarding the fertility transition.

Mortality transition

As mentioned before, CDR in India started to decline from the 1920s onwards and reached a level of 10 deaths per 1,000 population in 1992. The early reduction in death rates after 1921 was predominantly due to the control of famines and epidemics, like plague and cholera (Visaria and Visaria 1994), higher agricultural production, more efficient procurement and distribution of food grains and international collaboration on disease control (Roy 1993). At present there is a considerable reduction in deaths from gastro-enteric and diarrhoeal diseases due to improvement of supply of safe drinking water and sanitation (Roy 1993).

Some authors, such as Gowariker (1994), expect the CDR to level off to a figure of about 8 deaths per 1,000 population. Roy (1993) expects that a further substantial decline in CDR (from the level of 10 per 1,000) cannot be achieved unless there are concomitant declines in neonatal mortality which constitute 60 per cent of all infant deaths.

Infant mortality

At the beginning of the 20th century, infant mortality amounted to more than 200 deaths per 1,000 live births. It declined to 129 in 1961-1971, and in 1992 it amounted to 79 deaths per 1,000 live births (see Table 2.4). Differences exist between the urban and rural areas. In 1992, infant mortality was 85 deaths
per 1,000 live births in the rural areas, while it was 53 per 1,000 live births in the urban areas. The NFHS of 1992/93 found similar figures, but slightly higher values for the urban areas (combined: 78.5; rural: 85.0; urban: 56.1 deaths per 1,000 live births). This all-India survey reported the following levels of infant mortality according to level of education: for illiterate women 100.6 per 1,000 live births, for women with primary education 62.5 per 1,000 live births, for women with middle education 56.1 per 1,000 live births and for women with at least high school 3.2 per 1,000 live births.

**Life expectancy at birth**

The decline of mortality from the 1920s onwards was also reflected in the increase of life expectancy at birth (Table 2.5).

In the period 1900 - 1991, male life expectancy at birth rose from 22.6 years to 58.1 years. Female life expectancy at birth in the same period increased from 23.3 years to 59.1 years. Natarajan (1993) expects that life expectancy between 2016-2021

---

**Table 2.4: Infant mortality in India, 1900-1971**

<table>
<thead>
<tr>
<th>Year</th>
<th>Infant deaths per 1,000 live births</th>
</tr>
</thead>
<tbody>
<tr>
<td>1911-15</td>
<td>204</td>
</tr>
<tr>
<td>1916-20</td>
<td>219</td>
</tr>
<tr>
<td>1921-25</td>
<td>174</td>
</tr>
<tr>
<td>1926-30</td>
<td>178</td>
</tr>
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<td>1931-35</td>
<td>174</td>
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<td>1936-40</td>
<td>161</td>
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<td>1946-50</td>
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</tr>
<tr>
<td>1951-55</td>
<td>146</td>
</tr>
<tr>
<td>1961-65</td>
<td>129</td>
</tr>
</tbody>
</table>

Source: Centre for Monitoring Indian Economy (CMIE) 1988

**Table 2.4 continued: Infant mortality in India, 1971-1992**

<table>
<thead>
<tr>
<th>Year</th>
<th>Rural</th>
<th>Urban</th>
<th>Combined</th>
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</thead>
<tbody>
<tr>
<td>1971</td>
<td>138</td>
<td>82</td>
<td>129</td>
</tr>
<tr>
<td>1972</td>
<td>150</td>
<td>85</td>
<td>139</td>
</tr>
<tr>
<td>1973</td>
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<td>87</td>
<td>53</td>
<td>80</td>
</tr>
<tr>
<td>1992</td>
<td>85</td>
<td>53</td>
<td>79</td>
</tr>
</tbody>
</table>

Source: Registrar General of India, Sample Registration System (SRS)

**Table 2.5: Life expectancy (years) in India, 1901-1991 and projected life expectancy**

<table>
<thead>
<tr>
<th>Year</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>1901-10</td>
<td>22.6</td>
<td>23.3</td>
</tr>
<tr>
<td>1911-20</td>
<td>19.4</td>
<td>20.9</td>
</tr>
<tr>
<td>1921-30</td>
<td>26.9</td>
<td>26.6</td>
</tr>
<tr>
<td>1931-40</td>
<td>32.1</td>
<td>31.4</td>
</tr>
<tr>
<td>1941-50</td>
<td>32.4</td>
<td>31.7</td>
</tr>
<tr>
<td>1951-60</td>
<td>41.9</td>
<td>40.6</td>
</tr>
<tr>
<td>1961-70</td>
<td>46.4</td>
<td>44.7</td>
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<td>1970-75</td>
<td>50.5</td>
<td>49.0</td>
</tr>
<tr>
<td>1976-80</td>
<td>52.5</td>
<td>52.1</td>
</tr>
<tr>
<td>1981-85</td>
<td>55.4</td>
<td>55.7</td>
</tr>
<tr>
<td>1986-91</td>
<td>58.1</td>
<td>59.1</td>
</tr>
<tr>
<td>1991-1996*</td>
<td>59.1</td>
<td>60.2</td>
</tr>
<tr>
<td>1996-2001</td>
<td>61.0</td>
<td>62.4</td>
</tr>
<tr>
<td>2001-2006</td>
<td>62.9</td>
<td>64.2</td>
</tr>
<tr>
<td>2006-2011</td>
<td>64.7</td>
<td>65.7</td>
</tr>
<tr>
<td>2011-2016</td>
<td>66.4</td>
<td>67.3</td>
</tr>
<tr>
<td>2016-2021</td>
<td>68.1</td>
<td>68.7</td>
</tr>
</tbody>
</table>


* Natarajan 1993
will increase to 68.1 years for males and 68.7 years for females. The difference in life expectancy between men and women is remarkable. For a long time Indian men had a higher life expectancy than Indian women. The trend reversed only since the 1980s.

Sex ratio

This unfavourable mortality pattern for Indian women is indicated by the sex ratio (number of females per 1,000 males) (see Table 2.6). While in 1901 the sex ratio amounted to 972 females per 1,000 males, in the following decades the sex ratio steadily declined to a level of 930 in 1971. Data from the census of 1981 indicated an increase in the sex ratio (934 females per 1,000 males), but the census of 1991 again revealed a lower overall sex ratio of 927 women per 1,000 men. In the 1991 census there appeared to be 32 million fewer women than men (Visaria and Visaria 1994). The low sex ratio, indicating a higher mortality among women, reflects the low status of women in Indian society (see Section 3.5).

Fertility transition

At the beginning of the 20th century Indian birth rates remained high; no decline in CBR took place up to the mid-1960s. Although fertility fell significantly in the early 1970s, fertility decline stalled from the mid-1970s up to the mid-1980s (Chaudhry 1989; Srikantan and Balasubramanian 1989). From the mid-1980s onwards CBR slowly declined, reaching a level of 29.0 births per 1,000 population in 1992.

In regard to the stagnation of CBR between the mid-1970s and mid-1980s, Srikantan and Balasubramanian (1989) estimated the relative importance of four components i.e. age structure, marital status, marital fertility and the proportion of women in the reproductive ages (15-49) in the decline in the birth rate between 1961-1971 and 1971-1981 respectively. The authors stated that the increase in the proportion of women of reproductive age was unfavourable to a decline in CBR and they expected this to continue until the end of this century. They concluded that, to offset these positive effects on birth rates, contraceptive prevalence has to be enhanced substantially (Srikantan and Balasubramanian 1989, p.78).

Another explanation given for the stagnation of fertility between the 1970s and 1980s is an increase in natural fertility (i.e. fertility in the absence of parity dependent, deliberate fertility control) which counteracts the reducing effects of contraceptives (Srinivasan 1989; Chaudhry 1989;1990).

Natural fertility

The concept of natural fertility was developed by the French demographer Henry in the 1950s (Henry 1961) to highlight the key role of breastfeeding and postpartum abstinence in lengthening birth intervals and reducing the rate of reproduction.

In India before 1962, when virtually no deliberate birth control existed, it is believed that the rural areas were to be close to the natural fertility levels. A selected number of surveys (summarized by Srinivasan 1989, p.174), conducted in several regions of India prior to 1962, indicated a level of natural marital fertility\(^2\) ranging from 4.75 to 7.22, the average amounting to 5.5. This average is substantially lower than the one found in Europe by Henry (1961) for 13 populations: i.e. 8.4 (9.12 if only European countries are included). As Srinivasan (1989, p.174) concluded “the Indian total marital fertility rate, in the absence of contraception, is only 60 per cent of the average found by Henry”. Also, the age pattern of Indian fertility appears to be different from the European. In the age group of 20-24, the Indian average marital fertility rate is 66 per cent of European fertility; in the age group 35-39 and

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\(^2\) That however feels that these figures are too low.
40-44 this is 52 per cent and 37 per cent, respectively. Thus, Indian women seem to have completed their child-bearing earlier, probably by resorting to terminal abstinence based on customs like the grandmother complex (Srinivasan 1989, p.175), which is a traditional belief that women or couples should not have children after their grandchildren are born.

In the first stages of modernisation, total fertility might rise due to an increase in natural fertility. The increase in natural fertility is due to a decline of its major determinants, i.e. duration of breastfeeding and postpartum abstinence, which counteracts the fertility-inhibiting effects of a higher age at marriage and a higher level of contraceptive use. Srinivasan and Jejeebhoy (1981) reported that in the period 1959-1972, such a rise of natural fertility occurred in eight of the eleven states (except Kerala, Punjab and Orissa). However, Mari Bhat (1989, p.98) firmly believed that the rise may be due to changes in the completeness of survey birth reports. He questioned the reliability of data in the NSS survey (1960s) and of data collected during the initial stage of the SRS (beginning of the 1970s). Possible underestimates of the SRS in the initial stage and the effects on actual fertility level were also discussed by Visaria and Visaria (1994).

The fertility increasing effects of decline of breastfeeding and postpartum abstinence due to modernization are well-known. In India, new born children are almost unanimously breastfed, and generally for a long period thereby inducing a relatively long duration of postpartum amenorrhea. Rules regarding postpartum abstinence exist too. They are reinforced by the custom of ‘sending’ pregnant women to their own parents’ home in order to deliver and to rest for some months after delivery (see Section 3.4).

Indian studies (see for example Nag 1982; Chaudhry 1990), however, also mention other cultural customs, affected by modernisation and related to fertility. One of these factors is the traditional ban on widow remarriages. Bhat and Kanbargi (1984) state that this custom is indeed prevalent, especially in the higher caste groups, but that remarriage of widows is far more common than is often thought. Based on data from the census of 1971, the authors estimated that one third of ever widowed women, i.e. 12 million, were currently remarried. For comparison, nearly two-thirds of the ever widowed men were remarried. Given the fact that the proportion of remarried widows was considerably higher in the reproductive ages, widow remarriage was found to have a considerable effect on fertility. The authors concluded that widowhood would have reduced total fertility from 6.01 to 5.37 in the absence of remarriage. However, 61 per cent of this loss is regained by remarriage of widows (Bhat and Kanbargi 1984, p.100).

Also, with modernization, traditional rules regarding sexual abstinence might soften. Besides postpartum abstinence, several rules exist in Indian society regarding terminal abstinence and abstinence during religious days or inauspicious days.

Chaudhry (1990) concludes that “over the next two decades, it is likely that modernization will relax the ban on remarriage of widows, increase the proportions married, continue to erode practices associated with postpartum infecundability and soften the forces responsible for low coital frequency. Thus, fertility-enhancing factors will become more dominant than those curtailing fertility and the average annual increase in the percentage of couples protected by contraception will have to increase at a rate significantly higher than that recorded in the period 1981-1986 (2.7 per cent) to avert a rapid upswing in the crude birth rate”.

Total fertility

Total fertility (TFR) figures during the period 1900-1992 are depicted in Table 2.7. TFR amounted to an estimated 5.77 in the period 1901-1911 and remained around this level of 5 to 6 up to the 1970s (Bhat 1989, p.100). TFR then started to decline and stabilized around the 4.5 level from the late 1970s to the mid-1980s. From the mid-1980s onwards, TFR seems to have declined more rapidly, reaching a level of 3.6 in 1992 (rural areas 3.9, urban areas 2.6) (SRS).

The latest figures indicate a rapid fertility decline. TFR declined by roughly 40 per cent from 6.0 in 1966 to 3.6 in 1991, which means that for all-India nearly 58 per cent of the lowering of fertility required to reach the replacement level has been achieved. In the urban areas, 82 per cent of the path to be traversed to reach replacement level has been crossed, while the rural areas are only half way (Visaria and Visaria 1994, pp.3284-3285).
Table 2.7: Estimates of total fertility (TFR) in India, 1881-1986

<table>
<thead>
<tr>
<th>Year</th>
<th>Total fertility</th>
</tr>
</thead>
<tbody>
<tr>
<td>1881-1891</td>
<td>5.81</td>
</tr>
<tr>
<td>1891-1901</td>
<td>5.78</td>
</tr>
<tr>
<td>1901-1911</td>
<td>5.77</td>
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<tr>
<td>1911-1921</td>
<td>5.75</td>
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<tr>
<td>1921-1931</td>
<td>5.86</td>
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<td>1931-1941</td>
<td>5.98</td>
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<tr>
<td>1941-1951</td>
<td>5.96</td>
</tr>
<tr>
<td>1951-1961</td>
<td>6.11</td>
</tr>
</tbody>
</table>

Source: Registrar General of India, Census, estimates by Bhat 1989, p.100

Bhat (1994;1995), based on his fertility analysis of the 1991 census, also concludes that “the demographic scenario revealed by the 1991 census is one of dynamism rather than stagnation of levels” and “cumulative evidence ... strongly suggests that fertility is on a rapid downward course in India and the decline is much more widespread than is commonly believed”. His analysis at the district level shows that “fertility decline is sweeping across the coast and moving towards the interior, like the Indian monsoon, but has yet to penetrate the central plateau which displays birth rates not very different from North India” (Bhat 1995, p.15,23).

The outcomes of the National Family and Health Survey (NFHS) of 1992/93, indicate similar fertility levels. For all-India a TFR of 3.4 was found, with 2.7 for urban areas and 3.7 for rural areas. Some states appeared to have reached fertility below replacement level: Kerala (1.77), Goa (1.8) and Himachal Pradesh (2.01). Another South Indian state, Tamil Nadu, nearly reached this level with a TFR of 2.38. The NFHS reports the following levels of total fertility according to the level of education: for illiterate women 4.03, for women with primary education 3.01, for women with middle education 2.49 and for women with at least high school 2.15.

Several studies have estimated the timing at which the replacement level will be reached for all-India. The Expert Committee, constituted by the Planning Commission of the Government of India and initially setting a goal of achieving an NRR of one in the year 2001, now expects that the Indian population will reach replacement level in the period 2011-2016 (Planning Commission of India 1992; Eight Five Year Plan 1992-1997). The World Bank (Bos et al. 1992) and the UN (1993a) assume that India will reach replacement level five years later, i.e. in 2016-2021. Bhat (1994) estimates that India will reach replacement level around the year 2015. His estimates are based on the results of the census of 1991 and the assumption that TFR will decline in future as it did during the last decade, i.e. by 0.8 births per decade.

However, even if all young Indians now decide not to have more than two children, the population would continue to grow for the next 60-70 years due to the large proportion of women of reproductive age (Visaria and Visaria 1994). In 1961, 42 per cent of the population was younger than 15 years; in 1981 it was 38 per cent and in 1991 it still amounted to 37 per cent. Visaria and Visaria (1994) conclude that if India wants to restrict its population to below 1.6 billion, a sizeable proportion of Indians will have to limit their family to just one child.

Table 2.7 continued: Total fertility (TFR) in India, 1972-1992

<table>
<thead>
<tr>
<th>Year</th>
<th>Rural</th>
<th>Urban</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972</td>
<td>5.4</td>
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</tr>
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<tr>
<td>1992</td>
<td>3.9</td>
<td>2.6</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Source: Registrar General of India, Sample Registration System (SRS)
2.4 The history of the Indian family planning programme

In 1951, India formulated a formal and explicit population policy which has been developed into an extensive programme of family planning. Before the 1950s, the population problem was recognized by a few individuals, who formulated small scale programmes to deal with the problem (see Raina 1994, pp.19-24).

In the First Five Year Plan (1951-1956), the government of India sought to reduce the birth rate “to the extent necessary to stabilize the population at a level consistent with the requirements of the national economy”. Demographic goals were set from the Fourth Five Year Plan (1969-1974) onwards. While the Fourth Plan aimed at a reduction of the birth rate from 39 to 25 births per 1,000 within the next 10-12 years, the Sixth Five Year Plan (1978-1983) stated that “all resources of the country need to be harnessed towards a net reproduction rate (NRR) of one by the year 1996”.

In the National Health Policy of 1983, taking into account the results of the census of 1981, this goal of a net reproduction rate of unity was postponed to the year 2000. A NRR of unity implies the following levels of demographic parameters: a CBR of 21 births per 1,000 population, a CDR of 9.0 deaths per 1,000 population, an infant mortality of 60 deaths per 1,000 live births and a Couple Protection Rate of 60 per cent (Ministry of Health and Family Welfare 1991).

Recent demographic figures indicate still higher levels for all figures, except the CDR which in 1992 was 10 deaths per 1,000 population. However, in 1992 CBR was still 29 births per 1,000 population, infant mortality amounted to 79 deaths per 1,000 live births and the CPR was around 40 per cent. In the Seventh Five Year Plan (1985-1990), the demographic goal of NRR of unity was further postponed to the year 2006-2011, and in the recent Eighth Five Year Plan (1992-1997) to 2011-2016.

The First Five Year Plan stated that “The main appeal for family planning is based on considerations of health and welfare of the family. Family limitation or spacing of children is necessary and desirable in order to secure better health for mother and better care and upbringing of children. Measures directed to this end, should therefore form part of the public health programme” (cited by Raina 1994, p.31). In reality, however, throughout the years family planning became a synonym for family limitation, i.e. sterilization.

The family planning approach in the period 1952-1960, i.e. the first two Five Year Plans, is often classified as a ‘clinical approach’. A modest level of family planning services was available in the hospitals and clinics. Raina (1994), however, does not completely agree with this characterization, as extension and education were also included in the programme. During the early fifties, condoms and diaphragms, creams and jellies were the main birth control methods in the programme. Sterilization was not included during these first years. Only from 1960 onwards did the government start to support sterilizations too (Raina 1994, p.28-29).

The years 1962-63 formed an important landmark in the Indian family planning programme (Raina 1994, p.39). The program adopted an ‘extension approach’. The Reorganised Family Planning Programme, sanctioned by the Government of India in 1963, focused on “assisting people to discover their own needs (and) creating situations in which people make decisions...” (cited by Raina 1994, p.39). People’s participation was considered to be essential, as is evident from the following statement in the re-organised programme: “early success in the family planning programme is possible if it becomes really a people’s programme...” (cited by Raina 1994, p.40). Moreover, it was recognized that reproductive behaviour is conditioned by social, economic and cultural factors: not only age, sex, education and income of potential acceptors should be taken into account but also the social relationships within the family and community (Raina 1994, p.39-41).

In the Third Five Year Plan (1961-1966) these major principles of the re-organised programme were included: it emphasized the linkages between population and social policies like raising the age of marriage, education of women and improvement of employment opportunities (Raina 1994, p.34). The IUD was introduced for the first time in 1965, but was not much of a success due to the high expulsion rates of the Lippes loop used (Copper-T was introduced later on).

In practice, the ideas of the extension approach gradually faded and the programme slowly developed into a target oriented approach (Raina 1994, p.47). After an extensive review of the Indian family planning programme, Raina concludes that “It seems that the extension approach appeared illusive to some policy makers, as it did not promise immediate quantifiable results. The target approach...
was readily understood ...”. The Fourth Five Year Plan (1969-1974), as was mentioned before, set demographic goals for the first time.

In 1969, a separate department for Family Planning was established in the Ministry of Health and Family Planning (Khan and Prasad 1985; Raina 1994). In the same period, the two-child norm and the Red Triangle as the symbol of family planning were introduced. The Meerut study in 1969 demonstrated the usefulness of condoms for population control, if they were subsidized and made available at a price affordable for the common people. A marketing executive was appointed in the Family Planning Department and Hindustan Latex Ltd. started manufacturing of condoms (Nirodh: literally meaning ‘prevention’) for the Indian market (Raina 1994, p.29).

In the early seventies, the programme approach was characterized as ‘service delivery’: tubectomies and vasectomies were the main methods used and the camp approach was adopted (Chaudhry 1989; Premi 1991; Raina 1994). In December 1970 and July 1971, for example, mass sterilization camps were organized in Ernakulam in Kerala under the leadership of S. Krishna Kumar and over 60,000 people were sterilized (see Section 4). This example was followed in many other places, although not all were as successful as the one in Kerala.

A new dimension was added to the programme in 1973: incentives for acceptors, motivators and programme personnel. Targets were set for personnel working in the family planning programme, i.e. they had to attain a certain number of sterilizations (Raina 1994, p.30).

The preoccupation with sterilization targets, resulting in excesses and forced sterilizations, evoked the Indian people’s disenchantment with the programme during the Emergency in 1975-1977. It had severe political consequences for the Congress Party: after the elections of 1977 Indira Gandhi was turned out of office (Kocher 1980; Premi 1991; Banerji 1989; Brown 1984; Raina 1994).

After 1977, the new government -formed by the Janata Party- ruled out the idea of coercion or forced family planning. The programme was renamed the family welfare programme (Kocher 1980; Banerji 1989). More emphasis was put on overall development issues, on enforcement of a minimum age at marriage, changes in the educational system, and creating awareness of the population problem (Premi 1991; Banerji 1989). Tubectomy remained the most widely used method, while by 1977, contraceptive pills were also made available (Raina 1994).

The approach in the late 1970s and 1980s can be characterized as the ‘integrated’ approach (Chaudhry 1989). The Congress Party came back into power in 1980. The 1981-1985 Sixth Five Year Plan emphasized that family planning should be interwoven with development programmes, especially with health, maternal and child care and nutrition (Raina 1994, p.51). The National Health Policy, adopted in 1983 and setting long term demographics goals (see above), was strongly influenced by the Primary Health Care concept as defined at the Alma Ata conference regarding ‘Health for all in the year 2000’.

In the Seventh Five Year Plan (1985-1990) the government of India expressed the desire “to formulate the family welfare as multidisciplinary and integrate efforts of all relevant development agencies, and to elevate the programme into a genuine voluntary people’s programme” (Raina 1994, p.51). The role of Mahila Mandals (women groups), youth clubs, and village health committees were considered to be essential. More emphasis was put on the use of spacing methods like the pill, condoms (Nirodh), and IUD.

However, it was increasingly realized that “despite the massive efforts ..., the reduction in the rate of population growth had substantially fallen short of expectation (Government of India 1987; cited by Banerji 1989, p.51). Priority was given to “reaching the targets” and as Bose concludes in several of his articles “relying on figures on targets or achievements ... will not lead us anywhere” (Bose 1988; cited by Banerji 1989; Bose 1989).

Although from the First Five Year Plan onwards the importance and desirability of the spacing of children were emphasized in order to secure better health for mother and better care and upbringing of children, in reality family planning became a synonym for sterilization. Since its inception the Department of Family Welfare has disproportionately relied on sterilization as a method of contraception. Although the IUD was introduced in 1965, social marketing of condoms was propagated in 1967 and the pill was introduced from 1977 onwards, the actual use of these spacing methods was limited. The National Family and Health Survey (NFHS) of 1992/93 indicates that only 6 per cent of the currently married women used
any modern spacing method while 30.7 per cent of the couples were sterilized. Since sterilization is a non-reversible method, it is only relevant to couples who want to terminate child-bearing, which is usually not before at least three children are borne. India’s awareness raising approach has focused on the ‘two is best’ family norm, but the average desired family size is three children, i.e. two sons and one daughter (see Section 3.5). Son preference plays an important role: couples continue childbearing until they at least have one son. Indeed, the mean age of adopters at the time of vasectomy and tubectomy was found to be 31.8 and 30.3 years respectively (Banerji 1989, p.52) and the mean number of living children at the time of adoption 3.3 and 3.5 respectively (Ministry of Health and Family Welfare 1991). It now is increasingly realised that “the programme has not made any significant contribution in bringing into its fold the younger couples in the age group of 15-30 years who have higher fertility potential (Ministry of Health and Family Welfare 1991).

It also is realised that the programme failed in becoming a people’s movement (Ministry of Health and Family Welfare 1991). In the early 1960s, within the ‘extension approach’, participation of the people was considered to be essential; in practice, however, the ideas of the extension approach gradually faded and the programme slowly developed into a target oriented approach (Raina 1994, p.47).

Finally, the quality of services and accessibility of services of family welfare are reported to be poor (Ministry of Health and Family Welfare 1991). Banerji (1989) concludes that organization and management of the national programme has not changed much and states that “during the last ten years there has been a steep decline in the quality of the family planning and public health practice”. Family welfare programmes operate through different institutions and health care personnel. In 1974, the Multi-purpose Workers Scheme was launched with the objective of establishing a health delivery system in the rural areas through a team of multi-purpose workers, one male and one female for every population of 5,000 (Ministry of Health and Family Welfare 1991). In the Fifth Five Year Plan (1978-1983), under the concept of the Minimum Needs Programme (MNP), Sub-Centres, Primary Health Centres and Community Health Centre were established. A Sub-Centre, the first level where one male and one female health worker provide services, is expected to cater about 5,000 population covering about four to five villages. A Primary Health Care (PHC) Centre covers a population of 30,000, and a Community Health Centres a lakh (100,000) of people. Moreover, there is one health guide for 1,000 rural population (or for every village) and one trained dai for every village (Ministry of Health and Family Welfare 1991). In urban areas, family welfare services are also provided through family welfare clinics, postpartum centres and hospitals (Khan 1992).

The several drawbacks of the programme are tackled in the recent Action Plan for revamping the Family Welfare programme in India from the Ministry of Health and Family Welfare (1992) and in the Eighth Five Year Plan (1992-1997). The latter first of all emphasizes that the programme “must generate a cascading effect to become a peoples’ movement”.

**Becoming a people’s movement and the role of NGOs**

In order to strengthen community participation, a Scheme on Mahila Swasthya Sanghs (MSS) was established in the beginning of the nineties. These are women’s groups in villages having 1,000 or more population to help them to solve problems related to women and child health and to make them self-reliant. Each MSS consists of 15 persons, some of them selected from special communities like Scheduled Caste (SC), Scheduled Tribe (ST) or backwards classes (Ministry of Health and Family Welfare 1991). An important role is reserved for NGOs. As the Action Plan states: “the voluntary sector and NGOs can not only supplement the family welfare services provided by the government but also it is expected that they would have a better understanding of how to bridge the communication gap with the people and take the message of small family and maternal and child health in the language they understand” (Ministry of Health and Family Welfare, 1992 p.123).

Some examples of NGOs that successfully worked on family welfare programmes, reviewed by Khan (1990), are the Family Planning Association of India (FPAI), one of the pioneers in the field of family welfare and founded in 1949, and Parivar Seva Sanstha, earlier known as the Marie Stopes Society.

**Disregard targets**

The Action Plan emphasizes that “we should get rid of the ‘tyranny of targets’ all together” (Ministry of Health and Family Welfare, 1992 p.118) and wants
to set aside the incentives to Government personnel and family planning motivators and abolish the States Award Scheme which induced falsification of figures and unhealthy competition. In stead, a focus on social security measures is considered for individuals adopting a small family norm. Recently, however, targets for spacing methods were also introduced of which the achievements are heavily over-reported. Even the poor performing states of Uttar Pradesh, Bihar and Madhya Pradesh show a 100 per cent achievement of targets of IUD, pill and condoms (Khan 1992, p.64-65).

Focus on younger couples and temporary methods

Both the Action Plan and the Eighth Five Year Plan emphasize the need to focus on younger couples with greater fertility potential under spacing methods. The use of IUD, the oral pill and condoms will be propagated, mainly through social marketing while the free distribution schemes will be gradually curtailed and only adopted in areas where they are really needed.

Condoms are provided within the family welfare programme within two schemes: the free distribution scheme and the social marketing scheme (see also above). Under the first one, Nirodh condoms are made available free of charge through the PHC Centres and the Sub-Centres and through hospitals, dispensaries etc. Under the social marketing scheme, Nirodh is sold at a highly subsidized price. Other NGOs, like Parivar Seva Sanstha and Population Services International, market condoms under their own brand name (Bliss, Sawan, Masti) (Ministry of Health and Family Welfare 1991). The pill was made available (Raina 1994, p.31) by 1977. Under the name Mala-N, oral pills are made available through the Primary Health Centres and Sub-Centres. In a social marketing scheme in 1987, pills were distributed under the name Mala-D (Ministry of Health and Family Welfare 1991). NGOs like the Parivar Seva Sanstha have a social marketing scheme to distribute their own pill under the name Ecroz (literally: ‘each day one’).

Recently, more research has been conducted on alternative family planning methods like Norplant (a subdermal implant) and contraceptive vaccines. Experiments are being conducted, although the discussion about eventual physical drawbacks has not yet been finalized (see e.g. Talwar et al. 1993; Newton 1993).


Improvement of services

Furthermore, the Action Plan wants to improve the family planning services. Taking the diversity of the country into account, 90 Districts experiencing high fertility are to receive special attention. Information, Education and Communication (IEC) activities are also reported to need revitalisation.
3. THE FERTILITY PROCESS: A QUALITATIVE OVERVIEW

The fertility dynamics at the population level is the consequence of childbearing by individual women. The potential reproductive years start at menarche, the first menstruation in a woman’s life. Socially sanctioned childbearing in India takes place within marriage. Consummation of marriage may in practice be taken as the starting point of the reproductive years. Once marriage is consummated, a woman may be considered to be at risk of childbearing until the onset of permanent sterility or menopause, unless a marital disruption intervenes (Bongaarts and Potter, 1983).

In general, Indian women start and complete childbearing at an early age. In 1981, for the whole of India, mean age of women at birth of the first child was 21.6 years and the mean age at birth of the last child 35.6 years. Differences exist within India. Women in Kerala give birth for the first time at a later age (23.1 years) and stop reproduction at an earlier age (32.1 years). In Uttar Pradesh, women get their first child earlier (20.8 years) and their last child later (37.7 years) (Ram and Pathak 1989, p. 349).

The average length of the interval between two births is determined by the period of postpartum infecundability, waiting time to conception and the nine months of pregnancy. Intrauterine mortality, either spontaneous abortion, stillbirth or induced abortion, can prolong the length of birth interval. Postpartum infecundability is determined by the biological postpartum infecundable period (at least 1.5 months), by postpartum amenorrhea due to breastfeeding, and by postpartum abstinence. During the waiting time to conception, the probability of conception depends on the probability of coitus in the fertile period, which is approximated by the frequency of sexual intercourse, and the level and effectiveness of contraceptive use. While married and fecund, women reproduce at a rate inversely related to the average duration of the birth interval (Bongaarts and Potter 1983).

Biologically, potential fertility is about 15.3 children per woman with minor variations between human subpopulations. No population has even come close to this theoretical level of fertility.

The factors that directly affect fertility are called intermediate fertility variables (Davis and Blake 1956) or proximate determinants of fertility (Bongaarts and Potter 1983). Proximate determinants are defined as “the biological and behavioural factors through which social, economic and environmental variables affect fertility. The principle characteristic of a proximate determinant is its direct influence on fertility” (Bongaarts and Potter 1983, p.1-2).

Of the proximate determinants distinguished, four turn out to be most important: marriage, contraceptive use, induced abortion and postpartum infecundability (Bongaarts and Potter 1983). The other three, playing a minor role, are onset of permanent sterility, natural fecundability or frequency of intercourse and spontaneous intrauterine mortality.

Each of them has a direct effect on fertility and together they determine the level of fertility. The first proximate determinant, marriage, refers to the extent to which women are exposed to regular intercourse. The proximate determinants ‘use and effectiveness of contraception’ and ‘induced abortion’ measure the prevalence of deliberate marital fertility control while the others are the determinants of natural marital fertility. Postpartum infecundability refers to postpartum amenorrhea induced by breastfeeding and to postpartum abstinence.

In the following sections, we discuss the values of the proximate determinants and the relevant socio-economic variables in the Indian situation. Time paths for the period 1900-1995 are provided (if data are available). The information provided in this section will be implemented in the India fertility model presented in Section 5.

3.1 Marriage

In India, marriage is early and universal (Chaudhry 1990; Srinivasan 1991). Mean age at marriage of Indian women increased throughout the 20th century from 13.1 to 18.4 years (Table 3.1).

The data, and especially those of the beginning of the century, are difficult to interpret. It is unclear whether they reflect the real age at marriage. Low averages might be due to the inclusion of child marriages. When marriage is performed in early childhood cohabitation is usually delayed to a second ceremony (gauna), which usually happens
Table 3.1: Mean age at marriage (years) for Indian women, 1901-1981

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean age at marriage (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1901</td>
<td>13.1</td>
</tr>
<tr>
<td>1911</td>
<td>13.2</td>
</tr>
<tr>
<td>1921</td>
<td>13.4</td>
</tr>
<tr>
<td>1931</td>
<td>12.7</td>
</tr>
<tr>
<td>1941</td>
<td>14.7</td>
</tr>
<tr>
<td>1951</td>
<td>15.6</td>
</tr>
<tr>
<td>1961</td>
<td>16.1</td>
</tr>
<tr>
<td>1971</td>
<td>17.2</td>
</tr>
<tr>
<td>1981</td>
<td>18.4</td>
</tr>
</tbody>
</table>


only after the girl has reached maturity (Srinivasan 1991; Hutter 1994). In that case the actual mean age at marriage, i.e. the actual age at cohabitation, is higher. Many studies therefore, and also the Sample Registration System, distinguish age at effective marriage, which for females in 1991 amounted to 19.5 years. In general, as became evident during the workshop in Kerala, mean age at effective marriage is one year higher than the ‘common’ mean age at marriage.

The Child Marriage Restraint Act, popularly called the Sharda Act, of 1929 specified a minimum age for girls of 14 years and for boys of 15 years. In spite of this legislation and wide publicity, child marriages continued to be practised, especially in the northern states (Srinivasan 1991, p.50). In South India too, child marriages are still practised: mostly these marriages are cross-cousin or maternal uncle-niece marriages (Hutter 1994).

Furthermore, the data indicate that the mean age at marriage increased considerably between 1971-1981, from 17.2 to 18.4 years. This might be due to a real increase but might also partly reflect the fact that in 1978 Parliament adopted the Minimum Age at Marriage Act, stipulating a minimum age at marriage for girls of 18 years and for boys of 21 years (see also Srinivasan 1991).

Data on age specific proportions of currently married women for the period 1961-1991 indicate the same trend of increasing age at marriage (Table 3.2). While in 1961 the proportion married women in the age group of 15-19 years was 70 per cent and in 1981 it was 44 per cent, in 1991 it was only 31.3 per cent (note that data before 1991 are derived from the census and for 1991 from the SRS -as data from the 1991 census were not yet available). In 1991, in the age group 45-49 years more women were married (83.6 per cent) than in 1961 (70 per cent). This reflects lower levels of mortality but also might be an indication of the softening of the traditional ban on widow remarriages (see above).

Age-specific marital fertility rates for 1961-1991 are indicated in Table 3.3. Figure 3.1 also shows that in 1961 and 1971 the pattern of marital fertility remained more or less the same, most births occurring in the age group of 20-29 years. In 1981, fertility in the higher age groups showed the same pattern as before but at a lower level, while in 1991

Table 3.2: Age specific proportions of currently married women in the age group of 15-49 years, 1961-1991

<table>
<thead>
<tr>
<th>Age groups (years)</th>
<th>Proportion married (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-19</td>
<td>69.6</td>
</tr>
<tr>
<td>20-24</td>
<td>91.8</td>
</tr>
<tr>
<td>25-29</td>
<td>94.7</td>
</tr>
<tr>
<td>30-34</td>
<td>91.4</td>
</tr>
<tr>
<td>35-39</td>
<td>87.0</td>
</tr>
<tr>
<td>40-44</td>
<td>77.7</td>
</tr>
<tr>
<td>45-49</td>
<td>69.7</td>
</tr>
</tbody>
</table>

Source: 1961-1981: Registrar General of India, Census
         1991: Registrar General of India, Sample Registration System (SRS)
childbearing among women in the older age groups declined even more sharply, the peak of childbearing shifting to the 20-24 year age group.

Generally, mean age at marriage is related to development, especially education and particularly education when combined with economic activity of women in the formal sector (Van Vianen et al. 1994). Vaiyananathan (1989), using both macro-data regarding different Indian states as well as data from household surveys and fieldwork, showed a strong statistical relationship between age of marriage, education of women and women’s work participation, particularly in non-agricultural activities. Based on data from the 1981 census, Audinarayna (1985) found that 86 per cent of the variance in the mean age at marriage of females was explained by the proportion of effective female literates, females in the labour force and females in urban areas. Table 3.4 indicates mean age at marriage for Indian women according to their educational level, for the years 1971 and 1981 (based on the census). The mean age at marriage of rural women was 15.4 years in 1971 and 16.5 years in 1981. For urban women this was 16.8 years and 17.6 years, respectively. The differences between the educational classes are obvious, although the gap narrowed down in 1981. In 1971, rural illiterate women had a mean age at marriage of 15.2 years while graduate women married at the age of 21.2 years. In the urban areas these averages were 16.2 years and 21.9 years, respectively. In 1981, mean age at marriage of lower educated women definitely increased, while the mean age hardly changed among women in the two highest educational classes.

The NFHS of 1992/93 reports the following median age at marriage for females (age group 25-49 years) according to the level of education: for illiterate women 15.0 years, for women with primary
Table 3.4: Mean age at marriage (years) of currently married women, for rural and urban areas, by educational level, 1971-1981

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Illiterate</td>
<td>15.2</td>
<td>16.3</td>
<td>16.2</td>
<td>16.7</td>
</tr>
<tr>
<td>Literate but below middle</td>
<td>16.5</td>
<td>17.1</td>
<td>17.2</td>
<td>17.4</td>
</tr>
<tr>
<td>Middle but below matric</td>
<td>16.5</td>
<td>17.8</td>
<td>17.2</td>
<td>18.1</td>
</tr>
<tr>
<td>Matric but below graduate</td>
<td>19.3</td>
<td>19.3</td>
<td>19.8</td>
<td>19.8</td>
</tr>
<tr>
<td>Graduate and above</td>
<td>21.2</td>
<td>21.6</td>
<td>21.9</td>
<td>21.9</td>
</tr>
<tr>
<td>All educational levels</td>
<td>15.4</td>
<td>16.5</td>
<td>16.8</td>
<td>17.6</td>
</tr>
</tbody>
</table>

Source: Registrar General of India, Census

education 16.8 years, for women with middle education 18.4 years and for women with at least high school 21.3 years.

3.2 Contraception

3.2.1 Contraceptive Prevalence Rate and Couple Protection Rate: a warning

In our study of Indian literature on the use of contraceptives, i.e. the Contraceptive Prevalence Rate (CPR), some confusion arose. Several studies, based on data from the Ministry of Health and Family Welfare, use the concept of CPR but the meaning differs: CPR is the Couple Protection Rate. The Couple Protection Rate, a term used by the Department of Family Welfare, is supply oriented and is the ratio of the estimated numbers of couples protected and the estimated number of eligible couples (couples with currently married women in the reproductive age of 15-44 years). The estimated number of couples protected by vasectomy, tubectomy and IUD is based on the age distribution of acceptors and the estimated age-specific joint survival ratios of husbands and wives. Attritions that are the result of mortality, dissolution of marriages and discontinuation of use of the IUD are considered in estimating the survival ratios. The estimated number of couples protected by condoms and oral contraceptives is derived from the distribution figures of the two methods: 72 condoms or 13 cycles of oral contraceptives are assumed to equal one year of protection provided (derived from Visaria et al. 1994). The effective Couple Protection Rate takes into account the use-effectiveness of the different methods: 100 per cent for sterilization, 95 per cent for IUD and 99 per cent for oral pill. The difference between these two concepts, i.e. the Couple Protection Rate and the effective Couple Protection Rate, are indicated by the data in Table 3.5.

The three all-India surveys conducted by the Operations Research Group (ORG), Baroda (1970, 1980 and 1988) used the Contraceptive Prevalence Rate, which is more demand oriented: the percentage of currently married women (in the last two ORG surveys: couples) of reproductive age (15-49 years) who are currently using contraceptives. Furthermore, the National Family Health Survey (NFHS 1992/93) estimates current use of contraception among currently married women among women in the age group of 13-49 years (see Table 3.6).

The data of the ORG and NFHS surveys cannot easily be compared with those provided by the Ministry of Health and Family Welfare. The major difference is how CPR is defined. A minor difference is that the surveys include the traditional methods, like rhythm, abstinence, withdrawal, etc., while the Ministry does not report on those methods (Srinivasan 1993, p.159).

Let us compare the data of the Ministry of Health and Family Welfare with those of the all-India surveys of the ORG, Baroda, and the most recent National Family and Health Survey (see Table 3.5 and 3.6).

---

4 The ORG surveys and the NFHS survey are both financed and supported by the Ministry of Health and Family Welfare.
### Table 3.5: Couple Protection Rate: percentage of currently married couples in the reproductive age (15-44 years) currently and effectively using contraceptives, 1970-1991

<table>
<thead>
<tr>
<th>Year</th>
<th>Couples currently and effectively protected by sterilization (%)</th>
<th>Couples currently protected IUD (%)</th>
<th>Couples currently protected by other methods (%)</th>
<th>Couples effectively protected by other methods (%)</th>
<th>Couples currently protected by all methods (%)</th>
<th>Couples effectively protected by all methods (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970-71</td>
<td>8.0</td>
<td>1.4</td>
<td>1.1</td>
<td>2.1</td>
<td>1.0</td>
<td>11.5</td>
</tr>
<tr>
<td>1971-72</td>
<td>9.7</td>
<td>1.4</td>
<td>1.3</td>
<td>2.4</td>
<td>1.2</td>
<td>13.5</td>
</tr>
<tr>
<td>1972-73</td>
<td>12.2</td>
<td>1.2</td>
<td>1.1</td>
<td>2.4</td>
<td>1.2</td>
<td>15.8</td>
</tr>
<tr>
<td>1973-74</td>
<td>12.2</td>
<td>1.1</td>
<td>1.0</td>
<td>3.0</td>
<td>1.5</td>
<td>16.3</td>
</tr>
<tr>
<td>1974-75</td>
<td>12.6</td>
<td>1.0</td>
<td>1.0</td>
<td>2.4</td>
<td>1.2</td>
<td>16.1</td>
</tr>
<tr>
<td>1975-76</td>
<td>14.2</td>
<td>1.1</td>
<td>1.0</td>
<td>3.4</td>
<td>1.7</td>
<td>18.7</td>
</tr>
<tr>
<td>1976-77</td>
<td>20.7</td>
<td>1.1</td>
<td>1.1</td>
<td>3.4</td>
<td>1.7</td>
<td>25.3</td>
</tr>
<tr>
<td>1977-78</td>
<td>20.1</td>
<td>0.9</td>
<td>0.9</td>
<td>3.0</td>
<td>1.5</td>
<td>24.0</td>
</tr>
<tr>
<td>1978-79</td>
<td>19.9</td>
<td>1.0</td>
<td>0.9</td>
<td>3.1</td>
<td>1.6</td>
<td>23.9</td>
</tr>
<tr>
<td>1979-80</td>
<td>19.9</td>
<td>1.0</td>
<td>1.0</td>
<td>2.7</td>
<td>1.4</td>
<td>23.6</td>
</tr>
<tr>
<td>1980-81</td>
<td>20.1</td>
<td>1.1</td>
<td>1.0</td>
<td>3.3</td>
<td>1.7</td>
<td>24.4</td>
</tr>
<tr>
<td>1981-82</td>
<td>20.7</td>
<td>1.2</td>
<td>1.1</td>
<td>3.8</td>
<td>2.0</td>
<td>25.7</td>
</tr>
<tr>
<td>1982-83</td>
<td>22.0</td>
<td>1.4</td>
<td>1.4</td>
<td>4.9</td>
<td>2.5</td>
<td>28.4</td>
</tr>
<tr>
<td>1983-84</td>
<td>23.7</td>
<td>2.3</td>
<td>2.2</td>
<td>6.8</td>
<td>3.7</td>
<td>32.7</td>
</tr>
<tr>
<td>1984-85</td>
<td>24.9</td>
<td>3.0</td>
<td>2.9</td>
<td>7.7</td>
<td>4.4</td>
<td>35.7</td>
</tr>
<tr>
<td>1985-86</td>
<td>26.5</td>
<td>3.9</td>
<td>3.7</td>
<td>8.3</td>
<td>4.7</td>
<td>38.7</td>
</tr>
<tr>
<td>1986-87</td>
<td>27.9</td>
<td>4.8</td>
<td>4.5</td>
<td>8.7</td>
<td>5.1</td>
<td>41.4</td>
</tr>
<tr>
<td>1987-88</td>
<td>29.0</td>
<td>5.5</td>
<td>5.2</td>
<td>9.9</td>
<td>5.7</td>
<td>44.4</td>
</tr>
<tr>
<td>1988-89</td>
<td>29.8</td>
<td>6.2</td>
<td>5.9</td>
<td>10.7</td>
<td>6.2</td>
<td>46.7</td>
</tr>
<tr>
<td>1989-90*</td>
<td>30.1</td>
<td>6.6</td>
<td>6.3</td>
<td>11.9</td>
<td>6.9</td>
<td>48.6</td>
</tr>
<tr>
<td>1990-91*</td>
<td>30.3</td>
<td>7.0</td>
<td>6.7</td>
<td>12.3</td>
<td>7.2</td>
<td>49.6</td>
</tr>
</tbody>
</table>

Source: Ministry of Health and Family Welfare 1990-91
* estimated

### Table 3.6: Contraceptive Prevalence Rate: percentage of currently married women/ couples in the reproductive age (15-49) currently using contraception, 1970-1992/93

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sterilization</td>
<td>6.3</td>
<td>22.4</td>
<td>31.3</td>
<td>30.7 (.: 27.3 : 34)</td>
</tr>
<tr>
<td>IUD</td>
<td>0.7</td>
<td>0.5</td>
<td>1.9</td>
<td>1.9</td>
</tr>
<tr>
<td>Pill</td>
<td>0.3</td>
<td>0.8</td>
<td>1.4</td>
<td>1.2</td>
</tr>
<tr>
<td>Condom</td>
<td>2.6</td>
<td>4.4</td>
<td>5.3</td>
<td>2.4</td>
</tr>
<tr>
<td>Total modern methods</td>
<td>9.9</td>
<td>28.1</td>
<td>39.9</td>
<td>36.6</td>
</tr>
<tr>
<td>Traditional methods</td>
<td>4.1</td>
<td>7.2</td>
<td>5.0</td>
<td>4.3</td>
</tr>
<tr>
<td>Total</td>
<td>14.0</td>
<td>35.3</td>
<td>44.9</td>
<td>40.6</td>
</tr>
</tbody>
</table>

1992/93: National Family Health Survey (NFHS)
Data refer to women in the age group of 13-49 years.

---

25
In the 1970s the figures did not differ much: the Ministry estimated a Couple Protection Rate from all methods of 11.5 per cent, while the ORG of 1970 estimated a Contraceptive Prevalence Rate of 14.0 per cent. This latter figure, however, also included traditional methods. Without the traditional methods, the Contraceptive Prevalence Rate amounted to 9.9 per cent. The distribution of methods differs: compared to the official statistics, the survey data indicate a smaller number of women sterilized or using an IUD, while more women claimed to use condoms.

In the 1980s, the ORG survey found a higher Contraceptive Prevalence Rate than the official estimates did - even if traditional methods are excluded. The ORG found a Contraceptive Prevalence Rate of 28.1 per cent (without traditional methods) while the official figures indicate a Couple Protection Rate of 24.4 per cent. In the survey, more couples (22.4 per cent) were found to be sterilized than the official figures indicated (20.1 per cent). This could be due to the fact that at that time operations conducted by private doctors were not included in the Ministry figures (see also Bhat 1991 and Srinivasan 1993). The percentage of IUD users was lower (0.5 per cent against 1.1 per cent) and the use of other methods was much higher (5.2 per cent against 3.3 per cent) which can be attributed to the use of condoms. This higher figure for use of condoms might be due to the fact that the surveys include use of condoms (and also oral pills) which are distributed commercially. The Ministry includes these methods distributed commercially, but they are not adjusted for the rates given for the states (information from Roy, December 1995).

The latest figures of the Ministry of Health and Family Welfare, however, show higher percentages of women currently protected than do the surveys. In 1988, the official statistics reported a Couple Protection Rate of 44.4 per cent while the ORG of 1988 mentioned a Contraceptive Prevalence Rate of 44.9 per cent. However, although the two figures appear to be the same, they cannot be compared. Regarding sterilizations, there seem not to be many differences: the ORG reported a slightly higher percentage of 31.3 per cent, the Ministry of 29.8 per cent. The biggest differences existed for the reversible methods. The overestimation by the Ministry of reversible methods was set off by the inclusion of traditional methods, accounting for 5.0 per cent, in the survey data of the ORG.

The NFHS of 1992/93 also indicates differences between survey data and official data on contraceptive use. In 1990-1991, the Couple Protection Rate amounted to almost 50 per cent while the NFHS of 1992/1993 indicates a Contraceptive Prevalence Rate of 40 per cent only, where even traditional methods are included (4.3 per cent). Regarding sterilizations there seem not to be many differences. The Ministry mentions a sterilization rate of 30.3 per cent, the NFHS a rate of 30.7 per cent. The differences are very small and this confirms the statement made by the Indian demographers during the workshop in Kerala, that sterilization rates of the Ministry and the surveys can be compared. However, there are significant differences regarding the use of temporary methods. While in the NFHS only 1.9 per cent turns out to be protected by IUD, the Ministry reports a percentage of 7.0 per cent. While the NFHS finds 3.6 per cent using methods like condoms and the pill, the Ministry reports a percentage of not less than 12.3. This clearly illustrates the difference between the supply oriented approach (how much is distributed) of the Ministry and the demand oriented approach of the surveys (how much is actually used).

There might be an underestimate of spacing methods in the surveys, as there is evidence that these methods are often resorted to when there is opposition in the family to family planning, and female respondents might not mention actual usage (Bhat 1991). Visaria et al. (1994), analysing the degree of consistency between survey and service estimates of contraceptive use by conducting an in-depth study in four districts of Gujarat, however, found that the use of reversible methods in India is substantially overstated in the service statistics. The health workers themselves knew that 15-39 per cent of the women recorded as users of reversible methods were actually not using them. About 19-27 per cent of recorded IUD users and 3-4 per cent of recorded condom users appeared not to use these temporary methods. The authors relate the overestimation of use of temporary methods in the official statistics to the system of method-specific, time-bound targets assigned to field workers and the pressure exercised

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3 Since the end of the eighties, however, private doctors received reimbursement for operations and from that moment onwards these operations have been included in the official statistics. The NFHS of 1992/93 indicates that 13.3 per cent of all female sterilizations were conducted in the private medical sector.

6 During the workshop in Kerala, the Indian demographers indicated that the CPR found by the ORG in 1988, i.e. 44.9 per cent, overestimates current use of contraceptives by about 5 per cent.
at administrative levels to reach the targets. According to the authors this has "resulted in widespread falsification of statistics" and "compromised the credibility of the program among both grassroots workers and the general population" (Visaria et al. 1994, p.301-302).

### 3.2.2 Time path of the Contraceptive Prevalence Rate

The results of the study by Visaria et al. (1994) imply that the Couple Protection Rate in 1991/1992, as indicated by the Ministry, is most probably much lower than the stated 50 per cent. In the India fertility model, we therefore rely on the data from the all-India surveys and thus the Contraceptive Prevalence Rate.

Several studies show that nowadays awareness of family planning is high among the Indian population. The ORG, Baroda showed in the all-India survey of 1980 that most couples were aware of the terminal methods vasectomy and tubectomy, i.e. 95 and 94 per cent, respectively. In the 1970 survey, these percentages were much lower: 73 per cent and 62 per cent, respectively. The percentage of couples aware of spacing or temporary methods in 1980, however, was much lower compared to those for sterilizations: 54 per cent were aware of the condom, 43 per cent of IUD and 36 per cent of the pill (Khan and Prasad 1985).

On asking respondents whether they had knowledge about how to use the contraceptives in the right way (see Table 3.7), the ORG of 1980 showed that 54 per cent of the couples knew about tubectomy and 57 per cent about vasectomy. Knowledge of temporary methods was lower: 23 per cent knew about the IUD, 21 per cent about the oral pill and still 42 per cent knew about condoms (Khan and Prasad 1985). The most recent all-India survey, the National Family and Health Survey of 1992/93, indicates a rise in knowledge of all contraceptive methods. The percentage of currently married women knowing about female sterilization was 94.6 per cent, about male sterilization 84.5 per cent, IUD 60.8 per cent, oral pill 66.2 per cent and condoms 58.1 per cent.

Regarding the use of contraceptives (see Table 3.6), in 1970, the CPR amounted to 14 per cent only: 6.3 per cent of the women were sterilized, 2.6 per cent used condoms and 1.0 per cent used IUD and the pill. Another 4.1 per cent used traditional methods. In 1980, the CPR was 35.3 per cent. Of the currently married couples, 22.4 per cent was sterilized, 4.4 per cent used condoms and another 1.3 per cent used IUD and oral pill. The use of traditional methods was slightly higher: 7.2 per cent. Thus, from 1970-1980 the CPR increased with more than 20 per cent points. If only modern methods are considered, CPR increased with 18 per cent points. The increase was higher among urban than among rural couples. In 1980, CPR in the urban areas was 51 per cent, in the rural areas 31 per cent (Khan and Prasad 1985).

The ORG of 1988 indicated a CPR of 44.9% and a similar distribution between sterilization and spacing methods. Four years later, in 1992/93 the NFHS found a CPR of 40.6%. During the workshop in Kerala, the Indian demographers indicated that the CPR found by the ORG in 1988 overestimated actual use by about 5%. For the analysis and implementation of the model we therefore exclude these data of 1988.

The NFHS of 1992/93 reports 27.3 per cent of the women being sterilized; among another 3.4 per cent the husband was sterilized. Only 6 per cent of the women were using any modern spacing method,

### Table 3.7: Percentage of currently married women methods among currently married women in the reproductive age (15-49) having knowledge about modern family planning methods, 1970-1992/93

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vasectomy</td>
<td>31.0</td>
<td>54.0</td>
<td>94.6</td>
</tr>
<tr>
<td>Tubectomy</td>
<td>26.0</td>
<td>57.0</td>
<td>84.5</td>
</tr>
<tr>
<td>IUD</td>
<td>18.0</td>
<td>23.0</td>
<td>60.8</td>
</tr>
<tr>
<td>Pill</td>
<td>16.0</td>
<td>21.0</td>
<td>66.2</td>
</tr>
<tr>
<td>Condom</td>
<td>7.0</td>
<td>42.0</td>
<td>58.1</td>
</tr>
</tbody>
</table>

where use of condoms is again higher than the use of IUD and oral pill. Traditional methods were used by 4.3 per cent of the couples.

The findings of the European Fertility Project, the World Fertility Survey and the Demographic Health Survey, as described in Van Vianen et al. (1994), led to the conclusion that the fertility decline, once it has gained momentum, is best described as the diffusion of an innovation, with societal interactions only loosely related to development and population programs determining the speed of diffusion.

According to Coale and Cotts Watkins (1986) a certain threshold of family limiters must be passed before an irreversible spread takes place throughout society. Most researchers take this threshold (rather arbitrarily) to be 20 per cent of the eligible population.

From an analysis of findings from WFS and DHS, Rodríguez and Aravena (1991) found that a diffusion process with a speed of diffusion of 0.07 fitted their data on contraceptive prevalence well. Starting from the time a country passes the threshold of a CPR of 20 per cent it takes about 16 years to reach a percentage of 41 and in another 16 years contraceptive prevalence would be 62 per cent. This does not sound unreasonable; moreover, in a simulation it is easy to experiment with an ultimate CPR (CPR \( \infty \); see Van Vianen et al. 1994) and speed of diffusion. The ‘Asian Tigers’, in particular, underwent a more rapid transition.

Rodríguez and Aravena (1991) derived the speed of diffusion from two observations around 10 years apart for about 15 countries that conducted both a WFS and a DHS survey. This implies that it is a cross-sectional estimate reflecting an average speed under the conditions prevailing in the period 1975-1990 (not all surveys were simultaneous). In the generic model (the global level), we took into account the earlier, slower adoption in developed countries, and proposed a diffusion rate of 6 per cent.

Looking at the data on CPR, India seems to have reached the abovementioned threshold of 20 per cent CPR around 1972. Given the CPR of 41 per cent in 1992-1993, and comparing the data, a diffusion rate of 9.5 to 10.0 per cent seems to be a realistic estimate for India (see Section 5).

Regarding socio-economic factors related to the CPR, we found that in 1970, the CPR was 10.6 per cent in the rural areas and 27.0 per cent in the urban areas. For 1980, the rates were 31.3 per cent and 50.7 per cent respectively. In 1992/93, CPR in the rural areas was 40.6 per cent, in which spacing methods account for 3.4 per cent only. In the urban areas, CPR was 51.0 per cent, in which the use of spacing methods amounts to 11.7 per cent (NFHS 1992/93). There are differences between the educational classes. In 1970, illiterate women showed a CPR of 10.0 per cent while in 1992/93 the CPR among the same women amounted to 33.9 per cent (ORG, cited by Bhat 1991). The NFHS of 1992/93 reports the following CPR according to the level of education: for illiterate women 33.9 per cent, for women with primary education 50.4 per cent, for women with middle education 50.8 per cent and for women with at least high school 54.7 per cent. With increasing education, women rely relatively more on spacing methods, including traditional ones, than on sterilization.

3.3 Abortion

Abortion rates are not easily estimated due to lack of reliable data. In India, abortions have been legal since 1971 when the Medical Termination of Pregnancy Bill was passed by the Indian Parliament. The Act was enacted in 1972, to be enforced across the country, excluding Jammu and Kashmir. The latter, and Mizoram too, adopted the act only in 1980. The act has still not been adopted in Sikkim and the Union Territory of Lakshadweep (Chhabra and Nuna 1994).

Abortion in India is legal if it is performed to save the mother’s life, to protect the physical and mental health of women and of the unborn child, in cases of rape, and in case of contraceptive failure (Medical Termination of Pregnancy Act, 1971; cited by Chhabra and Nuna 1994). Up to 1972, the Indian Criminal Law permitted abortion only “to save the life of the mother”. It is permitted to conduct induced abortions only in approved institutions.

Legally, an abortion can be induced up to 12 weeks of pregnancy, but exceptions are made and abortions can still be induced up to 20 weeks of pregnancy. In reality, the majority of abortions take place within the first trimester (about four-fifths of all induced abortions), but India’s incidence of second trimester abortions is the highest anywhere in the world (Chhabra and Nuna 1994). Estimates about the number of induced abortions differ widely. The Shah Committee (installed by the Government of India at the end of the 1960s to study the possibility of legalisation of abortion) estimated
that before 1972 about 3.9 million induced abortions occurred every year (Government of India 1967; cited by Mehta 1989; Chhabra and Nuna 1994). In 1970 the IPPF (International Planned Parenthood Federation) estimated a much higher figure: 6.5 million illegal abortions in India, corresponding to 200 induced abortions per 1,000 known pregnancies and an abortion rate of 55 per 1,000 women in the reproductive age group.

Table 3.8 indicates the number of induced abortions, registered by the government in India between 1972 and 1990. The number of registered abortions slightly increased. In 1991-92, the official number of induced abortions, or medically terminated pregnancies, amounted to 632,526.

Estimates about non-registered abortions differ widely. Menon (1979; cited by Mehta 1989, p.213) estimated that about 4 million illegal abortions continue to take place annually. Goyal (1978; cited by Khan et al. 1993, p.253) estimated that every year 5 to 6 million abortions are induced by private practitioners, and remain unregistered by the government. Ramachandran (1988, p.244, 245) also estimated the number of illegal abortions at 6 million. Another study (Karkal 1991) estimates that for every registered abortion, three more are performed in rural areas and four or five in urban areas. Estimates by the UN (1993b) mention a number of illegal abortions of 2 - 6 million.

The most recent and comprehensive study on abortion in India, by Chhabra and Nuna (1994), concludes that the number of abortions in 1991-92 is probably over 11 million, of which 6.7 million are induced (4.5 million being spontaneous). This indicates a ratio of 10:11 illegal abortions for each MTP and an induced abortion rate of 257 per 1,000 live births.

Most induced abortions in India are conducted on married, multi-parous women. Official data (1986-1991) indicate that more than 80 per cent of the women are in the 20-34 year age group. During recent years there has been an increase in induced abortions among unmarried teenagers but their proportion is (still) low. The official figures mention 6-9 per cent (Chhabra and Nuna 1994). Officially, the Medical Termination of Pregnancy Act of 1991 mentions “No pregnancy of a woman, who has not attained the age of eighteen years ...... shall be terminated except with the consent in writing of her guardian”.

The major reasons for induced abortion, for the registered cases only, are contraceptive failure and severe mental and physical trauma caused by an unwanted pregnancy. However, Ministry data for 1986-87 indicate fewer than 50 per cent of the women who underwent an induced abortion subsequently accepted a contraceptive method: 29.6 per cent adopted sterilisation and 18.6 per cent IUD (cited by Chhabra and Nuna 1994).

Small-scale surveys, like the one by Khan et al. (1993) in three urban centres in Gujarat, Orissa and Bihar, and the one by Karkal (1991) in Bombay, found that most women had an induced abortion because they wanted to end childbearing. Khan et al. (1993) found that 67 per cent of the women said they had achieved the desired family size and did not want any additional children, about 27 per cent felt that their last child was too young to have another sibling, 16 per cent said they wanted to delay the birth of a following child, and 7 per cent said their health was not good enough to have another pregnancy.. Most women generally had two or more living children, and at least one living son.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total number of Medical Termination of Pregnancy (MTPs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972-76</td>
<td>381,111</td>
</tr>
<tr>
<td>1975-77</td>
<td>278,870</td>
</tr>
<tr>
<td>1977-78</td>
<td>247,049</td>
</tr>
<tr>
<td>1978-79</td>
<td>317,732</td>
</tr>
<tr>
<td>1979-80</td>
<td>360,838</td>
</tr>
<tr>
<td>1980-81</td>
<td>388,405</td>
</tr>
<tr>
<td>1981-82</td>
<td>433,527</td>
</tr>
<tr>
<td>1982-83</td>
<td>516,142</td>
</tr>
<tr>
<td>1983-84</td>
<td>547,323</td>
</tr>
<tr>
<td>1984-85</td>
<td>577,931</td>
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<tr>
<td>1985-86</td>
<td>583,704</td>
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<tr>
<td>1986-87</td>
<td>588,406</td>
</tr>
<tr>
<td>1987-88</td>
<td>584,870</td>
</tr>
<tr>
<td>1988-89</td>
<td>582,161</td>
</tr>
<tr>
<td>1989-90</td>
<td>596,357</td>
</tr>
<tr>
<td>1990-91</td>
<td>581,215</td>
</tr>
<tr>
<td>1991-92</td>
<td>632,526</td>
</tr>
</tbody>
</table>

Using information from several studies, e.g. the collaborative study by the ICMR (Indian Council of Medical Research), Ramachandran (1988, p.239) indicates the differences in background between women undergoing legal abortions and women having illegal abortions. The first group consists predominantly of higher educated women from economically advanced groups, living in the urban areas. The second group consists predominantly of women with no formal education, coming from the poorer section of society.

Obviously, the high number of abortions indicates a high unmet need for contraceptives. The three ORG surveys report an unmet need, defined as the percentage of couples who do not desire additional children but who are not using any methods of contraception: 40 per cent in 1970, 18.5 per cent in 1980 and 18.3 per cent in 1983 (cited by Bhat 1991).

Sex selective abortions are reported in India. The sex of the foetus can be determined by amniocentesis between 14-18 weeks of pregnancy. By the 1980s, facilities for sex determination commenced being widely advertised. In 1986, in Bombay, 84 per cent of the private gynaecologists were found to conduct sex determination tests which often led to abortion of the female foetuses (Baru 1993). One report claims that in 1986-87 an estimated 30,000 - 50,000 female foetuses were aborted (cited by Chhabra and Nuna 1994). In another study in 1984 in Bombay it was estimated that out of 8,000 abortions preceded by amniocentesis as many as 7,999 were female foetuses (WHO 1992).

Recent data at the national level indicate increasing sex ratios at birth. Normally the sex ratio at birth varies between 104 - 107 males per 100 females, but in India the data suggest a sex ratio at birth of 112 (cited by Westley 1995).

The state of Maharashtra has officially prohibited sex determination. However, the business has become clandestine, or women go to other states (Nandan 1993). Recently, Goa and Gujarat also drafted legislation to prevent the use of prenatal diagnostic tests for sex determination. A bill to ban the use of sex determination tests for purposes other than the detection of genetic abnormalities has been passed by the Indian Lower House of Parliament (Lok Sabha) (Visaria and Visaria 1994) and recently became a law (information from Nair, December 1995).

### 3.4 Postpartum infecundability

The index of postpartum infecundability measures the fraction of the fertile life span which is lost for reproduction due to postpartum amenorrhea induced by breastfeeding and to postpartum abstinence. In India, data on postpartum amenorrhea differ highly. Data from the ORG (Baroda) in 1988 indicated a mean length of postpartum amenorrhea for all-India of 5.7 months. In rural areas the mean length was 5.9 months and in urban areas it was 5.1 months. These values seem to be extremely low, especially given the almost universal practice of breastfeeding newborn children.

Kurup (1989) reported a mean duration of postpartum amenorrhea of 18 months for all-India. This seems to be very high. Some inconsistency occurred in his data, as later he mentions a $C_1$ value of 0.608, which indicates a mean duration of postpartum amenorrhea of 14.4 months.

Natarajan (1989) has reviewed several small-scale studies conducted throughout India. He found that prior to 1967 postpartum amenorrhea varied between 10 and 15 months in the rural areas, while after 1981 the range narrowed to 7.9 and 11.16 months. The simple average of postpartum amenorrhea in the rural areas before 1967 was 12.6 months, and 9.9 months after 1981. For urban areas - prior to 1967 - the author reports averages ranging from 9.0 to 11.5 months.

Other data for urban areas (1979 and 1981) indicate a mean duration of lactation of 15.2 and 19.8 months, respectively, and a mean duration of postpartum amenorrhea of 10.9 and 11.0 months (Ramachandran 1989, p.214).

The NFHS of 1992/93 found for all-India a mean duration of postpartum infecundability of 11.1 months. Regional variations occur: duration of postpartum non-susceptibility is lowest in the northern region (Haryana, Himachal Pradesh and Punjab), i.e. only 5 months (Roy and Pararasan 1996). The mean duration of postpartum amenorrhea amounted to 9.5 months; mean duration of postpartum abstinence was 5.4 months.

The duration of postpartum infecundability declines with levels of education: for illiterate women the median duration was 11.4 months, for women with primary education 9.2 months, for women with middle education 7.9 months and for women with at least high school 6.2 months. In addition, median duration of postpartum non-susceptibility was higher among rural women, i.e. 10.8 months, than among urban women, i.e. 8.0 months.
3.5 Wanted fertility, son preference and status of women

The demand for children is commonly measured by reference to the average desired family size. In India, the percentage of couples desiring a two-child family - the norm set by the Department of Family Welfare - increased from 9 per cent in 1970 to 33 per cent in 1988. In 1988, the mean number of children desired by couples who had no children amounted to 2.63 (compared to 1980: 3.0) (Khan and Rajagopal 1993). The NFHS of 1992/93 reports an ideal number of children for all-India of 2.9 children; 3.0 children in the less advanced region (Bihar, Madhya Pradesh, Rajasthan and Uttar Pradesh) and 2.4 in the northern (Haryana, Himachal Pradesh and Punjab) and southern region (Andhra Pradesh, Karnataka, Kerala and Tamil Nadu) (Roy and Parasuraman 1996). Among rural women the ideal number of children was 3.0, among urban women 2.5. Ideal family size varies with the level of education. The ideal family size among illiterate women was 3.1 children, among women with primary education 2.6 children, among women with middle education 2.4 children and among those with at least high school 2.1 children.

Son preference

The desired number of children in India reflects son preference. During the workshop in Kerala it became clear that in the Indian situation, rather than a desired family size, it would be better to use the desired number of sons. Son preference is indicated by data from the ORG, 1980, on desire for additional children given the sex composition in the family (Table 3.9).

Among two-child families, composed of two daughters only, 75 per cent of the respondents expressed the desire for additional children. For families having two sons, this percentage is 48 per cent. Looking at the three-child families, among those with only three daughters 68 per cent expressed the desire for additional children. Those families with one daughter and two sons have the lowest percentage of people desiring additional children: 11 per cent. Among those families with three sons only, 23 per cent expresses this desire. Besides the son preference, these data indicate that people are also willing to have a daughter in the family (Khan and Prasad 1985, p.319; Nag 1991, p 5). In fact, the ideal is to have two sons and one daughter (Das 1987, p.517). These 1980 ORG data can be compared to the ORG

<table>
<thead>
<tr>
<th>Family type</th>
<th>Percentage desiring additional children</th>
<th>Mean # of additional children desired</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-children families</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 daughters, 0 son</td>
<td>75.0</td>
<td>1.23</td>
</tr>
<tr>
<td>1 daughter, 1 son</td>
<td>44.0</td>
<td>0.72</td>
</tr>
<tr>
<td>0 daughter, 2 sons</td>
<td>48.0</td>
<td>0.68</td>
</tr>
<tr>
<td>3-children families</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 daughters, 0 son</td>
<td>68.0</td>
<td>1.05</td>
</tr>
<tr>
<td>2 daughters, 1 son</td>
<td>28.0</td>
<td>0.59</td>
</tr>
<tr>
<td>1 daughter, 2 sons</td>
<td>11.0</td>
<td>0.18</td>
</tr>
<tr>
<td>0 daughter, 3 sons</td>
<td>23.0</td>
<td>0.28</td>
</tr>
<tr>
<td>4 (or more)-children families</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 or more daughters, 0 son</td>
<td>59.0</td>
<td>0.85</td>
</tr>
<tr>
<td>3 or more daughters, 1 son</td>
<td>20.0</td>
<td>0.26</td>
</tr>
<tr>
<td>2 or more daughters, 2 sons</td>
<td>4.0</td>
<td>0.07</td>
</tr>
<tr>
<td>1 or more daughter, 3 or more sons</td>
<td>4.0</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Source: Operations Research Group (ORG), Baroda 1980
Khan and Prasad 1985, p. 314
surveys of 1970 and 1988. Table 3.10 presents percentages of women (1970) or couples (1980, 1988) wanting no more children. Apart from the preference for sons and the fact that people want at least one daughter, these data indicate some (minor) changes taking place over time (Nag 1991).

In two-child families, the percentage of couples wanting no more children increased, even when there was no son in the family (from 21.4 per cent to 33.0 per cent). In the three-child families, however, the percentage of couples without a son and wanting no more children remained at the same level: around 35 per cent. In the other three-child families the percentage has increased. Among four-child families with no son, the percentage wanting no more children increased between 1970 and 1980, but remained stable in 1988. In the other types of four-child families no, or very small, changes occurred. The data suggest that the norm of a small family became more acceptable at the end of the eighties.

Nag (1991) constructed an attitudinal index of son preference, derived from the methodology used by Freedman and Coombs (1974). This index is estimated as follows: “if, at a given parity, comparison between the two rows in the table (here Table 3.10) shows that the percentage wanting no more children is higher for those having a specific number of sons compared to the percentage for women having fewer sons, this may be defined as consistent with son preference. The difference in percentage points should be two or more to be considered as consistent with son preference. The attitudinal index of son preference, now, is computed as a ratio of the number of comparisons consistent

<table>
<thead>
<tr>
<th>Family type</th>
<th>1970</th>
<th>1980</th>
<th>1988</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-child families</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 son</td>
<td>13.5</td>
<td>10.0</td>
<td>13.0</td>
</tr>
<tr>
<td>1 son</td>
<td>25.8</td>
<td>17.0</td>
<td>22.0</td>
</tr>
<tr>
<td>2-children families</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 sons</td>
<td>21.4</td>
<td>25.0</td>
<td>33.0</td>
</tr>
<tr>
<td>1 son</td>
<td>45.8</td>
<td>56.0</td>
<td>63.0</td>
</tr>
<tr>
<td>2 sons</td>
<td>44.0</td>
<td>52.0</td>
<td>69.0</td>
</tr>
<tr>
<td>3-children families</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 son</td>
<td>37.8</td>
<td>32.0</td>
<td>33.0</td>
</tr>
<tr>
<td>1 son</td>
<td>60.5</td>
<td>72.0</td>
<td>72.0</td>
</tr>
<tr>
<td>2 sons</td>
<td>75.2</td>
<td>89.0</td>
<td>89.0</td>
</tr>
<tr>
<td>3 sons</td>
<td>48.1</td>
<td>77.0</td>
<td>87.0</td>
</tr>
<tr>
<td>4 or more children families</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 son (4 or more daughters)</td>
<td>20.7</td>
<td>41.0</td>
<td>39.0</td>
</tr>
<tr>
<td>1 son (3 or more daughters)</td>
<td>73.3</td>
<td>80.0</td>
<td>78.0</td>
</tr>
<tr>
<td>2 sons (2 or more daughters)</td>
<td>90.4</td>
<td>96.0</td>
<td>93.0</td>
</tr>
<tr>
<td>3 sons (1 or more daughters)</td>
<td>90.1</td>
<td>96.0</td>
<td>90.0</td>
</tr>
<tr>
<td>4 sons (0 or more daughters)</td>
<td>75.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Attitudinal Index of Son Preference* 0.72 0.87 0.88

Source:
3. Operations Research Group (ORG), Baroda 1988

* Nag (1991)
with son preference to the total number of comparisons possible from the available data (excluding comparisons with a difference of less than two percentage points)” (Nag 1991, p. 8). The data for India show the highest index for the year 1988 (0.88), while in 1970 and 1980 the index was 0.72 and 0.87, respectively. This indicates an increase in the prevalence of son preference in this period (Nag 1991, p.8).

Estimating the parity progression ratio (PPR), which is defined as the proportion of women who progress from parity x to parity x + 1, by sex of the previous children at parity 2 through 4, for 1979-1980, Das (1987) analysed son preference at a smaller scale in rural and urban Gujarat. On average, in the urban area the PPR amounted to 64 per cent at parity two, 58 per cent at parity three and 51 per cent at parity four. In the rural areas, these percentages are 79, 69 and 63 respectively. At each parity, a higher proportion of women with no sons did progress to a next child, compared to women who already had one or more sons. In case all living children were sons, a small increase in PPR was observed, indicating that one daughter is also wanted (Das 1987, p.527-528).

Subsequently, the effects of variables like education of women, elapsed time since attainment of pertinent parity, socio-economic status of the household and gender of the previous children were estimated. A multiple classification analysis (MCA) suggests that most of the variance can be explained by elapsed duration. The second most important predictor of PPR at parity three and four in the rural areas is the sex composition of the children in the family. In the urban areas, the second most important predictor of PPR at parity two and three is education of the mother, and at parity four the sex composition of the previous children. Rural couples displayed the effects of sex preference more distinctly than urban couples (Das 1987, p.520).

Why do people want a son, or rather more sons? A small-scale survey in Maharashtra (Jejeebhoy and Kulkarni 1989, p.112) indicates that the major reason for having a son is security in old age. Next is the continuation of the family line. Sons are expected to stay in their family, their brides coming to stay with their families (see also the section on status of women). Other reasons mentioned are help in the farm or business, and religious reasons. Regarding the latter, sons are supposed to take care of the death rituals of the parents, not only during the cremation or burial, but also during all rituals and worships later in life. In the discussions during the workshop in Kerala, however, it was doubted whether this would be a valid reason at the time of deciding to have a child or not, or a judgement made subsequently if the children were already born. The major reason for the desire for at least one girl, as indicated by the Maharashtra study, is help in the home.

Effects of son preference on fertility?

Sex preference would have an effect on fertility if couples who have already reached their desired family size continue child bearing in order to achieve the appropriate sex composition (Nag 1991, p. 26). The results of studies regarding the effects of sex preference on fertility, conducted in different countries, are not unanimous: conflicting results occur even in the same country (Das 1987, p.517). The Indian studies reviewed by Das (1987) were conducted in the 1960s and 1970s and point to a small effect of child’s gender on actual fertility. However, as the author concludes, the effects might have been small due to the fact that in the 1970s “use of contraception was imprecise and no clear evidence of conscious or parity specific control of fertility was available for Indian couples. Large families being the norm at the time, the probability of satisfying a sex preference was much greater. This might have weakened the effects of sexual preference on fertility behaviour. With reproduction now increasingly under voluntary control, attitudes and preferences may play an important role in determining actual fertility” (Das 1987, p.518; see also Nag 1991, p.30).

Is there a relationship between sex preference and CPR? Das (1987) found no effects in the analysis for Gujarath for 1960-1970. Data from the 1980 research (mentioned above) in urban and rural Gujarath, however, indicate (Table 3.11) that at each family size level, CPR increases with the number of sons (except for those cases in which every child is male) (Das 1987, p.523). The low percentage of contraceptive use is remarkable - in the Indian case this is predominantly sterilization - among women having only daughters. Among rural two-child families, only 12.3 per cent of women having daughters use contraception, against 51.6 per cent among women with two sons. Among five or more child families, only 18.2 per cent (!) of women having daughters use contraception, against 76.8 per cent of women who have one son. In urban areas the differences are smaller but still exist. Among 3-children-families, the CPR of women with three
Table 3.11: Percentage of second and higher parity women, rural and urban areas, currently using contraceptions

<table>
<thead>
<tr>
<th>Family type</th>
<th>Rural</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>No children</td>
<td>??</td>
<td>25.00</td>
</tr>
<tr>
<td>1 child families</td>
<td>11.29</td>
<td>26.00</td>
</tr>
<tr>
<td>1 son</td>
<td>12.50</td>
<td>27.59</td>
</tr>
<tr>
<td>1 daughter</td>
<td>9.09</td>
<td>23.81</td>
</tr>
<tr>
<td>2-children families</td>
<td>41.15</td>
<td>62.86</td>
</tr>
<tr>
<td>1 son, 1 daughter</td>
<td>46.18</td>
<td>64.41</td>
</tr>
<tr>
<td>2 sons</td>
<td>31.65</td>
<td>70.55</td>
</tr>
<tr>
<td>2 daughters</td>
<td>12.28</td>
<td>46.89</td>
</tr>
<tr>
<td>3-children families</td>
<td>68.64</td>
<td>76.83</td>
</tr>
<tr>
<td>2 sons, 1 daughter</td>
<td>82.89</td>
<td>84.21</td>
</tr>
<tr>
<td>1 son, 2 daughters</td>
<td>58.10</td>
<td>71.32</td>
</tr>
<tr>
<td>3 sons</td>
<td>80.72</td>
<td>83.91</td>
</tr>
<tr>
<td>3 daughters</td>
<td>18.97</td>
<td>53.97</td>
</tr>
<tr>
<td>4-children families</td>
<td>81.04</td>
<td>79.84</td>
</tr>
<tr>
<td>3 sons, 1 daughter</td>
<td>91.51</td>
<td>80.56</td>
</tr>
<tr>
<td>1 son, 3 daughters</td>
<td>71.57</td>
<td>75.25</td>
</tr>
<tr>
<td>2 sons, 2 daughters</td>
<td>85.88</td>
<td>86.45</td>
</tr>
<tr>
<td>4 sons</td>
<td>78.08</td>
<td>88.00</td>
</tr>
<tr>
<td>4 daughters</td>
<td>38.89</td>
<td>45.83</td>
</tr>
<tr>
<td>5 or more-children families</td>
<td>78.75</td>
<td>75.35</td>
</tr>
<tr>
<td>4 sons, 1 or more daughters</td>
<td>81.03</td>
<td>75.61</td>
</tr>
<tr>
<td>3 sons, 2 or more daughters</td>
<td>83.67</td>
<td>73.26</td>
</tr>
<tr>
<td>2 sons, 3 or more daughters</td>
<td>82.18</td>
<td>80.52</td>
</tr>
<tr>
<td>1 son, 4 or more daughters</td>
<td>76.81</td>
<td>81.82</td>
</tr>
<tr>
<td>All (5 or more) sons</td>
<td>73.33</td>
<td>61.54</td>
</tr>
<tr>
<td>All (5 or more) daughters</td>
<td>18.18</td>
<td>64.29</td>
</tr>
<tr>
<td>Total, parity 2 or higher</td>
<td>61.91</td>
<td>70.53</td>
</tr>
</tbody>
</table>

Source: Das 1987, p.524

Das (1987) in addition tries to find an explanation for the fact that such effects were not found in the 1960s and 1970s and states that the CPR should be above a certain threshold before conclusions can be drawn about the effects of sex preference. Therefore, an analysis was subsequently conducted on PPR among several marriage cohorts, assuming that among the more recent cohorts, who have reduced their ideal family size norm and consciously begun to control their fertility, stronger effects of sex preference would be found. The results indicate that "son preference is now having a more pronounced effect on fertility because couples are reducing their ideal family size downwards and are increasing contraceptive use". Couples are not only conscious about limiting their families but equally conscious of satisfying their sex preference (Das 1987, p. 526).

Regarding the size of the effect on fertility, Das (1987), and Nag (1991) too, conclude that the effects can only be small since at each parity only a small proportion of couples would be affected. Das (1987) concludes "that the reduction in (completed) fertility would not be more than 13 per cent in the absence of sex preference. This, however, includes effects of infant and child mortality. When the mortality effect was removed by excluding couples who had experienced any infant or child death, the corresponding figure was reduced to 9 per cent" (Das 1987, p.527; italics added).

Das (1987) expects for the future that as modernisation continues son preference may also diminish. However, given the size of the impact on fertility, the impact of disappearance of sex preference would not be great, although not insignificant (Das 1987, p.527-528).

Rajaretnam and Deshpande (1994) studied the effects of sex preference on CPR and fertility in five districts of Karnataka, in South India. They estimated that in the absence of sex preference, contraceptive use would increase from its current level by about 12 per cent in high-prevalence areas and by 25 per cent in low-prevalence areas. As a consequence of the higher CPR, marital fertility would increase by around 20 per cent (Rajaretnam and Deshpande 1994, p.95).

The workshop in Kerala discussed probable future developments of son preference. Several points of view were expressed. Bhat stated that, when total fertility is around 5-6, son preference does not affect fertility. If fertility declines to about 3 children, however, son preference starts to play a role. Nowadays in India, a second son is seen as insurance: if the first son does not survive, the second one might. Bhat expects that people will opt for one son only if infant mortality declines and people are sufficiently certain that this one son will survive.

The paper of Roy and Parasarumman (1996, p. 13) reports that "with the increase in education there is hardly any reduction in the extent of son preference."
Only among women with at least a high school education, is the extent of son preference found to be significantly less. Bose stated that, with the new technologies coming up, son preference actually did increase. An example is the technology of amniocentesis. With modernization, therefore, son preference will increase.

\textit{Status of women}

Son preference is one of the features reflecting the status of women in Indian society. The effects of status of women on fertility have been mentioned, by for example Dyson and Moore (1983), who distinguish two broad demographic regimes, i.e. the Southern and Northern states. They relate the lower fertility in the Southern states to higher status of women, i.e. higher female autonomy (Dyson and Moore 1983, p. 42-43). This hypothesis, the more autonomous status of women in southern India accounting for their lower fertility seems to be plausible and appealing (Freedman 1995, p. 13). Female autonomy could be defined as "the extent of women's exposure to the world outside the home, the extent of their active (economic) interaction with this extra-domestic world, and the extent of their autonomy in decision making (Basu 1989a, p.234).

The position of women is defined from birth onwards. The few cases of female infanticide, which have lately also been reported (see e.g. Rajarethnam 1992), are an extreme expression (as is prenatal female foeticide). At the time of birth itself, more joy is expressed in case a boy is born: special sweets are distributed, something not done if the newborn turns out to be a girl. Later in life, girls are observed to receive less food during childhood, less health care, and less attention (Miller 1981; Srinivasan and Kanitkar 1989; Basu 1989b; UNICEF 1991). The resulting higher mortality among females in general is illustrated by the low sex ratios indicated in Table 2.6.

The deaths rate for children aged 0-4 years is higher for females than for males. In 1992, for all-India, the death rate in this age category among girls was 28.2 deaths, and 24.9 deaths among boys. The difference is less in urban areas (15.9 against 15.4 deaths) than in rural areas (31.1 against 27.2 deaths) (SRS 1992).

Excess female mortality, however, exists predominantly in the Northern states of India, among others in the state of Uttar Pradesh (see figure 3.3, based on the census of 1981).

\textbf{Figure 3.2: Excess female child mortality, India Source: Registrar General of India, Census 1981}

In regard to infant mortality, only small differences exist between girls and boys: in 1992, infant mortality for females was 80, against 79 per 1,000 live births for males (SRS 1992). The reason for this small difference might be due to the general excess mortality of boys in the neonatal period.

In this patrilineal society, a girl is seen as only a temporary member of her natal family: after marriage she will be part of her husband’s family. The fact that a girl becomes a member of her husband’s family has important consequences. It is not considered worthwhile to invest in a girl who will leave the family, and as a consequence girls receive less education than boys. At the age of 11-14 years old, only 31 per cent of girls are still attending school, compared to 62.0 per cent of the boys.

Moreover, educating a girl has an adverse effect. The rule of hypergamy means that a girl should marry a boy with a higher education. If a girl receives more education, and if she were to marry a boy with even higher education, the dowry to be paid by her parents to the bridegroom’s family would increase (Hutter 1994). Depending on socio-economic class, the dowry consists of several items: durable goods, gold, money. At the time of the marriage it is transferred from the bride’s family to the husband’s family. Dowries, which can be very large, take a considerable part of the savings from the girl’s family.
The status of married Indian women is strongly determined by their reproductive role. A woman can improve her status by giving birth to a child. Her first child is proof of her fertility. She can further improve her status by giving birth to sons who will continue the family line and will take care of the parents, not only economically, but will also provide the necessary death rituals later on (Hutter 1994).

In regard to the adoption of contraceptives, the 1980 ORG survey reported interspouse communication and concluded that “the husband generally makes the final decision about family size and family planning” (Khan and Prasad 1985, p.39). Fieldwork experiences in Karnataka (Hutter 1994) reveal that, in her choice regarding family planning, a woman not only depends on her husband but also on the members of the joint family, in particular the mother-in-law and father-in-law.

Basu’s (1989a) definition of female autonomy, as mentioned above, is difficult to measure and the commonly used proxies are female education and labour force participation. In the fertility model, the status of women is operationalized by age at marriage in the State system, and female life expectancy and female literacy in the Pressure system (see also Van Vianen et al. 1994).

The 1991 census revealed that 52.2 per cent of the total population of India (aged seven and above) are literate: 64.1 per cent for men and only 39.6 per cent for women. In the census data, a literate person is defined as “someone who is able to read and write with certain understanding in any language” (Premi 1991, p.66). The data on literacy suffer from problems of comparison because different age groups are used in the denominator in several studies. The 1991 census estimated literacy, taking in the denominator the population of 7 years and older. In earlier censuses, before 1961, the total population was taken. And, in the censuses of 1961 up to 1981, the population below 5 years was treated as illiterate, but the denominator included the total population (Premi 1991, p.65-66).

In order to be able to compare literacy rates throughout time, from 1900 onwards, in this report we have decided to take the rates which include the total population in the denominator (the crude literacy rate). Then, in the 1991 census, 42.5 per cent of the population is literate (see above: 52.2 per cent); 52.7 per cent of the men and 32.5 per cent of the women. The data on literacy from 1900-1991 are presented in Table 3.12.

3.6 Policy measures

Two different views are defended in respect of policies on fertility: modernization versus family planning. In spite of the debate, growing empirical evidence indicates that both modernization and family planning efforts are related to the mechanisms that initiate fertility decline.

Regarding the family planning effort, India is classified as having a strong programme, and according to the definition of Ross and Frankenberg
(1993; see also Van Vianen et al. 1994) at this moment has a family planning score of 4.

Regarding modernization, we decided to use the Human Development Index (HDI) as an indicator in the generic model (see Van Vianen et al. 1994, p.24). HDI concentrates on life expectancy at birth, literacy levels and the Gross National Product. One of the disadvantages of HDI, however, as a composite index (scores 0-1), developing in time, and affecting fertility, is its ponderousness. The index does not reflect possible differentiations between the three factors: the same HDI scores might be composed of different proportions of the three factors. It therefore would be better to take literacy, life expectancy and GDP separately and estimate their effects on fertility. Data on life expectancy and literacy, and the development from 1900 onwards, have been reported above. Regarding the economic indicator, Table 3.13 presents both GNP per capita (in rupees) and GDP (in crores) from 1950 onwards.

Another indicator of economic growth might be the percentage of the population below the poverty line. Being below the poverty line has been defined as a monthly income of 65 rs in rural areas and rs 75 in the urban areas at 1977-78 prices (corresponding to the minimum calorie requirement of 2,400 per capita per day in rural areas and 2,100 calorie requirement per day in urban areas). At 1984-85 prices, the per capita monthly income expenditure at the poverty line has been estimated to be 107 rs (rural) and 122 rs (urban). In 1987-1988, the figures are 132 and 152 rs, respectively (CMIE 1988 and 1990).

From 1977 onwards, the percentage of the population below the poverty line declined from 48.3 per cent to an expected 25.8 per cent in 1989-1990 (see Table 3.14).

A small-scale survey in Bihar (1988) (Khan and Rao 1989) analysed the differences in reproductive behaviour between people living below the poverty
Table 3.14: Percentage of the population below poverty line, for rural and urban India, 1977-1990

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>51.2</td>
<td>39.9</td>
<td>32.7</td>
<td>28.2</td>
</tr>
<tr>
<td>Urban</td>
<td>38.2</td>
<td>27.7</td>
<td>-</td>
<td>19.3</td>
</tr>
<tr>
<td>Total</td>
<td>48.3</td>
<td>36.9</td>
<td>29.2</td>
<td>25.8*</td>
</tr>
</tbody>
</table>

Source: Centre for Monitoring Indian Economy (CMIE) 1990
* expected

line (BPL) and those living above the poverty line (APL). In the first group (BPL), more couples found the ideal size of the family to be four or more children (43 per cent against 25 per cent), while their ideal family size was 3.4 (against 3.0 among the APL group). Looking at the awareness of contraceptive methods, the two groups did not differ much regarding sterilization. Differences did exist, however, for spacing methods. Among the BPL group, the percentage using contraceptives was 29.8 per cent; among the APL group it was 44.2 per cent.

As mentioned in the Introduction, one can hardly speak about the Indian fertility pattern. Huge differences in fertility behaviour and related socio-economic and cultural circumstances exist within the country. Therefore, in the next section, we elaborate on the fertility pattern of Kerala and Uttar Pradesh.
4. TWO CASE STUDIES: KERALA AND UTTAR PRADESH

In this report on fertility change in India, the case studies of Kerala and Uttar Pradesh have been included to capture the rich diversity that characterizes India and to illustrate the different fertility regimes of the northern and southern states (based on Dyson and Moore 1983). We therefore describe the demographic transition in both Kerala and Uttar Pradesh (Section 4.2), the values of the proximate determinants in both states (Section 4.3), and the relevant socio-economic factors (Section 4.4). In the latter section we follow the generic model of integrated fertility change (Van Vianen et al. 1994) and discuss the socio-economic factors included in the Pressure sub-system (GNP, life expectancy and literacy), together with policy options in the Response system.

The objective is just to illustrate the huge variation existing in India: a separate fertility model of Kerala and Uttar Pradesh is beyond the scope of this report, but might be developed in a later phase.

4.1 Introduction

Kerala is situated in South India, bordering the Lakshadweep Sea (see Figure 4.1). The 1991 census found that its population amounted to 29 million. The decadal growth rate of Kerala's population, between 1971-1981 and 1981-1991, was much lower than in other Indian states: 19.2 per cent and 14.3 per cent respectively. Between 1971-1981, migration contributed greatly to population decline in Kerala, but in 1981-1991 decline in natural growth contributed the most (Pathak and Ram 1991). Of the total population, 29.7 per cent are younger than 15 years (SRS 1992).

Kerala is one of the Indian states with the highest population density, i.e. 749 persons per km2 in 1991. Even in 1901, population density was more than twice the all-Indian average (Bhat and Rajan 1990). Per-capita income in Kerala is lower than the national average and 27 per cent of its population still lives below the poverty line (CMIE 1990). Yet life expectancy is 25 per cent above the national level, infant mortality is less than half, and literacy is almost the double (Myers 1993). Moreover, Kerala has the lowest CBR of all Indian states and has a total fertility below replacement level, even in the rural areas. The state is an example of how fertility can decline without significant economic development (Nag 1989, p.155). Of the whole of India, Kerala is the only state which has achieved the demographic goal set by the Government of India of an NRR equal to 1.

Uttar Pradesh is located in Northern India (see Figure 4.1) and, with more than 139 million inhabitants, is the most populous state of the Indian subcontinent. Sixteen per cent of India's population lives in Uttar Pradesh. The decadal growth rate, between 1971-1981 and 1981-1991, was higher than the national growth rate, i.e. 25.5 per cent and 25.2 per cent, respectively. Of the total population, 39.4 per cent are younger than 15 years (SRS 1992).

With the states Bihar, Madhya Pradesh and Rajasthan, Uttar Pradesh contributed most (49 per cent) to the absolute increase in population between 1981-1991. Ashish Bose (1988) uses the acronym BIMARU for these four states which, besides summarizing the first letters of the four states, means 'sick' in Hindi. For these four states, it may take 30 years to reach a growth rate of 2 per cent. They are expected to determine the transition in population growth for the whole of India (Pathak and Ram 1991).

Figure 4.1: Situation of Kerala and Uttar Pradesh on the Indian subcontinent
Uttar Pradesh is one of the poorest states. Per capita income is slightly lower than in Kerala but the proportion of the population living below the poverty line is much higher, 45 per cent (CMIE 1990). Moreover, Uttar Pradesh has one of the highest levels of infant mortality and a very low female literacy rate. Of all the Indian states, it has the highest CBR, i.e. 36.3 births per 1,000 population, and the highest TFR, i.e. 5.2 in 1992 (SRS).

4.2 The demographic transition

Kerala is one of the few Indian states (with Tamil Nadu) that entered the final phase of the demographic transition and almost completed it (Kurup 1986; Pathak and Ram 1991). Of all Indian states, it has the lowest crude birth rate (CBR) and crude death rate (CDR). In 1992, CBR was 17.7 births per 1,000 and CDR 6.3 deaths per 1,000 population (see Table 4.1 and Figure 4.2). For all-India, these rates are 29.6 births per 1,000 and 10.1 deaths per 1,000 population, respectively.

Mortality rates were already low in 1956, when the CDR amounted to 16.1 deaths per 1,000 population. For all-India, the CDR at that time was around 26 deaths per 1,000 population. Bhat and Rajan (1990) argue that the lower level of mortality in Kerala did

![Figure 4.2: Demographic transition in Kerala
Source: Registrar General of India, Census and Sample Registration System (SRS)]

<table>
<thead>
<tr>
<th>Year</th>
<th>CBR Kerala</th>
<th>CDR Kerala</th>
<th>CBR Uttar Pradesh</th>
<th>CDR Uttar Pradesh</th>
</tr>
</thead>
<tbody>
<tr>
<td>1956</td>
<td>38.9</td>
<td>16.1</td>
<td>41.5</td>
<td>24.9</td>
</tr>
<tr>
<td>1966</td>
<td>37.5</td>
<td>13.7</td>
<td>42.5</td>
<td>24.2</td>
</tr>
<tr>
<td>1976</td>
<td>27.5</td>
<td>9.2</td>
<td>45.0</td>
<td>21.0</td>
</tr>
<tr>
<td>1977</td>
<td>26.4</td>
<td>7.5</td>
<td>40.3</td>
<td>20.0</td>
</tr>
<tr>
<td>1978</td>
<td>25.7</td>
<td>7.0</td>
<td>40.1</td>
<td>18.5</td>
</tr>
<tr>
<td>1979</td>
<td>25.9</td>
<td>7.0</td>
<td>39.8</td>
<td>17.7</td>
</tr>
<tr>
<td>1980</td>
<td>26.0</td>
<td>6.8</td>
<td>39.5</td>
<td>16.4</td>
</tr>
<tr>
<td>1981</td>
<td>26.2</td>
<td>6.7</td>
<td>39.2</td>
<td>16.0</td>
</tr>
<tr>
<td>1982</td>
<td>25.6</td>
<td>6.6</td>
<td>38.9</td>
<td>15.7</td>
</tr>
<tr>
<td>1983</td>
<td>24.7</td>
<td>6.6</td>
<td>38.6</td>
<td>16.2</td>
</tr>
<tr>
<td>1984</td>
<td>23.7</td>
<td>6.5</td>
<td>38.2</td>
<td>16.4</td>
</tr>
<tr>
<td>1985</td>
<td>22.9</td>
<td>6.3</td>
<td>38.0</td>
<td>16.1</td>
</tr>
<tr>
<td>1986</td>
<td>22.5</td>
<td>6.2</td>
<td>37.7</td>
<td>15.0</td>
</tr>
<tr>
<td>1987</td>
<td>21.5</td>
<td>6.2</td>
<td>37.5</td>
<td>14.1</td>
</tr>
<tr>
<td>1988</td>
<td>20.3</td>
<td>6.4</td>
<td>37.1</td>
<td>13.2</td>
</tr>
<tr>
<td>1989</td>
<td>19.8</td>
<td>5.9</td>
<td>37.0</td>
<td>12.6</td>
</tr>
<tr>
<td>1990</td>
<td>19.6</td>
<td>6.0</td>
<td>35.6</td>
<td>12.0</td>
</tr>
<tr>
<td>1991</td>
<td>18.3</td>
<td>6.0</td>
<td>35.7</td>
<td>11.3</td>
</tr>
<tr>
<td>1992</td>
<td>17.7</td>
<td>6.3</td>
<td>36.3</td>
<td>12.8</td>
</tr>
</tbody>
</table>

Source: Registrar General of India, Census and Sample Registration System (SRS)
not originate in the 20th century, but even before that, and they relate this to favourable climatological circumstances and the scattered settlement pattern that might have arrested the spread of epidemics.

The situation in Uttar Pradesh is very different (see Table 4.1 and Figure 4.3). In this northern state, CDR declined from 24.9 deaths per 1,000 population in 1956 to 12.8 deaths per 1,000 population in 1992. With regard to fertility, Uttar Pradesh has the highest birth rate of all Indian states. CBR was 41.5 births per 1,000 population in 1956. It remained high and stabilized around a level of 37.0 births per 1,000 population in 1986-1989. The latest figures from the SRS indicate a birth rate of 36.3 births per 1,000 population.

The level of mortality is reflected in the life expectancy at birth. Life expectancy at birth of Keralite women rose from 27.4 years in 1911-1920 to more than 72 years in 1986-91 (see Table 4.2). For all-India, female life expectancy rose from 20.9 years (1911-20) to 59.1 years (1986-91). Unlike the all-Indian situation, female life expectancy at birth in Kerala has always been higher than male life expectancy at birth.
### Table 4.3: Sex ratio (number of females per 1,000 males) for Kerala, Uttar Pradesh and all-India, 1901-1991

<table>
<thead>
<tr>
<th>Year</th>
<th>Kerala</th>
<th>Uttar Pradesh</th>
<th>All-India</th>
</tr>
</thead>
<tbody>
<tr>
<td>1901</td>
<td>1004</td>
<td></td>
<td>972</td>
</tr>
<tr>
<td>1911</td>
<td>1008</td>
<td></td>
<td>964</td>
</tr>
<tr>
<td>1921</td>
<td>1011</td>
<td></td>
<td>955</td>
</tr>
<tr>
<td>1931</td>
<td>1022</td>
<td></td>
<td>950</td>
</tr>
<tr>
<td>1941</td>
<td>1027</td>
<td></td>
<td>945</td>
</tr>
<tr>
<td>1951</td>
<td>1028</td>
<td>910</td>
<td>946</td>
</tr>
<tr>
<td>1961</td>
<td>1022</td>
<td>909</td>
<td>941</td>
</tr>
<tr>
<td>1971</td>
<td>1016</td>
<td>879</td>
<td>930</td>
</tr>
<tr>
<td>1981</td>
<td>1034</td>
<td>885</td>
<td>934</td>
</tr>
<tr>
<td>1991</td>
<td>1036</td>
<td>879</td>
<td>927</td>
</tr>
</tbody>
</table>

Source: Registrar General of India, Census

In Uttar Pradesh, life expectancy at birth is much lower, especially for females. In 1986-91 it was 49.6 years.

Kerala has been one of the few states in India where the overall sex ratio (number of females per 1,000 males) was more than 1000. In 1991, the sex ratio was 1036 (927 for all-India). Part of the higher sex ratio in Kerala can be explained by the out-migration of men, especially for labour in the Middle East. However, the main factor behind the sex ratio in Kerala is the greater longevity of women (Bhat and Rajan 1990). The sex ratio in Uttar Pradesh is one of the lowest in the whole of India. In 1951, the sex ratio was 910 and it declined further to 879 females per 1,000 males in 1991 (see Table 4.3).

A major contribution to the decline in mortality\(^1\) in Kerala was the decline in infant mortality (see Table 4.4). Of all Indian states, Kerala has the lowest infant mortality. Infant mortality declined from 242 deaths per 1,000 live births in 1911-20, to 128 deaths per 1,000 in 1951-1960 (Rajan 1989), and to 17 deaths per 1,000 live births in 1992 (SRS). The NFHS of Kerala reported a higher infant mortality of 24 per 1,000 live births (NFHS 1992/93). For comparison, for all-India infant mortality in 1911-20 was 278 per 1,000 live births, in 1951-61 140 per 1,000 live births, and in 1992 79 per 1,000 live births.

Infant mortality declined among all sections of Kerala society: among illiterate and rural women and among women of Scheduled Caste and Scheduled Tribe as well. In terms of the absolute level, however, differences in infant mortality between these groups still can be observed. In 1979, illiterate women in Kerala had an infant mortality of 55 per

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\(^1\) The NFHS for Kerala (1992/93) indicates that 20.7 per cent of all households in the survey had someone working outside India, of whom 92.8 per cent were male. Another conservative estimate, mentioned by Nair (1990), is that in 1988 over 600,000 Kerala residents were in the Middle East.

\(^2\) Although mortality in Kerala is low, morbidity still remains high (Bhat and Rajan 1990; Kumar 1993)
1,000 live births, while among the higher educated women infant mortality was 29 (Bhat and Rajan 1990). The NFHS of Kerala (1992/93) reports a level of infant mortality (10 years preceding the survey) of 32.6 per 1,000 live births in rural areas and 26.3 deaths per 1,000 live births in urban areas. Illiterate women had an infant mortality of 60.4 per 1,000 live births, women with at least high school education had an infant mortality of 14.5 per 1,000 live births.

Major factors assumed to be related to the decline in infant mortality are, first of all, the high female literacy and, in the second place, the expansion and spread of health facilities. Regarding the latter, in 1977 47 per cent of the villages in Kerala had a health centre within 2 kilometres (all-India: 12 per cent). Moreover, access to health centres is easier in Kerala due to better transport facilities (Bhat and Rajan 1990). These authors argue that, although it is often stated that access to health centres is so high in Kerala because of government policies, one should not underestimate the role of literacy (making access easier) and the high population density (reducing costs of providing health services, transportation).

In Uttar Pradesh, in 1970 infant mortality amounted to 154 deaths per 1,000 live births, then it started to decline substantially reaching a level below 100 deaths in 1990. The latest figures from the SRS of 1992 indicate an infant mortality of 98 deaths per 1,000 live births (for all-India this was 79 deaths per 1,000 life births). The NFHS of Uttar Pradesh (1992/93) reported an infant mortality of 100 deaths per 1,000 live births for the period 1988-1992 (see Table 4.4).

The NFHS report for rural areas a level of infant mortality (10 years preceding the survey) of 126.5 per 1,000 live births and for urban areas 67.5 deaths per 1,000 live births. Illiterate women had an infant mortality of 127.4 deaths per 1,000 live births, women with at least high school education had an infant mortality of 54.6 per 1,000 live births.

Kerala's fertility has been lowest of all-India or near to it, since the 1950s (Nag 1989, p.143). In fact, in 30 years Kerala has accomplished a reduction of fertility which took a century for developed countries to achieve (Austin 1993). The total fertility (TFR) declined from 5.0 in 1941-51, to 4.7 in 1961-71, and to 2.3 in 1985-87. From 1990 onwards, the Sample Registration System reports a TFR below replacement, i.e. TFR is 1.9 (see Table 4.5).

Differences in fertility between the urban and rural areas are observed throughout India. These differentials, however, are lower in Kerala (Nag 1989, p.145), especially from the beginning of the 1980s onwards. In 1992, in urban and in rural areas TFR amounted to 1.7. Kerala's fertility decline is also reported to be evenly distributed among socio-economic classes (Nair 1990), religious groups and caste groups (Zachariah 1990).

<table>
<thead>
<tr>
<th>Year</th>
<th>Kerala Total</th>
<th>Rural</th>
<th>Urban</th>
<th>Uttar Pradesh Total</th>
<th>Rural</th>
<th>Urban</th>
<th>All-India Total</th>
<th>Rural</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>1941-51*</td>
<td>5.0</td>
<td></td>
<td></td>
<td>6.1</td>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1951-61*</td>
<td>5.3</td>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1961-71*</td>
<td>4.7</td>
<td></td>
<td></td>
<td>6.4</td>
<td></td>
<td></td>
<td>5.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1971-81*</td>
<td>3.3</td>
<td></td>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
<td>5.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1972</td>
<td>4.2</td>
<td>3.6</td>
<td></td>
<td>5.4</td>
<td>4.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1978</td>
<td>2.8</td>
<td>2.3</td>
<td></td>
<td>4.6</td>
<td>3.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1981-83</td>
<td>2.8</td>
<td></td>
<td></td>
<td>5.8</td>
<td></td>
<td></td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>2.4</td>
<td>2.4</td>
<td></td>
<td>4.2</td>
<td></td>
<td></td>
<td>4.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1985-87</td>
<td>2.3</td>
<td></td>
<td></td>
<td>5.5</td>
<td></td>
<td></td>
<td>4.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>5.2</td>
<td>5.5</td>
<td>3.8</td>
<td>3.8</td>
<td>4.1</td>
<td>2.8</td>
</tr>
<tr>
<td>1991</td>
<td>1.8</td>
<td>1.8</td>
<td>1.7</td>
<td>5.1</td>
<td>5.4</td>
<td>3.7</td>
<td>3.6</td>
<td>3.9</td>
<td>2.7</td>
</tr>
<tr>
<td>1992</td>
<td>1.7</td>
<td>1.7</td>
<td>1.7</td>
<td>5.2</td>
<td>5.6</td>
<td>3.6</td>
<td>3.6</td>
<td>3.9</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Source: Registrar General of India, Sample Registration System
* Census, estimates by Srinivasan 1991

43
In Uttar Pradesh, total fertility is highest. Over the last few decades decline in fertility has been insignificant: from 6.1 in the period 1941-51 to 5.2 only in 1992 (see Table 4.5). The differences between the rural and urban areas are huge: the SRS of 1992 indicates total fertility to amount to 5.6 and 3.6, respectively. The NFHS in 1992/93 found a lower overall TFR (4.82), and the differences between the urban and rural areas were smaller (5.2 and 3.6, respectively).

Summarizing, Kerala has almost completed the demographic transition while in Uttar Pradesh fertility and infant mortality are still very high. What are the differences in proximate determinants of fertility between the two states?

### 4.3 Proximate determinants of fertility

For all-India, in 1981 the mean age at birth of the first child was 21.6 years and the mean age at birth of the last child 35.6 years. Women in Kerala not only give birth for the first time at a later age (23.1 years) but also stop reproduction at an earlier age (32.1 years).

In Uttar Pradesh, women bear their first child earlier (20.8 years) and their last child later (37.7 years) (Ram and Pathak 1989). What is the contribution of the proximate determinants to the length of the reproductive life span of women in both states?

**Marriage**

Women in Kerala marry later than anywhere else in India. This has been the case at least since 1921 (Nag 1989, p.147). In 1921, the mean age at marriage of Keralite women was 17.2 years, and in 1981 it was 21.8 years (see Table 4.6).

For all-India, these figures were 13.4 years and 18.4 years, respectively.³ In Uttar Pradesh, women marry younger: in 1921 at 12.4 years.³ Mean age at marriage remained low during the following decades, lower than the national averages, and in 1981 it was 16.9 years.

Table 4.7 indicates the differences in age at marriage for Kerala, Uttar Pradesh and all-India, according to educational level (1984). In both states, educated women have a higher mean age at marriage than illiterate women, although the difference is much more pronounced in Kerala where most educated, urban women marry at an age of 23.2 years (illiterate urban women at 17.6 years), while in Uttar Pradesh these women marry at an age of 19.9 years (illiterate urban women at 17.0 years). The differences in age at marriage between the rural and urban areas in Kerala seem to be less than in Uttar Pradesh.

**Contraceptive Prevalence Rate (CPR)**

For all-India, the Contraceptive Prevalence Rate (CPR), as estimated by the all-India surveys, was 14 per cent in 1970, 35.3 per cent in 1980, and 40.6 per cent in 1992/93 (see Section 3).

The CPR is much higher in Kerala. In 1970, the ORG survey indicated a CPR of 27 per cent for Kerala. In 1980, the CPR amounted to 61 per cent. Of these users, 93 per cent depended on modern methods.

The NFHS in 1992/93 reported a CPR of 63.3 per cent (see Table 4.8).

The CPR is much lower in Uttar Pradesh. In 1970, the ORG survey reported a CPR of 7 per cent, and in 1980 of 22 per cent. In 1980, 74 per cent of all users depended on modern methods, which indicates that a high percentage depend on traditional methods (Khan and Prasad 1985, p.317). The CPR remained very low and in 1992/93 it was only 19.8 per cent (see Table 4.8). Actually, the state shows the second lowest CPR (next to Nagaland).

The NFHS (1992/93) data indicate that in both

<table>
<thead>
<tr>
<th>Year</th>
<th>Kerala</th>
<th>Uttar Pradesh</th>
<th>All-India</th>
</tr>
</thead>
<tbody>
<tr>
<td>1901</td>
<td>17.4</td>
<td>12.3</td>
<td>13.1</td>
</tr>
<tr>
<td>1911</td>
<td>17.7</td>
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<td>13.2</td>
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<td>1921</td>
<td>17.2</td>
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<td>11.7</td>
<td>12.7</td>
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<td>1941</td>
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<td>14.7</td>
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<td>1951</td>
<td>19.9</td>
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<td>1961</td>
<td>20.1</td>
<td>14.8</td>
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</tr>
<tr>
<td>1971</td>
<td>20.9</td>
<td>15.6</td>
<td>17.2</td>
</tr>
<tr>
<td>1981</td>
<td>21.8</td>
<td>16.9</td>
<td>18.4</td>
</tr>
</tbody>
</table>

Table 4.7: Mean age at marriage (years) of women by level of education, Kerala, Uttar Pradesh and all-India, 1984

<table>
<thead>
<tr>
<th>Level of education</th>
<th>Kerala Rural</th>
<th>Urban</th>
<th>Uttar Pradesh Rural</th>
<th>Urban</th>
<th>All-India Rural</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illiterate</td>
<td>18.1</td>
<td>17.6</td>
<td>15.8</td>
<td>17.0</td>
<td>16.5</td>
<td>16.7</td>
</tr>
<tr>
<td>Literate but below middle</td>
<td>18.6</td>
<td>18.4</td>
<td>16.7</td>
<td>17.6</td>
<td>17.4</td>
<td>17.5</td>
</tr>
<tr>
<td>Middle but below matric</td>
<td>19.0</td>
<td>19.0</td>
<td>16.6</td>
<td>17.6</td>
<td>17.7</td>
<td>17.9</td>
</tr>
<tr>
<td>Matric but below graduate</td>
<td>20.9</td>
<td>21.2</td>
<td>17.1</td>
<td>18.6</td>
<td>19.0</td>
<td>19.4</td>
</tr>
<tr>
<td>Graduate and above</td>
<td>23.1</td>
<td>23.2</td>
<td>17.6</td>
<td>19.9</td>
<td>20.9</td>
<td>21.2</td>
</tr>
<tr>
<td>All educational level</td>
<td>18.8</td>
<td>19.1</td>
<td>15.9</td>
<td>17.5</td>
<td>16.7</td>
<td>17.6</td>
</tr>
</tbody>
</table>

Source: Registrar General of India, 1984

Kerala and Uttar Pradesh most people relied on sterilization. In Kerala too, as at the national level, the use of temporary methods like IUD, pill and condoms is very low, i.e. 5.1 per cent (5.5 per cent at the national level). In Uttar Pradesh, the use of temporary methods is relatively high (5.3 per cent), compared to the total CPR (19.8 per cent).

Table 4.9 indicates the use of contraceptive methods for urban and rural areas in Kerala and Uttar Pradesh for 1992/93. In Kerala there is not much difference in CPR between the urban and rural areas. CPR is slightly higher, i.e. 68.2 per cent, in the urban areas, but in the rural areas it still amounts to 61.4 per cent. The higher percentage of couples in the urban areas using traditional methods is remarkable. Remarkable too is that illiterate women had a higher CPR than women with at least high school

Table 4.8: Percentage of currently married couples of reproductive age (15-49 years) currently using contraception, in Kerala and Uttar Pradesh (1970-1992/93)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sterilization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>6.5</td>
<td>1.4</td>
<td>41.8</td>
<td>11.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0.7</td>
<td>1.1</td>
<td>0.3</td>
<td>1.0</td>
<td>2.9</td>
<td>3.2</td>
</tr>
<tr>
<td>IUD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pill</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condom</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Total modern methods</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>54.4</td>
<td>18.5</td>
</tr>
<tr>
<td>Traditional methods</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8.9</td>
<td>1.3</td>
</tr>
<tr>
<td>Total</td>
<td>27.0</td>
<td>7.0</td>
<td>61.0</td>
<td>22.0</td>
<td>63.3</td>
<td>19.8</td>
</tr>
</tbody>
</table>


1992/93:
Table 4.9: Percentage of currently married couples of reproductive age (15-49 years) currently using contraception, in Kerala and Uttar Pradesh, 1992/93

<table>
<thead>
<tr>
<th>Method</th>
<th>Kerala Total</th>
<th>Rural</th>
<th>Urban</th>
<th>Uttar Pradesh Total</th>
<th>Rural</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sterilization Male</td>
<td>6.5</td>
<td>6.0</td>
<td>7.8</td>
<td>1.4</td>
<td>1.2</td>
<td>2.2</td>
</tr>
<tr>
<td>Female</td>
<td>41.8</td>
<td>41.5</td>
<td>42.6</td>
<td>11.7</td>
<td>11.2</td>
<td>13.6</td>
</tr>
<tr>
<td>IUD</td>
<td>2.7</td>
<td>2.9</td>
<td>2.3</td>
<td>1.1</td>
<td>0.6</td>
<td>3.4</td>
</tr>
<tr>
<td>Pill</td>
<td>0.5</td>
<td>0.4</td>
<td>0.6</td>
<td>1.0</td>
<td>0.9</td>
<td>1.5</td>
</tr>
<tr>
<td>Condom</td>
<td>2.9</td>
<td>2.5</td>
<td>3.9</td>
<td>3.2</td>
<td>1.8</td>
<td>8.8</td>
</tr>
<tr>
<td>Total modern methods</td>
<td>54.4</td>
<td>53.2</td>
<td>57.3</td>
<td>18.5</td>
<td>15.8</td>
<td>29.6</td>
</tr>
<tr>
<td>Traditional methods</td>
<td>8.9</td>
<td>8.1</td>
<td>10.9</td>
<td>1.3</td>
<td>1.0</td>
<td>2.4</td>
</tr>
<tr>
<td>Total</td>
<td>63.3</td>
<td>61.4</td>
<td>68.2</td>
<td>19.8</td>
<td>16.7</td>
<td>32.0</td>
</tr>
</tbody>
</table>

Source: National Family Health Survey, 1992/93

education: 66.7 per cent and 62.9 per cent, respectively. Taking only modern methods into account the differences are even bigger: 63.4 per cent and 46.5 per cent, respectively, indicating that higher educated women rely more on traditional methods than illiterate women do. In addition, Muslims had a much lower CPR (37.8 per cent) than Hindus (72.5 per cent) and Christians (71.7 per cent) (NFHS 1992/93).

In Uttar Pradesh, the differences between the urban and rural areas are huge. In the urban areas 32.0 per cent of couples in the reproductive age use contraceptives while in the rural areas this is only half, i.e. 16.7 per cent. Women with at least high school education had a much higher CPR of 40.4 per cent than illiterate women, i.e. 15.5 per cent. Also in Uttar Pradesh, literate women rely more than illiterate women on traditional methods like periodic abstinence (2.5 and 0.7 per cent, respectively) and withdrawal (1.0 and 0.1 per cent), although the differences are smaller than in Kerala. In addition, also in Uttar Pradesh Muslims had a lower CPR (10.5 per cent) than Hindus (21.2 per cent) and other religions (41.1 per cent) (NFHS 1992/93).

Abortion

Data on the exact number of induced abortions per state are difficult to obtain and conclusions about the differences between Kerala and Uttar Pradesh are difficult to draw. Data available on regional variation are those registered by official institutions (see also Section 3).

Chhabra and Nuna (1994) conclude that within the limited performance of data, the two top performers are Uttar Pradesh and Maharashtra. Cumulatively, since the inception of the programme in 1972 to 1991-92, Uttar Pradesh accounts for 18.4 per cent of the medically terminated pregnancies (MTP). Maharashtra accounted for 16.3 per cent. The state of Kerala accounted for 6.5 per cent of all MTPs. In the year 1991-92, the state of Maharashtra, containing 9.4 per cent of India's population, accounted for 20.07 per cent of all MTPs. Uttar Pradesh, with 16.6 per cent of the total population, accounted for 19.13 per cent of MTPs and Kerala, with 3.5 per cent of the population, accounted for 5.8 per cent. Bihar, one of the BIMARU states, has a share of 10.3 per cent of India's population and takes only 1.64 per cent of the MTPs.

The NFHS (1992/93), however, indicates that the percentage of all pregnancies of ever-married women ending in an induced abortion is slightly higher in Kerala (1.6 per cent) than in Uttar Pradesh (0.9 per cent).

Postpartum infecundability

A study in rural Kerala in 1984 (reviewed by Natarajan 1989) reported an average duration of postpartum amenorrhea of 7.9 months. A small-scale survey in a suburban area of Trivandrum
(Padmanabharu and Sudev 1993) reports an average duration of breastfeeding of 16.6 months and an estimated average duration of postpartum amenorrhea of 3.4 months. The same survey indicates a mean duration of postpartum abstinence of 4 months. These latter figures seem to be very low, especially given the fact that "unlike in many other countries, the custom of breastfeeding has not suffered serious set-backs so far in Kerala, even among urbanites" (Nair 1990).

The NFHS of 1992/93 reports a mean duration of postpartum non-susceptibility of 10.1 months. Mean duration of postpartum amenorrhea was 7.3 months while the mean duration of postpartum abstinence was 7.6 months. There was a small difference between rural and urban Keralite women: median duration of postpartum non-susceptibility for rural women was 7.5 months, for urban women 6.9 months. The major difference between rural and urban woman appeared to be the duration of abstinence: 5.1 and 3.9 months, respectively. With regard to the duration of postpartum amenorrhea, rural and urban women hardly differ: 5.5 and 5.3 months, respectively. Illiterate women had a shorter (1) period of postpartum non-susceptibility, i.e. 5.4 months, than women with at least high school education, i.e. 6.4 months. The longest period, i.e. 9.2 months, was found among women with less than middle school education (NFHS 1992/93).

The duration of postpartum amenorrhea appears to be longer in Uttar Pradesh. A rural study in Uttar Pradesh (Sehgal and Singh 1968; cited by Srinivasan 1991) reported an average duration of postpartum amenorrhea of 12.5 months. Older women (40-49 years) turned out to have a longer period of amenorrhea (15.4 months) than women in the youngest age group of 15-19 years (8.8 months only). The mean duration of breastfeeding did not vary much, though: 22.6 months among the youngest and 24.0 months among the eldest women.

A study conducted in rural Lucknow in 1967 indicated a similar duration of postpartum amenorrhea of 12.5 months. Yet another study, conducted in the rural areas in 1980, reported a mean duration of postpartum amenorrhea of 11.6 months (reviewed by Natarajan 1989).

The NFHS of 1992/93 reports a mean duration of post-partum non-susceptibility for women in Uttar Pradesh of 11.8 months (Kerala: 10.1 months; all-India: 10.0 months). Mean duration of postpartum amenorrhea was 10.5 months while the mean duration of postpartum abstinence was 5.6 months. Differences between rural and urban areas exist: for rural women the median duration of postpartum non-susceptibility was 9.8 months, for urban women 7.1 months. The major difference is due to a longer period of postpartum amenorrhea among rural women. Moreover, unlike Keralite women, illiterate women had a much longer duration of postpartum non-susceptibility, i.e. 9.9 months, than women with at least high school education, i.e. 6.9 months (NFHS 1992/93).

Summary

Summarizing, the major differences in proximate determinants between the two states are age at marriage, contraceptive prevalence rate and postpartum amenorrhea. In Kerala, both mean age at marriage and CPR are high. Mean age at marriage of women in 1981 was 21.0 years and CPR amounted to 63.3 per cent in 1992/93. Bhat and Rajan (1990) rule out increase of age at marriage as a major principle affecting fertility in Kerala, thus leaving CPR as the major determinant of fertility. The authors review different theories about the decline of fertility in Kerala and conclude that, in their judgement "fertility transition in Kerala adheres more closely to the diffusion principle".

In Uttar Pradesh, both age at marriage and CPR are low. Mean age at marriage of women was 16.7 years in 1981 and the CPR amounted to 19.8 per cent in 1992/93. Mean duration of postpartum infecundability is longer, however, (11.8 months) than in Kerala (10.1 months).

4.4 Socio-economic and policy factors affecting proximate determinants

What economic, social, cultural or political factors are related to the proximate determinants of fertility in Kerala and Uttar Pradesh? In other words, what factors are responsible for the differences in proximate determinants and fertility in the two states?

Economic conditions

There are some differences in economic conditions between the two states (see Table 4.10). In Kerala, most of the state income is provided by services (43.0 per cent) and agricultural activities (38.9 per cent), while mining and manufacturing play a minor role (18.0 per cent). Uttar Pradesh is more agriculturally oriented: 49.3 per cent of the state income is provided by agricultural activities, 23.2 per cent by manufacturing and mining and 27.5 per
Table 4.10: Economic indicators for Kerala, Uttar Pradesh and all-India

<table>
<thead>
<tr>
<th></th>
<th>Kerala</th>
<th>Uttar Pradesh</th>
<th>All-India</th>
</tr>
</thead>
<tbody>
<tr>
<td>State income (%) (1983-86)</td>
<td>38.9</td>
<td>49.3</td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>18.0</td>
<td>23.3</td>
<td></td>
</tr>
<tr>
<td>Mining and manufacturing</td>
<td>43.0</td>
<td>27.5</td>
<td></td>
</tr>
<tr>
<td>Percentage population below poverty line (%) (1983/84)</td>
<td>27.0</td>
<td>45.0</td>
<td>37.0</td>
</tr>
<tr>
<td>Per capita income (Rs) at current prices</td>
<td>594</td>
<td>486</td>
<td>486</td>
</tr>
<tr>
<td>1970-71</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1985-86</td>
<td>2,140</td>
<td>2,003</td>
<td>2,003</td>
</tr>
</tbody>
</table>

Source: Centre for Monitoring Indian Economy (CMIE) 1988; 1990

Table 4.11: Crude female literacy rates (%) in Kerala, Uttar Pradesh and all-India, 1951-1991

<table>
<thead>
<tr>
<th>Year</th>
<th>Kerala</th>
<th>Uttar Pradesh</th>
<th>All-India</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>32.0</td>
<td>3.6</td>
<td>7.9</td>
</tr>
<tr>
<td>1961</td>
<td>39.0</td>
<td></td>
<td>13.0</td>
</tr>
<tr>
<td>1971</td>
<td>54.0</td>
<td></td>
<td>18.7</td>
</tr>
<tr>
<td>1981</td>
<td>65.0</td>
<td>14.0</td>
<td>24.8</td>
</tr>
<tr>
<td>1991</td>
<td>75.0</td>
<td>20.9</td>
<td>32.5</td>
</tr>
</tbody>
</table>

Source: Registrar General of India; Census
All-India: Premi 1991, p.67
Kerala: Nag 1989, p.147
Uttar Pradesh: Satia and Jegatbhoj 1991, p.10

Infant mortality and life expectancy at birth

The differences in infant mortality between the two states are huge, as we discussed earlier in Section 4.2. Of all Indian states, Kerala has the lowest and Uttar Pradesh the highest infant mortality. In 1992, infant mortality in Kerala amounted to 17 deaths per 1,000 live births and in Uttar Pradesh it was 98 deaths per 1,000 live births. Female life expectancy at birth in Kerala was, in 1986-91, 72.3 years and in Uttar Pradesh 49.6 years.

Literacy

Data from 1951 onwards show that Kerala has the highest level of literacy in India (see Table 4.11). In 1991, the crude female literacy rate was 75 per cent. The NFHS in 1992/93 found an illiteracy rate among women in the reproductive period of 17.6 per cent. In rural areas, the illiteracy rate was slightly higher but the differences are small. In Uttar Pradesh, according to the 1991 census, the crude female literacy rate was 20.9 per cent. The NFHS found an illiteracy rate of 68.4 per cent.

The level of literacy can also be indicated by the percentage of girls attending school. At the age of 11-14 years, in Kerala 89.7 per cent of all girls are still engaged in education. At the national level this percentage is 36.3 per cent. In Uttar Pradesh, however, the percentage is even lower: only 22.5 per cent of the girls are still engaged in education (data for 1984/85; CMIE 1988).

The differences in literacy between Kerala and Uttar Pradesh can explain the differences in age at marriage and use of contraceptives and, as a
consequence, fertility. Satia and Jejeebboy (1991) conclude that "... in Uttar Pradesh ...female status indicators, and especially female literacy, have the maximal negative effect on fertility, exceeding by far the effect of such indicators as caste, religion and even rural-urban residence". Nag (1989, p.155) concludes that in Kerala "the effect of education on the proximate determinants of both fertility and mortality explain more than anything else the relatively higher decline of vital rates".

Why, then, is female literacy so high in Kerala? Nag (1989) mentions several factors that are responsible for the high level of education. Historical factors play a role, i.e. the emphasis on non-formal education in the early temple culture, the tradition of female education among the matriarchal caste group of the Nayars (see status of women), encouragement of education by native rulers like the Maharajas of Travancore and Cochin and by Christian missionaries* and British administrators (although the latter were also present in other parts of India). Other factors reported by Nag (1989) to be responsible for the high level of education in Kerala are the early commercialisation of the economy and expansion of trade in Kerala (facing the Lakshadweep Sea, the state has had contacts with (foreign) traders for centuries), social movements among the lower castes demanding education facilities and the higher priority given to education in post-independence governmental expenditure. Bhat and Rajan (1990) add the high population density which made accessibility to schools higher.

Status of women and son preference

One of the indicators of status of women is the sex ratio (number of females per 1,000 males). As mentioned before, Kerala is one of the few Indian states where the sex ratio is higher than 1000. The overall sex ratio has always been above 1000, and in 1991 it was 1040. Although the outmigration of men played a role, the main factor underlying the sex ratio in Kerala is the greater longevity of women (Bhat and Rajan 1990). In Uttar Pradesh, the overall sex ratio is one of the lowest of all Indian states. In 1991 the sex ratio was 879 females per 1,000 males, implying that female mortality is much higher than male mortality.

Moreover, a fair indicator of female autonomy in Kerala is the high percentage of female literacy and the high age at marriage. An important related factor is that Kerala, unlike most of the other states in India, was traditionally a matriarchal society with a matrilineal mode of inheritance (from mother to daughter, from brother to sister's children (Mandelbaum 1971, p.56-57); women can inherit land, for example) (Kannan et al. 1991). Traditionally, women are seen as an asset, not as a liability. Although the matrilineal system has weakened recently it is believed to have left women with more power and autonomy than elsewhere in India (Bhat and Rajan 1990). In Kerala, for example, girls still inherit land (verbal information from Nair during the workshop in Kerala).

This does not mean that the custom of son preference does not exist in Kerala. It exists, although the custom is less strong than in Uttar Pradesh (Mahadevan and Jayashree 1989; Ramakumar and Devi 1989). Still, in Kerala, parents desire at least one son to care for them in old age (Zachariah 1984, cited by Nag 1989, p.152).

Differences in desired family size exist. In Kerala, the two-child-family norm is well-established and in urban areas people even talk about one-child families (Nair 1990). In Uttar Pradesh, as Saxena (1989) concludes, the two-child norm propagated by the national Family Planning programme and adopted in many states "has yet to become an integral part of rural life". The study of Kumar and Sharma (1983) (cited by Basu 1991) indicates that in Uttar Pradesh the average ideal family size is 3.9. For all-India, the average ideal size is 3.0 (Khan and Prasad 1985).

The differences in son preference between the two states is nicely analysed by Mahadevan and Jayashree (1989). This study indicates that among couples with women of reproductive age, 87 per cent in Uttar Pradesh and 54 per cent in Kerala showed an interest in having a son during their lifetime (Mahadevan and Jayashree 1989, p.123).

The reasons for son preference, or the values attached to sons, are shown in Table 4.12. Economic support in old age, salvation of parents by the conduct of ritual functions, and physical support in old age played a major role in both states, although in Uttar Pradesh these considerations were a little bit stronger. Provision of traditional links, meeting

*The influence of the Christian missionaries can still be observed in the religious composition of Kerala. Only 58.2 per cent of its population is Hindu, 21.2 per cent Muslim and a relatively high proportion (20.6 per cent) is Christian. The religious composition of Uttar Pradesh differs: 83.3 per cent is Hindu and 15.9 per cent Muslim, while a minority is Christian and Sikh (census 1981). In Uttar Pradesh, 21.4 per cent of the population belongs to scheduled caste or tribe. In Kerala, this is 11.0 per cent (CMIE 1981).
family obligations, inheritance of family property,
and enhanced status are considerations that play a
major role in Uttar Pradesh but that are far less
important in Kerala.

Policies

Data indicate that in Kerala fertility started to decline
even before the intensification of the family planning
programme (Bhat and Rajan 1990). Nair and Devi
(1992, p.1), however, mention that in Kerala "although there has been a host of highly favourable
and conducive socio-cultural factors (for fertility
decline) the role of official family planning program
through its contraceptive service delivery ....in the state cannot be underestimated". From the early years of the family welfare programme (late 60s) onwards, Kerala has been at
the top of all states in amount of rupees spent on
family welfare programme. The programme focused
on both urban and rural areas (Nag 1989). One of the
most successful sterilization camps was organized in
1970-71 in Ernakulam in Kerala under the leadership
of S. Krishna Kumar: over 60,000 people were
sterilized (Shariff 1989). This example was followed
in many other places, although not all were as
successful as the one in Kerala (see also Section 2).

Bose (1989) concludes that, especially in the states
of Bihar, Haryana, Madhya Pradesh, Rajasthan and
Uttar Pradesh, the credibility of the family planning
programme is near zero, as these states have not yet
recovered from the shock of the 'Emergency'
sterilisation programme (see also Section 2).

Fieldwork too revealed that villagers in Uttar Pradesh
were hostile to the national family planning effort.
This seems to result from a low frequency of contact
with field staff and a recruitment style that had
coercive elements (Misra et al. 1988). Accessibility
to and utilization by the rural masses of family
planning services are reported to be limited and the
credibility of government health services in Uttar
Pradesh is said to be fairly low (Khan et al, 1989).

Per capita expenditure on health, education and
social welfare in the BIMARU states is only 60 per
cent of the all-Indian expenditure (Satia and
Jejeebhoy 1991, p.9). In 1986-87, in all-India 43 rs
per capita were spent on health, in Uttar Pradesh this
were 29 rs and in Kerala 61 rs (CMIE 1988). More
important is the expenditure per capita on education,
which of all states is highest in Kerala. In 1986-87, 193
rs were spent per capita on education. In Uttar
Pradesh, this were 80 rupees rs per capita and for all-
India 119 rs (CMIE 1988).

In Kerala the Communist Party, established in 1939
and elected in the late 1950s, was spending 80 per
cent of the budget on health and education (Austin
1993; Den Uyl 1992). From the 1950s onwards,
medical expenditure, number of institutions and
health care personnel per capita have increased
dramatically in Kerala. There has been a spread of
maternity and child welfare centres and health
education campaigns. The health care system is
characterized by a more even spatial distribution
(Panikar 1985).
4.5 Discussion

In Uttar Pradesh, both age at marriage and CPR are very low. In respect of the socio-economic and policy variables that affect these proximate determinants, the poor economic status of the state can be one of the contributing factors. The economic conditions in Kerala, however (for example the per capita income, which is lower than the national figure), are also low and are not such that they can explain the low levels of fertility in this state. In fact, Kerala is one of the few cases (like China and Sri Lanka) where low economic development is related to low fertility.

The extremely high level of infant mortality in Uttar Pradesh might play a role, the major factor, however, seems to be the very low level of literacy. Satia and Jejeebhoy (1991) conclude that "... in Uttar Pradesh ...female status indicators, and especially female literacy, have the maximal negative effect on fertility, exceeding by far the effect of such indicators as caste, religion and even rural-urban residence".

Policy plays a part, too. The negative connotation of the family planning programme in this state where the Emergency was strongly felt, the low expenditures on health, education and social welfare: all these factors contribute to high fertility.

In Kerala, the major proximate determinant is the CPR. Bhat and Rajan (1990) rule out increase of age at marriage as a major principle affecting fertility in the state. The authors review different theories about the decline of fertility in Kerala and conclude that, in their judgement "fertility transition in Kerala adheres more closely to the diffusion principle".

In respect to the socio-economic and policy factors that affect the proximate determinants, the importance of female literacy is obvious. Many studies also point to the importance of the education policies and health policies by the Keralite state government. Another favourable condition would be the greater female autonomy due to the matriarchal system. Also, the mobility of the people, the contacts with other cultures through trade and missionaries, and exposure to mass-media are reported to have induced a more rapid acquisition of new ideas (like contraceptive use) and diffusion of ideas. The large group of outmigrants, too, formed an important source of new ideas and technology (Nag 1989).

Besides this, political awareness and action among the masses are reported to be important (Nag 1988). Kerala has a long tradition of caste and peasant movements calling for social and economic rights, which made a more effective use of educational and health services possible.

Bhat and Rajan (1990, p.1979), however, based on a statistical analysis, conclude that egalitarian reforms, greater autonomy of women, higher unemployment rates and ecological factors did not affect fertility in Kerala as much as is sometimes assumed in the literature. These authors found that the major role is played by female literacy (driven by male literacy): once the difference in adult female literacy and percentage of Muslims were controlled for, little difference in fertility remained to be explained.

During the workshop in Kerala, Bose did not agree at all with this last conclusion. He formulated a model of fertility decline for both states, thereby nicely summarizing most of the factors mentioned above and adding a few more.

For Uttar Pradesh, the most important factors responsible for the high fertility as discerned by Bose are: poverty, the high degree of illiteracy, the physical inaccessibility of areas, the higher proportion of Muslims which creates a so-called 'Muslim environment', more orthodoxy among the Hindus, a more feudal caste system, resentment against the family planning programme (due to the Emergency), and probably also climatic factors.

For Kerala, the most important factors responsible for the low fertility and included in the Bose's so-called M-model are: the role played by the Maharajas, the Missionaries, the Marxists, Matrilineal society, Mobility and migration, Monetary expenditure on health and education, the Media (Kerala has the highest percentage of readers of newspapers), Money incentives (during the sterilization camps in Ernakulam, for example, clothes for men - lungis and dhotis - were provided as gifts), Movement of the backward class and, last but not least, .... Magic.
5. FERTILITY CHANGE: AN INTEGRATED SYSTEMS APPROACH

The information provided in Sections 2 and 3 has been used in the implementation of the India fertility model. We follow the outline presented in Van Vianen et al. (1994). Values of parameters of the generic model are implemented and - where necessary - modified, changed or improved. Note that a major drawback of the global model (TARGETS distinguished only the 15-45 year age group, is resolved in the India model: six five-year age groups within the Impact subsystem are discerned. Among other things, this enables us to add the topic of aging to the fertility model. Furthermore, a specific variable added to the India model is the custom of son preference. Values of the parameters of the India model and expected future developments were discussed with the renowned Indian demographers during the workshop in Kerala (see also Preface). These expert judgements are included in the India model.

5.1 Conceptual model of fertility change

The conceptual model, which serves as starting point for our mathematical modelling effort, is structured in terms of Pressure, State, Impact and Response (P-S-I-R) systems (Rotmans et al. 1994). The State system encompasses the total fertility (TFR) and the factors which directly influence fertility, i.e. the proximate determinants as distinguished by Bongaarts and Potter (1983): marriage, contraceptive use, induced abortion and postpartum infecundability. The Pressure system describes the driving forces underlying fertility changes and comprises the following indirect variables: life expectancy, female education, gross national product and (current) population growth. Population growth is considered to be a feedback from the impact system. The Impact system describes the outcome of the fertility process. We distinguish the immediate and long-term consequences of actual fertility. Within TARGETS, the immediate outcome is the number of births which, together with the number of deaths from the health module, generates the actual population dynamics. The long-term outcome is modelled as the population momentum (Bongaarts 1994), which estimates the factor by which the current population will ultimately grow before reaching stationarity, in case fertility is immediately reduced to replacement level of 2.1 child per woman. The changing age structure is expressed in terms of the proportion of the elderly population. A declining fertility is associated with an increasing proportion of elderly and hence an aging population. The Response/steering system includes the response to, or feedbacks from, the impact subsystem. In the fertility model, unmet need and policy awareness are feedback mechanisms which influence the priority for population policy. The policy priority becomes manifest in four spearheads: abortion policy, education policy, family planning allocation, and mass communication. The response or steering system also includes those variables by which the user can influence or change the proximate determinants of fertility, i.e. the steering variables. In the model, the steering variables refer to the four spearheads mentioned above. Delays between feedbacks and priority for population policy, and between policy measures and actual influences are taken into account.

Figure 5.1 shows the India fertility model. A major addition to the global model is the custom of son preference, related to wanted fertility and influenced by HDI, and affecting fertility through the Contraceptive Prevalence Rate.

5.2 The pressure system

In the global model, the indicator of level of socio-economic development is the Human Development Index (HDI), as defined by the UNDP. HDI is estimated on the basis of three factors: life expectancy at birth, literacy, and Gross National Product. One of the disadvantages of HDI as a composite index, developing in time, and affecting fertility, is its ponderousness. The index does not reflect differentiations: the same HDI scores might be composed of the three factors in different proportions. In the India model, therefore, literacy, life expectancy and GNP are treated as separate entities.

5.3 The state system

The state system considers the inhibiting effects of the proximate determinants on fecundity level. The total fecundity rate (TF) is generally considered to
INDIA INTEGRATED FERTILITY MODEL

Figure 5.1: Systems diagram of the Pressure-State-Impact-Response (P-S-I-R) chain, related to the India fertility model

amount to 15.3 children per woman. The inhibiting effects of the four proximate determinants are measured by indices,\(^1\) which can take values between 0 and 1.

- \(C_m\) index of proportion married (equals 1 if all women of reproductive age are married and 0 in the absence of marriage)
- \(C_c\) index of contraception (equals 1 in the absence of contraception and 0 if all fecund women use 100% effective contraception)
- \(C_a\) index of abortion (equals 1 if the absence of induced abortion and 0 if all pregnancies are aborted)
- \(C_i\) index of postpartum infecundability (equals 1 in the absence of lactation and postpartum abstinence and 0 if the duration of infecundability is infinite)

Each index equals the ratio of the fertility levels in the presence and in the absence of the inhibition caused by the corresponding intermediate fertility variable:

\[
C_m = \frac{TFR}{TM}
\]
\[
C_c \cdot C_a = \frac{TM}{TN}
\]
\[
C_i = \frac{TN}{TF}
\]

In which:

- TFR = Total fertility
- TM = Total marital fertility
- TN = Total natural marital fertility
- TF = Total fecundity

From substitution it follows (Bongaarts and Potter 1983, p.80) that:

\[
TFR = C_m \cdot C_c \cdot C_a \cdot C_i \cdot TF
\]
\[
TM = C_c \cdot C_a \cdot C_i \cdot TF
\]
\[
TN = C_i \cdot TF
\]

Index of marriage: \(C_m\)

In the global model, the equation for \(C_m\) became:

\[
C_m = \frac{U_{mt} \cdot 40 - Avg_m}{25}
\]

where

- \(U_{mt}\) = proportion of women ultimately married (scale 0-1);
- \(Avg_m\) = mean age at marriage (in years);
- 40 = age at last childbirth, according to data from populations not practising contraception;
- 25 = width of the reproductive interval (15-40 years).

\(^1\) Here, the concept of index does not have the same connotation as defined in TARGETS (see Rotmans et al., 1994). We follow the connotation of Bongaarts and Potter (1983) who measure the fertility inhibiting effects of the different proximate determinants by indexes.
In the generic model, the proportion of women ultimately being married in the world population was assumed to be constant, and was set at 0.90. This assumption can be maintained for India as well: marriage is universal in the subcontinent. The proportion of women ultimately being married, however, is higher: 0.95-0.99.

In general, mean age at marriage is related to development, especially education and particularly education when combined with economic activity of women in the formal sector. In the global model, the rate of increase in the age at marriage with increasing HDI was assumed to remain constant at 0.65. This means that an increase of the HDI with 0.1 (from 0.4 to 0.5, say) increases the mean age at marriage by 6.7 percent [exp(0.65*0.1)-1]. The equation became:

$$\text{Avg}_m = \text{Min}_m \times \exp(0.65 \times \text{HDI})$$

in which $\text{Min}_m = \text{the minimum age at marriage}$.

The minimum age at marriage can be specified for each region or country separately. In the global model, minimum age at marriage was set at 16. For India, the minimum age at marriage is set at 15 years. The Indian experts do not expect the mean age at marriage for women to go beyond 25 years.

The values of $C_m$ estimated with this equation were compared to values of $C_m$ estimated with the equation provided by Bongaarts and Potter (1983). These authors' equation for $C_m$ is:

$$C_m = \frac{\sum m(a) g(a)}{\sum g(a)}$$

where $m(a)$ is the age-specific proportions of women currently married, and $g(a)$ is the age-specific marital fertility rate. Data on age specific proportions of women currently married and age specific marital fertility rates in India were presented in Section 3. Based on these data we find the following values of $C_m$ for 1961–1991:

- $C_m(1961) = 0.87$
- $C_m(1971) = 0.86$
- $C_m(1981) = 0.82$
- $C_m(1991) = 0.72$

If one compares these values of $C_m$ to those derived with the first equation, they appear to fit very well (see Section 6).

**Index of contraception: $C_c$**

In the global model, we proposed the following equation for $C_c$:

$$C_c = 1 - 1.08 \times \text{CPR} \sum_{i=1}^{d} s_i e_i$$

in which

- $\text{CPR} = \text{Contraceptive Prevalence Rate}$;
- $s_i = \text{the share of method } i \text{ in contraception}$;
- $e_i = \text{the use-effectiveness of method } i$.

The information presented in Section 2.4 has been used to modify the method mix ($s_i$) adapting it to the Indian situation. From 1900 up to the first years of the start of the family planning programme, i.e. the 1950s, traditional methods were important. From 1960 onwards, sterilization became the major contraceptive method, while IUD, pill and traditional methods played only a minor role.

The Indian experts expect that in future the percentage of couples using sterilization will decline, maybe to 40-50% but certainly not beyond 30%. The percentage of couples using temporary methods will increase, up to 30-35%. It is assumed that people will rely more on oral pills and condoms than on IUD.

The use-effectiveness ($e_i$) of the contraceptive methods sterilization and IUD remains as defined in the global model:

- $\text{Eff}_{\text{ster}} = 1.00$
- $\text{Eff}_{\text{IUD}} = 0.95$

In the global model, use-effectiveness of the pill and other methods (condoms and traditional methods) were related to HDI. Given the fact that the Indian government wants to redirect its family welfare programme towards spacing methods, and assuming that this change to temporary, less-effective methods needs an extra effort in extension education, we propose to add a mass communication component.

---

Note that $C_m$ for 1991 is estimated from the SRS while the other values are estimated from the census. The SRS indicates a much smaller proportion of married women in the younger age groups (see Tables 3.2 and 3.3). The decline in $C_m$ might be due to this difference in data source or to differences in the definition of marriage.
The equation becomes:

\[ \text{eff - pill} = 0.35 \times \text{HDI} + 0.6 + \text{masscomm} \times (0.35 - 0.35 \times \text{HDI}) \times \left(1 + 0.5 \times \text{masscomm}\right) \]

and

\[ \text{eff - others} = 0.30 \times \text{HDI} + 0.5 + \text{masscomm} \times (0.35 - 0.35 \times \text{HDI}) \times \left(1 + 0.5 \times \text{masscomm}\right) \]

Regarding the Contraceptive Prevalence Rate (CPR), the following formula is used in the India model:

\[
\text{CPR} = \frac{\text{base CPR} + (1 - \text{base CPR}) \times 0.29 \times \left(\frac{\text{Awareness}_{\text{ind}} + \frac{\text{MaxCPR} - 0.29 \times \text{Awareness}_{\text{ind}}}{1 + e^{\text{diffusion rate} \times \text{t}_0 - \text{t}_0}}}{\text{d}}\right)}{1}
\]

in which \( t_0 = 1972 \);

and where:

- \( \text{base CPR} \) = the base CPR in 1900;
- \( \text{Awareness}_{\text{ind}} \) = individual awareness;
- \( \text{MaxCPR} \) = the maximum level of CPR;
- \( \text{diffusion rate} \) = diffusion rate;

In the India model, a base_{CPR} has been specified for the generic model in order to get a more realistic (higher) estimate of CPR around the year 1900. At that time, traditional methods of contraception were used and CPR will start at a (slightly) higher level than is assumed in the global model.

In the global model we proposed that when CPR does not pass the threshold of about 20 per cent, CPR is determined by individual awareness which is defined as the awareness of an individual to control her or his fertility. The effect of human development on awareness, which is assumed to be twice the level of development, is stimulated by family planning efforts (family planning, formerly PES) and by mass communication. This pattern is described by the following equation, in which \( \text{Awareness}_{\text{ind}} \) is bounded by 1:

\[
\text{Awareness}_{\text{ind}} = (2 \times \text{HDI})^{(1 \times \text{famplan}) \times (1 \times \text{masscomm})}
\]

where:

- \( \text{famplan} \) = family-planning effort (scale 0-1);
- \( \text{masscomm} \) = mass-communication (scale 0-1).

For the Indian situation, famplan has been estimated on the basis of information about the history of the Indian family planning programme given in Section 2. The highest score is set around 1975, the period of forced sterilizations (the Emergency).

When the threshold level of 20% of CPR is reached an autonomous diffusion process starts. The transition from an awareness-driven change in CPR to an autonomous diffusion process is not abrupt but smooth. The threshold of 20% is indicative rather than rigid.

In Section 3, we saw that India reached the abovementioned threshold of 20% CPR in 1972. Thus in the India model, \( t_0 = 1972 \). Based on the data from the all-India surveys, a diffusion rate of 9.5%-10% would be realistic. In the model, the diffusion rate is set at 10%. In fact, a diffusion rate of 10% shows in 1980 a CPR which is slightly too low, and in 1989 a CPR which is too high, indicating that the diffusion rate for India is not constant over time.

During the workshop in Kerala, Bhat suggested that one should distinguish two diffusion rates: one representing the internal dynamics, i.e. a constant diffusion rate, and a second one that is externally determined. The latter would be affected by policy: if more emphasis is put on family planning, the diffusion rate will be higher. In the India model this idea is incorporated by the relationship between CPR and the individual awareness driven by the family planning effort.

In the global model, the maximum level of CPR was set at 80% (see CPR equation in Van Vianen et al. 1994, p.31). In the India model, a max_{CPR} is included, related to the custom of son preference (see later).

**Index of abortion: \( C_a \)**

In the global model, \( C_a \) was determined by AR (the number of induced abortions per 1,000 live births) which in turn was affected by the level of CPR (see Van Vianen et al. 1994, pp.32-33). Now we introduce into the generic model a factor linking abortion policy (one of the spearheads in the Steering or Response Subsystems) and the number of abortions. This indicates that in case of an explicit abortion policy (more facilities made available by the government, for example) there will be more induced abortions than would be expected on the basis of CPR alone.

The index of abortion, \( C_a \), becomes:

\[
C_a = \frac{(1 - \text{abortion}_{\text{leg}}) + \text{abortion}_{\text{leg}}}{I + b \times AR_{\text{pol}}}
\]

Where:

- \( \text{abortion}_{\text{leg}} \) = legalization of induced abortion.
- Following Bongaarts and Potter (1983), we assume that if induced abortion is not legalized, \( C_a \) is 1;
- \( AR_{\text{pol}} \) = the new factor: AR influenced by
abortion policy, which is

\[
AR_{pol} = AR \times (1.0 + abortion\text{policy})
\]

where:
- abortion policy = spearhead abortion policy in the Steering system;
- \(AR\) = the number of induced abortions per life births.

AR is estimated as:

\[
AR = base_{AR} + (1 - base_{AR}) \times (1 - \exp[-1.6 \times CPR + 1.0 \times CPR^2 + 0.9 \times CPR])
\]

where:
- \(base_{AR}\) = base abortion rate; in the India model, a \(base_{AR}\) has been specified for the generic model in order to get a more realistic (higher) estimate of AR in 1900. Base \(base_{AR}\) is assumed to be 0.2 (scale 0-1).
- CPR = contraceptive prevalence rate;
- \(b\) = correction factor:

\[
b = \frac{14}{(18.5 + pp_{amen})}
\]

with \(pp_{amen}\) = mean duration of postpartum infecundability.

At the global level, the correction factor \(b\) was assumed to be constant (0.53) with an assumed mean duration of postpartum infecundability of 8 months. In the India model, \(pp_{amen}\) varies in time (see \(C_i\)) and \(b\) consequently varies, too.

**Index of postpartum infecundability: \(C_i\)**

The equation for the index of postpartum infecundability, \(C_i\):

\[
C_i = \frac{20}{18.5 + pp_{amen}}
\]

with \(pp_{amen}\) = the mean duration of postpartum infecundability (in months).

Based on data from especially the NFHS where in 1992/93 a mean duration of 11 months was found, we estimate a mean duration of 12 months for the 1980s. This implies a \(C_i\) of 0.66.

As stated in Van Vianen et al. (1994), due to the introduction of western life styles (formula feeding), urbanisation, employment of women outside the household and modern education, one sees a rapid erosion of such traditional patterns as breastfeeding or the custom of postpartum abstinence, resulting in an increase of \(C_i\).

In the global model, based on typical values of \(C_i\) in several developing countries and values of HDI for the same regions (derived from UNDP), we postulated the function:

\[
C_i = 1 - \beta \exp[-\alpha \times HDI]
\]

with
- \(\alpha = 2.21\)
- \(\beta = 0.51\) (Rsquared = 0.94)

The formula has been modified in the India model. Instead of a relationship between HDI and \(C_i\), we define the relationship between HDI and \(pp_{amen}\), which is actually the right way to relate these two variables. Based on values of \(pp_{amen}\) and HDI in time, we propose the formula:

\[
pp_{amen} = \frac{20}{1 - 0.51 \times e^{Cl_{fac} \times HDI}} - 18.5
\]

where \(Cl_{fac}\) = a factor indicating strength of effect of HDI on \(pp_{amen}\).

In India, the custom of breastfeeding is still highly prevalent (see also Nair 1990), unlike many other developing countries where a strong negative correlation can be found between development and duration of breastfeeding. The relationship between HDI and \(C_i\), as stated in the global model, appeared to be too strong for the Indian case. Therefore, a factor is introduced, the \(Cl_{fac}\), which indicates the strength of the effects of HDI in the mean duration of postpartum infecundability.

**Wanted fertility**

In the India model, wanted fertility is related to the custom of son preference. In India, it is not the number of children desired, but the number of wanted sons that is important. We formulate the following equation for wanted total fertility (WTFR):

\[
WTFR = \text{MAX} (2.1, (5.1 - 6.1 \times HDI_{det} - 1.2 \times famplan_{wd} \times (1 + sp_{hp} \times son_{pref})))
\]

where:
- \(son_{pref}\) = son preference
- \(sp_{hp}\) = a factor indicating the strength of the effect of son preference on wanted fertility. We assume that in the absence of son preference, WTFR
will be 25% lower.
Son preference is estimated with the attitudinal index used by Nag (1991). In 1970 the index was 0.72, 0.87 in 1980, and 0.88 in 1988. The figures indicate that son preference has increased during the recent decades.

The following arguments are used in regard to the values of the son preference index in the period before 1970. During the workshop in Kerala, Bhat argued that when total fertility is around 5-6, son preference does not affect fertility. If total fertility declines to a level around 3, son preference starts to play a role. Das (1987) stated that effects of son preference on fertility were only likely to be found when the CPR is above a certain threshold. In his study of Gujarat, this meant that son preference started to have an effect from the 1980s onwards (see Section 3). We assume therefore that before the 1970s the index of son preference was lower than the ones stated above.

Furthermore, as stated in Section 3.5, Bhat argued that in present-day India, couples want to have at least two sons. The second son is seen as insurance: if the first son does not survive, the second one might. Bhat expects that people will decide for one son only if infant mortality declines and people are sufficiently certain that this one son will survive. He expects that the preference for one son will start at a level of total fertility of 2. In addition, Roy and Parasuraman (1996, p.13) concluded, based on the NFHS datam, that "with the increase in education there is hardly any reduction in the extent of son preference. Only among women with at least a high school education, is the extent of son preference found to be significantly less".

Based on these arguments, we define a function for the relationship between HDI (which includes female literacy and infant mortality) and son preference (see listing), assuming that the son preference index will increase up to a value around 0.90, with HDI around 0.5 - 0.6, and then starts to decline.

We also include son preference as a factor affecting CPR and fertility in the India model. The study in Gujarat (Das 1987) indicated that fertility would decline by 9% in the absence of son preference. The study in rural Karnataka (Rajaretanam and Deshpande 1994) indicated that in the absence of sex preference, contraceptive use would increase from its current level by about 12 per cent in high-prevalence areas and by 25 per cent in low-prevalence areas. As a consequence of the higher CPR, marital fertility would increase by around 20 per cent.

In the model, the index of son preference is linked to CPR, more specifically to the maximum CPR (which in the global model was set to 80%). We assume that this maximum CPR of 80% will be reached that in the absence of son preference. In case the custom remains prevalent in Indian society, this maximum CPR of 80% will not be reached and will remain at a level of 70%. We define the following equation:

$$\text{MAX}_{\text{CPR}} = 0.8 - \text{son\_pref} \times 0.10$$

where:
$$\text{MAX}_{\text{spr}} = \text{maximum CPR}$$
$$\text{son\_pref} = \text{son preference}$$

5.4 Impact system

From TFR to age-specific fertility rates: the fertility schedule

The fertility level is measured by the TFR. In order to assess the impact of fertility on population growth and to determine the number of births, the TFR must be decomposed into age-specific fertility rates (ASFR). The ASFR and the age composition of the female population combined determine the number of births and, consequently, the population growth. In order to decompose the TFR into ASFR, we use the gamma distribution. The gamma distribution is often used in fertility analysis to describe the age profile of fertility (see e.g. Hoem et al. 1981; Kellman and Manting 1987). The function is a skewed distribution, increasing rapidly to a maximum and decreasing more slowly afterwards. It resembles most fertility schedules. The age-specific fertility rate is:

$$F(y) = K \lambda^p y^{(p-1)} \exp(-\lambda y) / \Gamma(p)$$

where
$$y = \text{the time since the start of the fertility process, generally assumed to be age 15 (hence } y \text{ is current age - 15);}$$
$$F(y) = \text{the age-specific fertility rate, with age equal to } 15 + y;$$
$$K, \lambda \text{ and } p \text{ are parameters, and } \Gamma(p) \text{ is the gamma function:}$$

$$\Gamma(p) = \int_0^\infty \exp(-y) y^{(p-1)} dy$$

which has the property: $$\Gamma(p+1) = p \Gamma(p) (p>0)$$

The parameters K, λ and p related to easily
interpretable indicators of the fertility schedule: the TFR, the mean age of the fertility schedule (μ) and the variance of the schedule σ². Let \( x = 15 + y \), then

\[
TFR = h \sum_x F(x)
\]

\[
\sigma^2 = \frac{1}{h} \sum_x (\mu - x)^2 F(x) \quad \text{and} \quad \mu = \frac{1}{h} \sum_x (x + \frac{h}{2}) F(x) \quad \text{where} \quad y = x - 15 \quad (\text{hence} \quad \mu_y = \mu_x = 15).
\]

**K = TFR**

\[
\lambda = \frac{\mu_y}{\sigma_y^2}
\]

\[
p = \frac{\mu_x^2}{\sigma_x^2} - \lambda \mu_y
\]

**Aging**

In order to determine the extent of aging associated with fertility decline, a population projection is performed. Assuming no migration, the future population is determined only by fertility and mortality. Let \( M(x,s,t) \) represent the mortality rate of sex \( s \) at age \( x \) in year \( t \) (number of deaths in a given year divided by the mid-year population), \( F(x,t) \) the age-specific fertility rate in year \( t \) (number of births in a given year divided by the mid-year female population), and \( P(x,s,t) \) the number of people of sex \( s \) at the beginning of year \( t \). The rates are assumed to be period rates, i.e. the age is measured at the event of death or childbirth. The projection model is presented in two parts. The first part relates to the number of survivors; the second part relates to the number of births.

**A. Survivors**

Consider a projection interval of length \( h \) years; usually \( h \) is one year or five years. The probability that a person of sex \( s \) and aged \( x \) to \( x+h \) at time \( t \) survives the entire projection interval from \( t \) to \( t+h \), is

\[
S(x,s,t) = \frac{L(x+h,s,t)}{L(x,s,t)}
\]

where \( L(x,s,t) \) is the number of people of sex \( s \) and aged \( x \) to \( x+h \) in the stationary population; it is calculated as part of the life table estimated from age-specific mortality rates observed in year \( t \). The survival probability may be expressed in terms of mortality rates:

\[
S(x,s,t) = \frac{1 - \frac{h}{2} M(x,s,t)}{1 + \frac{h}{2} M(x+h,s,t)}
\]

(for derivation, see e.g. Willekens and Rogers 1978, pp.57-58).

Let \( z \) denote the last, open-ended, age group. The survival probability for the next to last age group is

\[
S(x-z,s,t) = \frac{L(z,s,t)}{L(z-h,s,t) + L(z,s,t)}
\]

\[
= \frac{e(z,s,t) p(z-h,s,t)}{e(z-h,s,t)}
\]

where \( e(z) \) is the expectation of life at age \( z \) \( [e(z,s,t) = M(z,s,t)^{-1}] \) and \( p(z-h) \) is the probability of surviving from exact age \( z-h \) to \( z \) \( [p(z-h,s,t) = \frac{1 - \frac{h}{2} M(z-h,s,t)}{1 + \frac{h}{2} M(z-h,s,t)}] \)

The number of people aged \( x+h \) to \( x+2h \) at time \( t+1 \) is equal to

\[
P(x+h,s,t+1) = S(x,s,t) P(x,s,t)
\]

**B. Births and surviving infants**

The number of women aged \( x \) to \( x+h \) at time \( t \) is denoted by \( P(x,f,t) \). The number of births in \( h \) years to women aged \( x \) to \( x+h \) at the beginning of the interval (i.e. at time \( t \)) is

\[
\frac{h}{2} F(x,t) P(x,f,t) + \frac{F(x+h,t) P(x+h,f,t+1)_-}{} =
\]
\[
\frac{h}{2} F(x, t) + F(x + h, t) S(x, f, t) P(x, f, t)
\]

If \( g \) is the sex ratio, the number of boys is

\[
B_m(t) = \frac{g}{1 + g} B(t)
\]

and the number of girls is

\[
B_f(t) = \frac{1}{1 + g} B(t)
\]

Note that \( B(t) \) is the number of births in the period of \( h \) years. In order to determine the average number of births per year, it suffices to divide \( B(t) \) by \( h \).

Of these new-born children, some will die during the first \( h \) years of life. The probability that a child born during the period from \( t \) to \( t+1 \) survives to the end of the period, i.e. to \( t+1 \), is denoted by \( S(00) \) and is equal to

\[
S(00) = \frac{1}{1 + \frac{h}{2} M(0)}
\]

provided the mortality rate is the same for all ages in the age interval from 0 to \( h \). The number of children aged 0 to \( h \) to time \( t+1 \) is

\[
P(0, s, t + 1) = S(00) B(t) = \frac{B(t)}{1 + \frac{h}{2} M(0)}
\]

C. Total population

The total population by sex is

\[
P(s, t) = \sum_x P(x, s, t)
\]

Population momentum

The introduction of birth control does not immediately stop population increase for two reasons. First, the diffusion of awareness and contraceptive use takes time (see Section 3.3.4). Second, the age structure of an increasing population is relatively young and consequently favours further increase. If fertility were to decline immediately to the replacement level of about 2.1 children per woman on average, the population would continue to grow due to the relatively young age structure of the population at the time of fertility decline. When fertility stays at replacement level, the growth will level off and the population will tend to a stationary population, i.e. a population of constant size. The ratio between the ultimate stationary population and the population at the time of immediate fertility decline is called the momentum of population growth. This is the continued population growth following an immediate fertility decline to replacement level, that is due to the favourable age structure of the population before fertility decline. The momentum can easily be determined when the age structure of the initial population is assumed to be stable. In that case, the momentum only depends on the life expectancy at birth and the crude birth rate before the drop in fertility and on the sex ratio at birth (Keyfitz, 1985, p. 157):

\[
\text{Momentum} = \frac{b \ast e_0}{\sqrt{TFR \ast \frac{1}{1 + \text{SRB}} \ast l_m}}
\]

where \( b \) is the number of births divided by the population, \( e_0 \) the life expectancy at birth and TFR the total fertility. SRB is the sex ratio at birth, the number of boys divided by the number of girls, equals 1.05. \( l_m \) is the probability of survival to mean age at childbearing. In TARGETS \( m=30 \) and with the UN General Life Tables we estimate:

\[
l_{30} = .0231 e_0 - .00011 e_0^2 - .142
\]

5.5 Response / steering system

In the fertility model, unmet need and policy awareness are feedback mechanisms from the impact system. Unmet need and policy awareness affect the priority for population policy.

Unmet need

The unmet need is defined as the wanted CPR (WCPR) minus the actual CPR. The WCPR indicates the level of CPR needed to reach the level of wanted fertility. In India, the ORG surveys indicated an unmet need of 40 per cent in 1970, 18.5 per cent in 1980, and 18.3 per cent in 1988.

Policy awareness

Population growth is estimated by taking the number of births to women of reproductive age and the number of deaths from the health model. A
discrepancy between population growth and economic growth (GNP) could induce a response from governments, a phenomenon which we call 'policy awareness'. If the discrepancy between the two is too great, i.e. when population growth cannot be supported by economic growth, we may expect governments to respond by designing population policies.

The policy priority becomes manifest in four spearheads: abortion policy, education policy, family planning allocation and mass communication. In the India model, the distribution of the population priority over the four spearheads has been estimated on the basis of the information in Sections 2 and 3. Initially, the family planning spearhead is most important. The other three play a minor role but become stronger later on. For example, the mass-communication spearhead starts to play a role in the 1960s, time of the extension approach within the Indian family planning programme. The abortion spearhead starts to play a role after 1972 when the Medical Termination of Pregnancy Act was enacted, and remains at the same level. More recently, the education spearhead started to play a role and certainly will continue to do so in the coming period.

The Indian experts described different scenarios for the future. Natarajan expects that in the year 2020, 35 per cent will be allocated to family planning, 25 per cent to mass-communication, 35 per cent to education, while abortion will remain at the same level of 5 per cent. Bose expected a slightly different distribution: 25 per cent family planning, 25 per cent mass communication, 40 per cent education and 5 per cent abortion.
6. FUTURE FERTILITY CHANGE: SOME MODEL EXPLORATIONS

6.1 Introduction

The fertility model for India as presented in this report can be used to assess the impact of different population policies on fertility levels, in optimistic and less-optimistic scenarios regarding economic growth and change in literacy status of women. A variety of social and family planning policy measures may affect fertility too. In the India model, four broad categories of policy measures are distinguished as listed below. Different policies may be combined, as in reality, and are referred to as spearheads to indicate that they differ in their emphasis. In the following section three major policy options are considered separately because of their relevance to the Indian population debate. Their net effect on changes in total fertility in time are studied.

First, a major policy line can be focusing on education and human development aiming at related changes in fertility behaviour. This includes reduction of childbearing and the postponement of childbearing as women receive more years of education and participate more in the formal labour force. Shifts in occupational activities may simultaneously lead to a reduction in demand for large families, i.e. a reduction in wanted pregnancies.

Secondly, a policy line can be aimed at family planning programmes to reduce the number of unwanted pregnancies by increasing the access to sterilization and to safe and reliable temporary contraceptive methods. Sterilization, a limiting method, determines the absolute number of children that one will be raising, while temporary methods may facilitate the timing of children.

Third, one more component of population policy is considered separately because of its relevance to the present population debate: promotion of the awareness of the possibility of fertility control. This can be enhanced through distribution of information and the promotion of changes in reproductive attitudes at various levels of society through mass media or, on a smaller scale, through communication channels at the micro-level. Information and communication may affect awareness among the population that control of one's own fertility is possible and may be beneficial to one's own future actions and future health, and to the future of one's children. Awareness of the ability to control fertility and the consequences of fertility control are important factors in the process of fertility reduction.

A fourth, additional, policy option including abortion is given on default values as listed in the model description in the previous Section. In the scenarios chosen, abortion is not considered a feasible Indian overall population policy. The model can be run, however, to explicitly assess, in a more speculative way, the impact on fertility of population policies that emphasize abortion.

The selection of policy options is based on the priorities that have been listed by the participants of the workshop preceding this report and on the present international debate on societies in earlier stages of the fertility transition. If one compares these policy options to international thinking on possible population policy strengthening, one can make a comparison with the options recently presented in a paper by Bongaarts (1994). He distinguished three broad policy options to slow down population growth. They included two major lines of fertility policy that are simulated while applying the fertility model for India. First, investments in human development, which mainly refers to improvements in education, the empowerment of women, and the lowering of child mortality, are considered as largely affecting the demand for large families. Secondly, strengthening family planning programmes, emphasizing the health of the women involved and temporary contraceptive methods, should lead to a further reduction of early and late unwanted pregnancies (UNFPA 1995). The remaining international emphasis is on the promotion of an increase in the average age of women at childbearing. This would lead to a distinct demographic effect, i.e. a reduction in the population momentum. In the India model, the age of childbearing is dependent on the age at marriage, which itself depends on the level of education and income status (see Section 3).

6.2. Three sets of scenarios

The objective of this Section is to present some results of the India fertility model. It should be stressed that the model output is a potential impact assessment and should not simply be viewed as a
forecast. The model outputs have been obtained by applying a stand-alone version of the fertility model. During the run, the number of women within the reproductive age category (15–45 years) is calculated using a simple demographic model that uses the projected and extrapolated age-specific mortality rates from the Office of the Registrar General of India. The historical GNP development have been taken as reported from the HYDE project (Klein Goldewijk et al. 1995). The projected high GNP per capita levels are based on the, presently only available, Intergovernmental Panel of Climate Change (IPCC, Alcamo 1994) scenario. The projected IPCC figures are used for the most optimistic economic scenario. In the stand-alone version of the fertility model, this variable is treated as an unchanging exogenous driving force and is based on modified internationally used scenarios.

Three sets of scenarios are distinguished of which the most informative are described in more detail below and also depicted in the model print-outs (Figures 6.1 to 6.5). The first set of scenarios is used as a reference scenario where a steady and moderate increase in overall human development takes place and two different population policies are simulated. The second, more optimistic set of scenarios includes a stronger education-oriented population policy as well as a more favourable increase in gross national product. Most policy efforts are devoted to education with default and business as usual. Values for the input parameters related to family planning programme efforts, mass-communication and the policy enabling women to abort unwanted pregnancies, are set to default values. The third, more pessimistic set of scenarios assumes no absolute improvements in education of adult females and a limited economic growth just sufficient to balance the population surplus. This results in a constant human development.

In this Section, the various scenario analyses quantify the impact of various policies on the level of fertility in terms of total fertility.

6.2.1 The reference scenario (0-scenario)

In the reference scenario (Figure 6.1 and Figure 6.2), the values of the policy mix options are set to default, as reported earlier in Section 5, except for the mix of contraceptive methods and mass communication effort. HDI and Famplan change due to forces unrelated to population policies. Human development takes place (although it is not enhanced by explicit social policy measures that are designed to affect population growth). Consequently, HDI is not affected by population policies although its pattern of change may be influenced by other policies which are not considered in this study. The variation in HDI is determined by exogenous changes in health (life expectancy), literacy and economic welfare (GNP). Hence, the changes in driving forces for this scenario are determined by factors outside the fertility model only. The HDI slowly develops upwards from a value of 0.41 in 2010 to a level of 0.49 around 2050, and to 0.57 in 2100. It continues to increase afterwards mainly because of assumed changes in literacy rate. Family planning effort scores increase at a diminishing rate as an effect of socio-economic development. Family planning services continue to be available as a result of explicit governmental, or NGO, intervention.

In addition, there are two scenarios for a changing mix of contraceptive methods. In the first scenario, an increase in the use of sterilization is computed up to more than 80 per cent. This means that of all contraceptive methods used, 80 per cent will go to sterilization and, as a consequence, 20 per cent to temporary methods of IUD, oral pill and others (Figure 6.1). We call this the scenario of an increase in sterilization. In the second scenario, there is a huge shift from sterilization (towards 30 per cent in 2050) to temporary methods: IUD, oral pill and other methods are all well over a 20 per cent in 2050 (Figure 6.2). We call this the scenario of a shift from permanent to temporary methods.

Considering the state variables, one notices that the increase in HDI leads to an increase in mean age at marriage (21 years in 2020). As a consequence $C_m$ declines. On the other hand, the slight increase in HDI results in a decline of the duration of postpartum infecundability: from more than 20 months in 1900 to about 7 months in 2100. As a consequence, one can observe an increase in $C_r$. The absence of an explicit abortion policy results, after an expected increase in the abortion rate, in a small decrease and a levelling-off. The state variable $C_e$ remains around 0.8. The simulated CPR increases and reproduces the historical figures since the 1970s. After reaching the 20 per cent level, the autonomous diffusion process takes over and the CPR increases further until it reaches a level of around 70 per cent, in both methods mix scenarios. In the scenario of an increase in sterilization, the contraceptive index $C_c$ reaches 0.34 in 2020 and slows down to 0.25 later on. In the scenario of a shift from permanent to temporary methods, $C_c$
remains at a level of 0.34. This is due to the fact that the use-effectiveness of the spacing methods oral pill and others methods are dependent on the level of HDI. In this scenario of a slight increase in HDI, the use-effectiveness is lower and as a consequence $C_c$ is higher. Wanted total fertility, including son-preference, declines slowly as a result of the slight increase in HDI.

The patterns of change in the proximate determinants cause the TFR to decline from 6.3 in 1900 to a level of 1.8 from 2050 onwards, in the scenario of an increase in sterilization. Actually, in this scenario, TFR reaches the level of 2.1 in the year 2019. In the second scenario of a shift from permanent to temporary methods, TFR is continuously well above replacement level, i.e. around 2.3 which is due to the lower use-effectiveness of the temporary methods oral pill and other methods.

In addition, following the mass communication option, i.e. assuming that the shift to temporary, less-effective methods, needs an extra effort in extension education (see also Section 5), the TFR drops another 10 per cent but still does not reach replacement level.

This first scenario illustrates that replacement fertility levels can be reached before 2020 with an explicit population policy and lower socio-economic development (as expressed in the HDI). The main factor is the simulated diffusion process.

Figure 6.1: Model assessments: reference scenario with increasing sterilization
6.2.2 The optimistic human development scenario

In this scenario (Figure 6.3), HDI increases considerably faster than in the reference scenario, because of an emphasis on female literacy and economic growth. HDI reaches the level of 0.57 (the maximum in the reference scenario) in 2010, and increases to 0.70 in 2020 and ultimately reaches a level above 0.90 in 2100. The higher level of HDI is reflected in the values of the proximate determinants.

Considering the state variables, one notices (Figure 6.3) that the increase in HDI leads to a higher mean age at marriage (23 years in 2020 and 26 in 2050). As a consequence $C_m$ declines faster. On the other hand, due to the increase in HDI the duration of postpartum infecundability decreases more rapidly than in the reference scenario and to a lower level: from more than 20 months in 1900 to less than 5 months in 2100. This results in a relatively rapid increase of $C_i$. The absence of an explicit abortion policy results, after an expected increase in the abortion rate, in a small decrease and a levelling-off. The state variable $C_o$ remains around 0.8. Compared to the reference scenario, the CPR increases a little faster (and as a consequence, $C_e$ declines a little bit faster). After reaching the 20 per cent level, the autonomous diffusion process takes over and the CPR increases further until it reaches a level of 70 per cent around 2030. It levels off at 73 per cent from 2050 onwards.
The ultimate level of CPR is slightly higher than in the reference scenario due to a decline in son preference. Wanted total fertility, including son-preference declines mainly as a result of the increase in HDI.

The population policy which emphasizes education has a two-fold effect on the unmet need. Initially, the unmet need increases much faster than in the absence of any population policy. Later on there is a decrease in unmet need as there is also a rapid decline in wanted total fertility (WTFR). As a result of a policy mix including education and family planning, the unmet need increases faster initially but reaches a lower level and it starts declining sooner.

This scenario too included the two methods mix scenarios. Regarding the scenario of a shift from permanent to temporary methods, the high human development level makes the use of oral pill and other contraceptive methods most effective like in the industrialized countries.

The patterns of change in the proximate determinants cause the TFR to decline. In the scenario of an increase of sterilization, TFR declines from 6.3 in 1900 and reaches replacement level in 2014. Afterwards TFR continues to be around 1.6. Within this high-HDI scenario, in the second scenario of a shift to temporary methods, TFR reaches replacement level but at a later moment, i.e. in 2018.

The scenario shows that replacement fertility can be reached before 2020 without an explicit population
policy. Socio-economic development (as expressed in the HDI) and non-governmental family planning programmes may bring fertility down but it may be longer than in the presence of population policies.

Policy awareness, i.e. the awareness that population policies are needed to keep population growth in line with economic growth, starts to increase around 1950-1960 and is high in the subsequent period. In the second half of the 21st century, policy awareness starts to decline, however. The reason is that the CPR has reached a sufficiently high level for government to be able to retreat and the demand to rise high enough for non-governmental activities to take over.

6.2.3 The stagnating human development scenario

In this scenario (Figure 6.4 and Figure 6.5), HDI is kept at a constant global level of 0.38. This is a pessimistic economic scenario represented by a per capita income about US$ 400. Also there are no improvements of the literacy level: it remains at 34 per cent, the level existing around 1990. In addition there are the two method mix scenarios: one with an increase in sterilization and one with the shift from permanent to temporary methods.

Considering the state variables one can observe that the mean age at marriage would still increase but remain low (under 20 years) and consequently the

Figure 6.4: Model assessments: the stagnating human development scenario with increased sterilization.
$C_m$ would remain at a higher level as compared with the two previous scenario sets. The duration of postpartum infecundability would be higher, around 9.5 months, and $C_i$ considerably lower (up to 0.70). The contraceptive prevalence would still rise because of the diffusion process. The rising CPR would level off around 70 per cent in the year 2040. The patterns of change in the proximate determinants cause the TFR to decline from 6.3 in 1900 to reach replacement level in 2021, in case of the sterilization scenario. In the other scenario of the shift to temporary methods, TFR remains high above replacement level. This is, like in the reference scenario, due to the low level of the use-effectiveness of the spacing methods oral pill and other methods, but also because of the persisting son-preference.

6.3 Conclusions on the scenarios.

The scenarios shown in this section are only a few of the possible fertility trajectories that can be simulated by the fertility model. Some important conclusions are:

a. Further fertility decline without explicit population policies is possible, because of the assumed continuation of the diffusion process and

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*Figure 6.5: Model assessments: the stagnating human development scenario with increasing temporary methods.*
changing son-preference; it may take slightly longer, however. Education and overall human development are important determinants of fertility decline. The decline is a consequence of changes at the micro-level: changes in reproductive attitudes in relation to son-preference and the demand and use for family planning methods. The ultimate level of total fertility will depend on the speed of changes in these issues.

b. Also in case of the scenarios with less economic development, explicit policies to increase the possibilities of women to choose the moments to have their children are possible. The reduced use-effectiveness of child spacing methods can only partially be compensated by increased information and health education.

c. Fertility decline is set in motion and even in some areas accelerating. Some scenarios show that replacement levels can be reached within two decades. Under less favourable scenarios the diffusion process might be completed but wanted fertility levels will remain above replacement level.
7. CONCLUSION AND EPILOGUE

Indian population growth is the outcome of decisions made every day by hundreds of millions of women and men, and such individual behaviour is governed by aspirations and desires. Whether intended behaviour yields the expected result depends not only on the behaviour itself, but also on the means available to people to affect the outcome. In this report, fertility is regarded as the result of interdependent biological, behavioural and cultural processes, whereby human development is an important determinant of fertility change. Fertility decline without human development can exist, but is rare. It is believed that some human development is necessary to spread the idea that fertility can be influenced and to motivate enough people to limit their fertility or space child births through the use of contraceptives. When contraceptive prevalence reaches about 20 per cent, the diffusion of contraceptive use largely becomes an autonomous process. Human development is therefore most important during the early stages of the fertility transition. In the case of India, human and cultural development will ultimately determine the level of the age of marriage and wanted fertility.

The model of fertility change in India that is presented in this report incorporates the perspective which has that, as human development increases, people are more aware of what they want and how many children they would like to have. If realized fertility differs substantially from desired fertility, fertility will not be adjusted unless fertility control is socially-accepted and the means of fertility control are accessible. Thus, in this sense, human development and family-planning programmes are complementary. Human development changes peoples' aspirations and family planning programmes provide reliable means by which to meet the new aspirations. The speed with which changes take place depends on information available to people; information on alternative ways and means of meeting aspirations without the need for large families, and information about the means by which family size can be reduced so that the quality of life of parents and their children can be improved. Information operates at two levels. At the micro level, it is associated with individual awareness; at the macro-level, information is a basis for policy-awareness and the design of population policies.

Human development and family planning programmes affect the behaviour of people only indirectly and with a time lag. Their effects are mediated by a set of intermediate variables. Some of these variables, the proximate determinants, have an important biological component and are of particular significance. The relation between the fertility levels and the proximate determinants is relatively well-understood and documented and provides the conceptual framework for fertility studies like the National Family and Health Survey (1992/93). It also provides the changes in the conceptual framework for the fertility model presented in this report. Human development, population policies and programmes of education, income generation, empowerment and family-planning affect fertility through these determinants. The model illustrates how the effectiveness of population policies is influenced by variables at levels intermediate between the policies and individual decision-making. Population policies cannot ensure sustainable development unless behavioural changes accompany the process of development.

The surplus value of an integrated systems approach of population growth is that it is treated as a dynamic process, complementary to a trend-extrapolations approach or to taking population numbers as exogenous time-series, as is usually done in economic or environmental modelling. A dynamic integrated fertility model enables us to analyse the complex interrelations between biological, behavioural and social processes determining fertility. The results of the population conference in Cairo show that there is a need for an instrument, which enables decision makers to evaluate population policies in the context of sustainable development (UNDP 1994). The Indian version of the generic TARGETS model, comprising the dynamic fertility model as organic part, will provide such a framework when the fertility module can be linked to other relevant environmental models. It shows the inertia and the autonomous nature of fertility processes at the population level and the role of individual fertility behaviour at the micro level. The model will enable policy makers and researchers to test their questions for their relevance and to analyse the various inter-linkages and feed-backs between the environmental and human system as well.
It is illusory to suppose that a fertility model comprising all factors influencing fertility is possible for the whole of India or even for individual states. Due to the high all-India aggregation level, factors which are of vital importance on a state level are neglected. Furthermore, inherent to modelling is the need to translate linkages which are only qualitatively known into quantitative relationships, which causes a distorted image of the state-of-the-art in demography. The consensus meeting between the academic experts from a variety of background and the project team has partially filled the gaps in information and has provided expert judgements on a number of issues. Other questions are unresolved and can be the basis of further empirical research.

Due to our incomplete knowledge and inadequate understanding and the inherent deficiencies of modelling, the predictive value of the presented integrated fertility model is small. Therefore, it should be regarded an interpretative and illustrative tool for assessment of fertility trends by researchers and policy analysts at the all India level and at the state level.

The generic model, now calibrated and validated for India, is also tested for use at the state level by applying it to a selection of Indian states. In addition it will be tested for China and, as a Latin American example, for Mexico. For both the countries population growth is a key issue in relation to their future economic growth and well-being of their male and female populations. All three case studies are of crucial importance for the global fertility pattern. These case-studies enable us to evaluate the limitations arising from aggregation and simplification. Based on the additional case-studies the fertility model will be evaluated, adapted and improved.

Notwithstanding the above limitations, the developed fertility model for India as integrated part of regionalised TARGETS framework can, in addition, be a helpful tool in the analysis of the complex interlinked processes and for the development of policies relating to populations making a sustainable use of its natural and societal resources.
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APENDIX I LISTING

!! FERTILITY MODULE of the HUMAN SYSTEM of TARGETS, INDIA
! Version date: March 1996
! Author(s): RUG, RIVM
! Contactperson: Henk Hilderink (E-mail: henk.hilderink@rivm.nl)

CONST nFert = 6; lage specific, 5 years, groups in stead of 15 to 45.
#INCLUDE from subm

T.MIN = 1900.0; !start of simulation period
T.MAX = 2100.0; !end of simulation period
T_STEP = 1.0;
T.SAMPLE = 1.0;
T.METHOD = RK2;

CONST nsex = 2, ! 1 = male, ! 2 = female
nage = 12;
! age groups: 1a = age_0_to_4, 1b = age_5_to_9, 1c = age_10_to_14
! 2a = age_15_to_19, 2b = age_20_to_24, 2c = age_25_to_29, 2d = age_30_to_34
! 2e = age_35_to_39, 2f = age_40_to_44
! 3 = age_45_to_64, 4 = age_65_to_74, 5 = age_75_plus

REAL cohort [nage] = 5, 5, 5, 5, 5, 5, 5, 5, 15, 10, 25;
REAL aging [nage] (t);

MODULE main

BEGIN

!!! writers comments on variable definitions

REAL GNP_pc (t) = FILE("input/gnp_pc.dat");
REAL GNP (t);
REAL LE_sex [nsex] (t) = FILE("input/le_sex.dat"); !Life expectancy by sex [years]
REAL LE (t); !life expectancy [years]
REAL female_lit (t); ![%] female literacy level
REAL fort_women [nFert] (t) ![person] !number of women in reproductive age (15-49 year)
REAL GNP_growth (t); ![fraction]
! growth of Gross National Product
! in the integrated version GNP growth
! will be calculated (economy module)
REAL HDI (t), HDI_diel(t); ![on scale 0 to 1
! Human Development Index (UNDP, 1990, 1993)
! an indicator of the level of development,
! determinant of Cc, Cm and C1
! based on education level (adult literacy), life expectancy
! and income (real GNP per capita). Where especially the
! development level of women is a determinant for fertility.
! Female life expectancy (from Health module) and literacy

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are used in this fertility model
In world model: development of HDI as such;
In India model: each component estimated at each point of time and
HDI estimated from this. See Hindex

REAL Hindex[3](t),
  min_LE = 22.0,
  max_LE = 85.0, ! max LE UNDP 1994,
  min_fem_lit = 0,
  max_fem_lit = 100, ! adult lit, wij nemen female lit UNDP 1994,
  max_GNP_pc = 5385, !Should be 5120 + 2 * (40000 - 5120) ** 1/2,
  min_GNP_pc = 200,
  GNP_trash = 5120,
  GNP_x (t);

! RESPONSE

REAL spearh_mass_comm (t) = FILE("input/mass_com.pol");
  !fraction (equals 1): differentiation for
  !4 policies, based on approaches in
  !fp programme India
  !e.g. in 1950, only famplan, none of others.
  !Strength of famplan in fam_plan

REAL spearh_fam_plan (t) = FILE("input/fam_plan.pol");
REAL spearh_education (t) = FILE("input/educ.pol");
REAL spearh_abortion (t) = FILE("input/abort.pol");
  !Termination of Pregnancy Act 1972
  !remains the same

!Spearheads expert judgement (workshop) [1994,2020]
!feedbacks which determine priority for population policy

REAL policy_awareness (t),
  awareness_del(t); ! on scale 0 to 1
  !awareness on macro level that population growth is a problem
  !For India: should be from end 40's onwards
REAL awar_hlp = 3; ! help_factor

DOUBLE d1;
REAL son_pref_fition (d1) = [0.00, 0.094216, 0.10, 0.615392, 0.19, 0.72, 0.25, 0.87, 0.30, 0.88, 0.50, 0.905784, 0.60, 0.900327, 0.70, 0.853265, 0.80, 0.797271, 0.90, 0.693377, 1.00, 0.374067];
REAL  unmet_need(t),
    unmet_need_del(t);  ! {\%}
  ! percentage of couples at reproductive age who are not
  ! currently using contraceptives,
  ! but who want to control their fertility
  ! (given the data on desired fertility (WFS, DHS))
REAL  WCPR(t);  ! [fraction]
  ! see CPR below
  ! CPR belonging to the level of desired fertility
  ! determinant of unmet need
  ! In India model: not included
REAL  priority(t);
  ! overall priority for population policy
! policy (response)
REAL  mass_comm(t),
    fam_plan(t),
    fam_plan_del(t),
    education_policy(t),
    education_policy_del(t),
    abortion_policy(t),
    abortion_leg(t) = [  
      1900.0, 1.00,
      1990.0, 1.00,
      2020.0, 1.00,
      2100.0, 1.00];
  ! actual population policies
  ! 'del' is abbreviation of delay, necessary to implement delays
  ! between policy and results

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! INDEX OF MARRIAGE
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 Unreal: 

REAL  ult_m = FILE("input/ult_mar.dat");
! fraction: 90% of women will ultimately marry,
! expert judgment (Willekens et al., 1994)
! India: same. 10% of women never marry (TARU, Mari Bhat))
! proportion of women ultimately married
! determinant of Cm

 INDEX OF CONTRACEPTION

REAL  CPR (t); ![fraction]
! contraceptive prevalence rate:
! percentage of couples currently using contraceptives
! determinant of Cc
REAL  base_CPR = 0.00; !NEW: in stead of 0.06% CPR in 1900,
! base_CPR is assumed to be 8%.
! In CPR always traditional methods: also in 1900.
! Effects too on Ca: in stead of 1.00, around 0.95;
REAL  CPR_max (t); ![maximum level of cpr, related to son preference
REAL  cpr_max_base = FILE("input/cpr_maxb.dat");
REAL  CPR_t = FILE("input/cpr_t.dat"); ![year]
! the year in which CPR approaches 20%, so autonomous diffusion
! will start (Rodriguez and Aravena, 1992)
! in India: 1977; choosen based on data from
! Ministry of Family Welfare
REAL  son_pref (t); ![son preference depends on human development index
REAL  awareness_ind (t); ![fraction]
! the awareness of the possibility to control fertility
! (current knowledge of contraceptives)
REAL  diffusion_rate = FILE("input/dif_rate"); ![fraction]
! the rate of diffusion with which contraceptive use
! is spread through a population
! determinant of Cc
! in global model: 6%; Rodriguez and Aravena: 7%
REAL  mix_1 (t) = FILE("input/cpr_mix1.dat"); ![sterilisation
! Expert-judgement
REAL  mix_2 (t) = FILE("input/cpr_mix2.dat"); ![pill
REAL  mix_3 (t) = FILE("input/cpr_mix3.dat"); ![IUD
REAL  mix_4 (t); ![others
! Based on data from All-India surveys: ORG and NFHS
! the portion of sterilisation (mix_1), pill (mix_2),
! IUD (mix_3) and others (mix_4) to total contraceptives
REAL  eff_1 (t) = [1900.0, 1.0, 2000.0, 1.0, 2100.0, 1.0];
REAL  eff_2 (t);
REAL  eff_3 (t) = [1900.0, 0.95, 2000.0, 0.95, 2100.0, 0.95];
REAL  eff_4 (t); ![fraction]
! the effectiveness of sterilisation (mix_1), pill (mix_2),
! IUD (mix_3), and others (mix_4)
! determinants of Cc (use-effectiveness, 'c' in Bongaarts (1983))

 INDEX OF ABORTION

82
REAL AR (); ! [fraction]
  ! number of abortions on number of life births
  ! determinant of Ca
  ! At present (90%) in India: 6.7 million abortions on
  ! 26 million births (CBR = 29/1000) annually
  ! means: AR = 0.25;
REAL AR_pol ();
  ! AR influenced by abortion policy
REAL base_AR = 0.2;
REAL time_lost_ab (); ! determinant of Ca. In global model: b.
  ! in India assumed to be 1980's: 12 months
  ! (=estimation, not all data are reliable;

INDEX OF PP INFECUNDABILITY

REAL pp_amen (); !NEW in the India model: mean duration of pp amenorrhea;
REAL CI_fac = 1.50;
  !NEW: a factor to indicate the strength of effects of HDI in CI:
  ! In global model effects too strong! For India: longer amenorrhea,
  ! due to longer breastfeeding, than expected on basis of formula
  ! in global model. Universal breastfeeding in India,
  ! especially in rural areas (more than 70% of population)

OTHER
REAL educ_eff_E = 1/2; ! factor for increasing effect of education policy
REAL TFR(); ! [child]
  ! total fertility
  ! number of births that would occur to a woman who has experienced
  ! a particular set of age-specific fertility rates as she has passed
  ! through the reproductive period

REAL WHTFR(); ! [child]
  ! the number of births which will occur to a woman
  ! at the end of her reproductive period if only
  ! wanted children are born

IMPACT

REAL total_births ();
  ! number of births
REAL births [nsex]();
  ! number of births by sex
REAL perc_preg (); ! percentage of women pregnant
REAL S_age = 26; ! GFR/TFR (Van Vianen, 1994)
  ! age distribution
  ! usually GFR is estimated for women in age group 15-49
  ! in the health model age group 15-45 is used
  ! so we assume that no births occur after age 45
REAL sex_ratio = 1.05; ! [ratio] using data of Health module
  ! ratio of boys-births over girls-births.
REAL pop_growth (i);
  ! population growth
  ! necessarily exogenous in stand alone version, because no series of
  ! death rates are available
  ! in the integrated version population growth will be calculated as
  ! difference between birth rate (fertility module) and death rate
  ! (derived from health module)
REAL momentum (i); !
  ! Population momentum: tendency of population size to increase
  ! for some time after fertility has reached the level consistent with
  ! long range population stationarity (below replacement level,
  ! (Keyfitz, 1985)
REAL l_30(); !probability of survival to age of 30.

!EQUATIONS======================

@@@@@@@@@@@@@@@@@@@@@@@@@
! PRESSURE
@@@@@@@@@@@@@@@@@@@@@@@@@
female_lit = 0.01 * FEMALE_LIT_HIST;
fert_women[i] = pop_sex_age [2,i+1], !result from India Population & health model
   i = 1 to n fert;
GNP = GNP_pc * pop;
GNP_x = MAX(min_GNP_pc, SWITCH(GNP_pc < GNP_tresh ? GNP_pc
   ELSE GNP_tresh + 2 * (GNP_pc - GNP_tresh)**0.5));
LE = LSUM(i = 1 to n sex, LE_sex[i]) / n sex;
Hindex[1] = 1/3 * (LE - min_LE) / (max_LE - min_LE);
Hindex[2] = 1/3 * (100 * female_lit - min_fem_lit) / (max_fem_lit - min_fem_lit);
Hindex[3] = 1/3 * (GNP_x - min_GNP_pc) / (max_GNP_pc - min_GNP_pc);
HDI = LSUM(i = 1 to 3, Hindex[i]);

@@@@@@@@@@@@@@@@@@@@@@@@@
! RESPONSE
@@@@@@@@@@@@@@@@@@@@@@@@@
mass_comm = nLAST(priorty,2,0.01) * spearch_mass_comm;
fam_plan = nLAST(priorty,2,0.01) * spearch_fam_plan;
education_policy = nLAST(priorty,2,0.01) * spearch_education;
abortion_policy = nLAST(priorty,2,0.01) * spearch_abortion;
! nLAST with n=2 means a delay of 2 years

! feedbacks (with delay)
   smooth1 asmooth1; ! instantiation of smooth3 function
   asmooth1.inp = unmet_need;

84
asMOOTH1_avtime = 10;
asMOOTH1_smth1ic = unmet_need;
unmet_need_del = asMOOTH1_smth1;

asMOOTH1_bsmooth1; ! instantiation of smooth3 function
bsMOOTH1_inp = policy_awareness;
bsMOOTH1_avtime = 5;
bsMOOTH1_smth1ic = policy_awareness;
awareness_del = bsmooth1.smth1;

esMOOTH1_csmooth1; ! instantiation of smooth3 function
esMOOTH1_inp = education_policy;
esMOOTH1_avtime = 10;
esMOOTH1_smth1ic = education_policy;
education_policy_del = esMOOTH1_smth1;

policy_awareness = SWITCH(t < 1910 ? 0
ELSE MAX(0, 10 * (awar_blp * LSUM(i = 1 to 10, pop_growth (t-i)/10) -
LSUM(i = 1 to 10, GNP_growth(t-i)/10)));

pop_growth = SWITCH(t >= 1901 ? (pop(t) - pop(t-1)) / pop(t-1) ELSE 0.0055);

GNP_growth = SWITCH(t >= 1901 ? (GNP - GNP(t-1)) / GNP(t-1) ELSE 0.002);

unmet_need = MAX(WCPR - LAST(CPR,base_CPR),0);

WCPR = (7.5 - WTFR) / (0.88 * 7.5);

priority = (unmet_need_del + awareness_del)/2;

!--------------------------------------------------------
! STATE
!--------------------------------------------------------
smooth1_csmooth1; ! instantiation of smooth3 function
csmooth1_inp = HDI;
csmooth1_avtime = 5;
csmooth1_smth1ic = HDI;
HDI_del = csmooth1.smth1;

smooth1_dsmooth1; ! instantiation of smooth3 function
dsmooth1_inp = fam_plan;
dsmooth1_avtime = 20;
dsmooth1_smth1ic = fam_plan;
fam_plan_del = dsmooth1.smth1;

! INDEX OF MARRIAGE

Cm = ult_m * (45 - avg_mar) / 30;

! determinants of Cm

avg_mar = min_mar_age * (exp(0.65 * HDI));
INDEX OF CONTRACEPTION

mix_4  = 1 - mix_1 - mix_2 - mix_3;

Cc  = 1 - 1.08 * CPR * (mix_1 * eff_1 + mix_2 * eff_2 + mix_3 * eff_3 + mix_4 * eff_4);

! determinants of Cc

awareness_ind  = MIN(1, (2 * HDI) ** ((1 - fam_plan) * (1 - mass_comm)));

son_pref  = son_pref_tion (HDI);

CPR_max  = cpr_max_base - son pref * 0.10;

CPR  = base_CPR + (1 - base_CPR) * (0.29 * awareness_ind + (CPR_max - 0.29 * awareness_ind) / (1 + exp(2.093 - diffusion_rate * (1 - CPR_t))));

eff_2  = 0.35 * HDI + 0.6 + spearh_mass_comm * (0.35 - 0.35 * HDI)**(1 + 1/2 * spearh_mass_comm);

eff_4  = 0.30 * HDI + 0.5 + spearh_mass_comm * (0.35 - 0.35 * HDI)**(1 + 1/2 * spearh_mass_comm);

! effectivity pill and other methods linear dependent of HDI,
! might be logistic (M+I, 27/7), because effectivity of pill
! depends on education women have.
! as exogeneous serie: eff_2 = [1900.0, 0.6, 2000.0, 0.8, 2100.0, 0.9];
! eff_4 = [1900.0, 0.5, 2000.0, 0.7, 2100.0, 0.8];
! actually pill is invented between 1950-1960

INDEX OF ABORTION

Ca  = (1 - abortion_leg) + abortion_leg / (1 + time_lost_ab * AR_pol);

! not using definition of Bongaarts (TA: total abortion rate)
! because no data available on TA for India, at this moment (April 95)

time_lost_ab  = 14 / (18.5 + pp_amen); lin global model: b

! determinants of Ca
! India: now 5 or 6 millions to 24 million life births
! CPR starts at proximately 5%

AR_pol  = AR * (1.0 + abortion_policy);

AR  = base_AR + (1 - base_AR) * (1 - exp(-1.6 * CPR + 1.0 * CPR**2 + 0.9 * CPR**3));

INDEX OF PP INFECUNDABILITY!

pp_amen  = 20/(1 - 0.51 * exp(-CI_fac * HDI)) - 18.5;

!NEW: HDI affects directly pp amenorrhea
!mean duration (in global model: HDI to CI).

Ci  = 20/(18.5 + pp_amen);
! OTHER

! state variables
REAL son_pref_fac = 1/4;

WTFR = MAX(2.1, (5.3 - 6.1 * HDI_del - 1.2 * fam_plan_del) * (1 + son_pref_fac * son_pref));

TFR = Cm * Cc * Ca * Ci * TF;

REAL mean_age = 28.5,
    fert_sig = 9,
    fert_lambda (t),
    fert_fac (t),
    tfr_ftion [naje] (t),
    TFR_age [naje] (t);

fert_lambda = (mean_age - 15) / fert_sig**2;

fert_fac = fert_lambda * (mean_age - 15);

ftr_ftion[j] = fert_lambda ** fert_fac * 
    (12.5 + (j-1)*5 - 15)**(fert_fac - 1) * 
    exp(-fert_lambda*(j-1)*5 - 2.5)),
    j = 2 to 7;

ftr_ftion[j] = 0, j = 8 to naje;

TFR_age[j] = TFR * ftr_ftion[j] / (5 * LSUM(k=1 to naje, ftr_ftion[k]));
    j = 1 to naje;

! IMPACT
!

total_births = LSUM(i=1 to nfert, fert_women [i]) * TFR / S_age;

births[i] = SWITCH(i=1 ? sex_ratio / (1 + sex_ratio) ELSE 1 / (1 + sex_ratio)) * total_births,
    i = 1 to nsex;

perc_preg = 3/4 * total_births / LSUM(i=1 to nfert, fert_women[i]);

momentum = ((total_births / pop) * LE) / SQRT (TFR * 1_30 / (1 + sex_ratio));

! Actually the equation is (Keyfitz, 1994)
! (total_births / pop) * LE / SQRT (TFR / 1 + sex_ratio);
! with sex_ratio equals number of women per 1000 men
! So in the integrated version of the TARGETS model
! sex_ratio = LSUM(i=1 to 5, pop[i,2]) / (LSUM(i=1 to 5, pop[i,1]));
! LE is total female life expectancy (?)

! probability of survival to age of 30
! estimation based on UN general life tables
1_30 = 0.231 * LE - 0.00011 * LE**2 - 0.142;

END;
### APPENDIX II LIST OF SYMBOLS AND CONCEPTS SPECIFICALLY FOR INDIA

<table>
<thead>
<tr>
<th>symbol</th>
<th>name</th>
<th>definition</th>
<th>dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abortion(_{leg})</td>
<td>abortion legalization &amp; Abortion(_{leg})</td>
<td>abortion legalized or not</td>
<td>scale 0 - 1</td>
</tr>
<tr>
<td>AR</td>
<td>abortion rate</td>
<td>number of induced abortions per live births</td>
<td>[abortions/live births]</td>
</tr>
<tr>
<td>AR(_{pol})</td>
<td>abortion(_{pol})</td>
<td>effect of abortion policy on number of abortions</td>
<td></td>
</tr>
<tr>
<td>Awareness(_{ind})</td>
<td>awareness individual &amp; Awareness(_{ind})</td>
<td>awareness of an individual in the year 1900 of modern methods to control fertility</td>
<td>[%]</td>
</tr>
<tr>
<td>Avg(_{m})</td>
<td>mean age at marriage</td>
<td></td>
<td>[years]</td>
</tr>
<tr>
<td>B</td>
<td>births</td>
<td>number of live births in a year</td>
<td></td>
</tr>
<tr>
<td>Base(_{AR})</td>
<td>base abortion rate</td>
<td>estimate of AR in the year 1900</td>
<td>[abortions/live births]</td>
</tr>
<tr>
<td>Base(_{CPR})</td>
<td>base contraceptive prevalence rate</td>
<td>estimate of CPR in the year 1900</td>
<td>scale 0 - 1</td>
</tr>
<tr>
<td>CBR</td>
<td>Crude Birth Rate</td>
<td>number of births per 1,000 population in a given year</td>
<td>[persons/1,000]</td>
</tr>
<tr>
<td>CDR</td>
<td>Crude Death Rate</td>
<td>number of deaths per 1,000 population in a given year</td>
<td>[persons/1,000]</td>
</tr>
<tr>
<td>C(_{a})</td>
<td>index of abortion</td>
<td>fraction of the fertile life span that is lost for reproduction due to induced abortion</td>
<td>scale 0 - 1</td>
</tr>
<tr>
<td>C(_{c})</td>
<td>index of contraception</td>
<td>fraction of the fertile life span in which reproduction is possible in face of deliberate fertility control via contraceptives</td>
<td>scale 0 - 1</td>
</tr>
<tr>
<td>C(_{i})</td>
<td>index of postpartum infecundability</td>
<td>fraction of the fertile life span that is lost for reproduction due to breastfeeding and culturally motivated abstinence</td>
<td>scale 0 - 1</td>
</tr>
<tr>
<td>C(_{m})</td>
<td>index of marriage</td>
<td>fraction of the fertile life span spent in stable sexual union</td>
<td>scale 0 - 1</td>
</tr>
<tr>
<td>CPR</td>
<td>Contraceptive Prevalence Rate</td>
<td>proportion of couples in reproductive age, currently using contraception</td>
<td>scale 0 - 1</td>
</tr>
<tr>
<td>Variable</td>
<td>Definition</td>
<td>Scale</td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>--------------------------------------------------------------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>CPR&lt;sub&gt;max&lt;/sub&gt;</td>
<td>Maximum CPR</td>
<td>0 - 1</td>
<td></td>
</tr>
<tr>
<td>diffusion_rate</td>
<td>Rate of adoption of contraception</td>
<td>[%]</td>
<td></td>
</tr>
<tr>
<td>e&lt;sub&gt;i&lt;/sub&gt;</td>
<td>Average use-effectiveness of contraceptive methods I</td>
<td>0 - 1</td>
<td></td>
</tr>
<tr>
<td>e&lt;sub&gt;o&lt;/sub&gt;</td>
<td>Life expectancy at birth</td>
<td>[years]</td>
<td></td>
</tr>
<tr>
<td>Famplan</td>
<td>Family planning programme effort score (formerly PES)</td>
<td>0 - 1</td>
<td></td>
</tr>
<tr>
<td>F(y)</td>
<td>Age-specific fertility rate</td>
<td>[-]</td>
<td></td>
</tr>
<tr>
<td>female_lit</td>
<td>Female literacy</td>
<td>0 - 100%</td>
<td></td>
</tr>
<tr>
<td>g(a)</td>
<td>Age-specific marital fertility rate</td>
<td>[-]</td>
<td></td>
</tr>
<tr>
<td>HDI</td>
<td>Human development index</td>
<td>0 - 1</td>
<td></td>
</tr>
<tr>
<td>lm</td>
<td>Probability of survival to mean age of childbearing</td>
<td>0 - 1</td>
<td></td>
</tr>
<tr>
<td>m(a)</td>
<td>Age-specific proportion of women currently married or in a sexual union</td>
<td>0 - 1</td>
<td></td>
</tr>
<tr>
<td>masscomm</td>
<td>Mass communication factor</td>
<td>0 - 1</td>
<td></td>
</tr>
<tr>
<td>Min&lt;sub&gt;m&lt;/sub&gt;</td>
<td>Minimum age at marriage</td>
<td>[years]</td>
<td></td>
</tr>
<tr>
<td>s&lt;sub&gt;i&lt;/sub&gt;</td>
<td>Share of method I in contraception</td>
<td>[%]</td>
<td></td>
</tr>
<tr>
<td>Son&lt;sub&gt;pref&lt;/sub&gt;</td>
<td>Son preference</td>
<td>0 - 1</td>
<td></td>
</tr>
<tr>
<td>SRB</td>
<td>Sex ratio at birth</td>
<td>[-]</td>
<td></td>
</tr>
<tr>
<td>TFR</td>
<td>Total fertility</td>
<td>[-]</td>
<td></td>
</tr>
<tr>
<td>TM</td>
<td>Total marital fertility</td>
<td>[-]</td>
<td></td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Definition</td>
<td>Note</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>TN</td>
<td>total natural marital fertility</td>
<td>total fertility ignoring the effect of celibacy</td>
<td></td>
</tr>
<tr>
<td>TF</td>
<td>total fecundity</td>
<td>the theoretical maximum number of births per woman</td>
<td>15.3</td>
</tr>
<tr>
<td>Pp\text{amen}</td>
<td>postpartum infecundability, mainly due to postpartum amenorrhea</td>
<td>mean duration of postpartum infecundability</td>
<td>[months]</td>
</tr>
<tr>
<td>Ult\text{m}</td>
<td>proportion women ultimately married</td>
<td>scale 0 - 1</td>
<td></td>
</tr>
<tr>
<td>WCPR</td>
<td>wanted contraceptive prevalence rate</td>
<td>number of couples using contraceptives necessary to reach the wanted fertility</td>
<td>scale 0 - 1</td>
</tr>
<tr>
<td>WTFR</td>
<td>wanted total fertility rate</td>
<td>number of births a woman will have, assuming that all of her births are wanted</td>
<td>[persons]</td>
</tr>
</tbody>
</table>

**Concepts specifically for India**

**Contraceptive Prevalence Rate (CPR)**
- Concept used in all-India surveys, the Operation Research Group (ORG), Baroda and the National Family and Health Survey (NFHS): percentage of currently married women/couples in the reproductive age (15-49 or 13-49), currently using contraceptives.

**Couple Protection Rate (CPR)**
- Concept used by Ministry of Health and Family Welfare: ratio of the estimated numbers of couples protected and the estimated number of eligible couples (couples with currently married women in the reproductive age of 15-44 years).
- The estimated number of couples protected by vasectomy, tubectomy and IUD is based on the age distribution of acceptors and the estimated age-specific joint survival ratios of husbands and wives. Attritions that are the result of mortality, dissolution of marriages and discontinuation of use of the IUD are considered in estimating the survival ratios. The estimated number of couples protected by condoms and oral contraceptives are derived from the distribution figures of the two methods: 72 condoms or 13 cycles of oral contraceptives are assumed to equal one year of protection provided (derived from Visaria et al. 1994).

**Effective age at marriage**
- Age at consummation of marriage

**Effective Couple Protection Rate**
- The effective Couple Protection Rate takes into account the use-effectiveness of the different methods: 100 per cent for sterilization, 95 per cent for IUD and 99 per cent for oral pill.

**Sex Ratio**
- Number of females per 1,000 males