Chapter VIII

A SIMULATION MODEL

8.1 THE PROBLEM

The impact of sex preference on fertility has generally been studied by mathematical or stochastic models. The present study has also proposed a probability model in this regard. The importance of the development of such mathematical or stochastic models for the proper study of these problems cannot be undermined, although these models sometimes involve some rigid assumptions which may or may not influence the results. For example, while developing the mathematical model for the present study in Chapter IV, it was assumed that (i) each conception leads to a live birth, (ii) fecundability over age is constant and (iii) infant and child mortality occur in the first a years of life and later no deaths occur among the children until the couples complete their reproduction. These assumptions are made so that the model becomes simpler. Even without these assumptions the results may hold - indeed, the results hold, as revealed by the analysis presented later on in this chapter. Many complex situations which are not amenable to mathematic modelling can be analysed easily by simulation techniques. The development of simulation models does not require the simplifying assumption of stationarity (parameters do not change with age) or even of homogeneity (all couples share the same parameter values) which many reproductive models presuppose (Bongaarts and Potter, 1983). In the present chapter, the same problem has therefore been studied through development of a simulation model, the underlying assumptions for which are sufficiently general and realistic. The results obtained are finally compared with those based on probability models, developed in Chapter IV.

8.2 THE MODEL

The basic approach followed here to study the effect on current fertility, of allowing couples to satisfy their sex composition, is the same as that used earlier (Chapter IV, Section 4.2) and can be looked upon a controlled experiment. The analysis was done in two segments. One segment is a cohort simulation model of human fertility which is very similar to the model of Ridley and Sheps (1965) and Venkatacharya (1970b). This would provide estimates of birth probabilities ($f_{x,y}$) for a given current age (x) and age at marriage (y) of woman, once assuming usual reproductive behaviour (control set), and the other with specific rules for stopping after achieving a certain specific family size composition (experimental set). All the input values except those of stopping rules are identical for the two sets. The second segment involves estimation of various current fertility rates from the current age and age at marriage specific birth matrices derived in the first segment. To estimate fertility rates in the second segment; a simple population projection technique was used, details of which have already been discussed in Chapter IV, Section 4.2.2. A difference in the fertility rate of the two sets in each case is a measure of the impact of allowing couples to attain specified family size composition on fertility.

8.2.1 The Monte Carlo Model to Obtain Age and Age at Marriage Specific Birth Probabilities

In the Monte Carlo model the sequence of events such as marriage, pregnancy, stay in various pregnancy periods, outcome of a conception, stay in post-partum non-susceptible period are worked out with the help of a set of psuedo-random numbers. Let us consider an example where we are interested in simulating the age at marriage of a woman on the basis of a certain probability distribution. Let the chance of a single woman aged x marrying before x+1 be m(x). A random number, with values between 0 and 1 generated in the computer, is drawn and it is tested whether this random number is less than or equal to m(x). If the random number is less than or equal to m(x), the marriage takes place at age x, otherwise not and a similar procedure is adopted to decide her marriage at age x+1 . The same technique can be followed to determine other events. For each female partner, the successive reproductive states entered are determined. Repeating this process many times produces a collection of reproductive histories, for which as many details as desired may be retained. Thus in order to determine the event we use the probability of its occurrence. The detailed procedure for simulating a woman's fertility history has been described by Venkatacharya (1970b). Simulation models are very widely used because of their flexibility and ease due to the advent of high speed electronic computers.

The present model simulates fertility histories of married women from their entry into marital union to the end of their reproductive life, and records all the events necessary for the computation of various current fertility indices. The sequence of events that can take place while simulating the fertility history of a married woman under the control set and experimental set, is shown in Figures 1 and 2. All the events are generated on the basis of the input probability density functions corresponding to the specific event. In the following section the assumptions and input parameters underlying the Monte Carlo model are discussed.

Assumptions :

(1) Fertility is simulated from age at marriage to 44 years of age. Marriage is considered as universal and remarriage is not considered. No woman starts her reproduction before age 15. This is an arbitrary assumption and the model can be used for any age other than

Figure 1 : Flow Chart showing the Sequence of Events that Can Take Place while Simulating the Fertility History of a Married Woman Under the Control Set

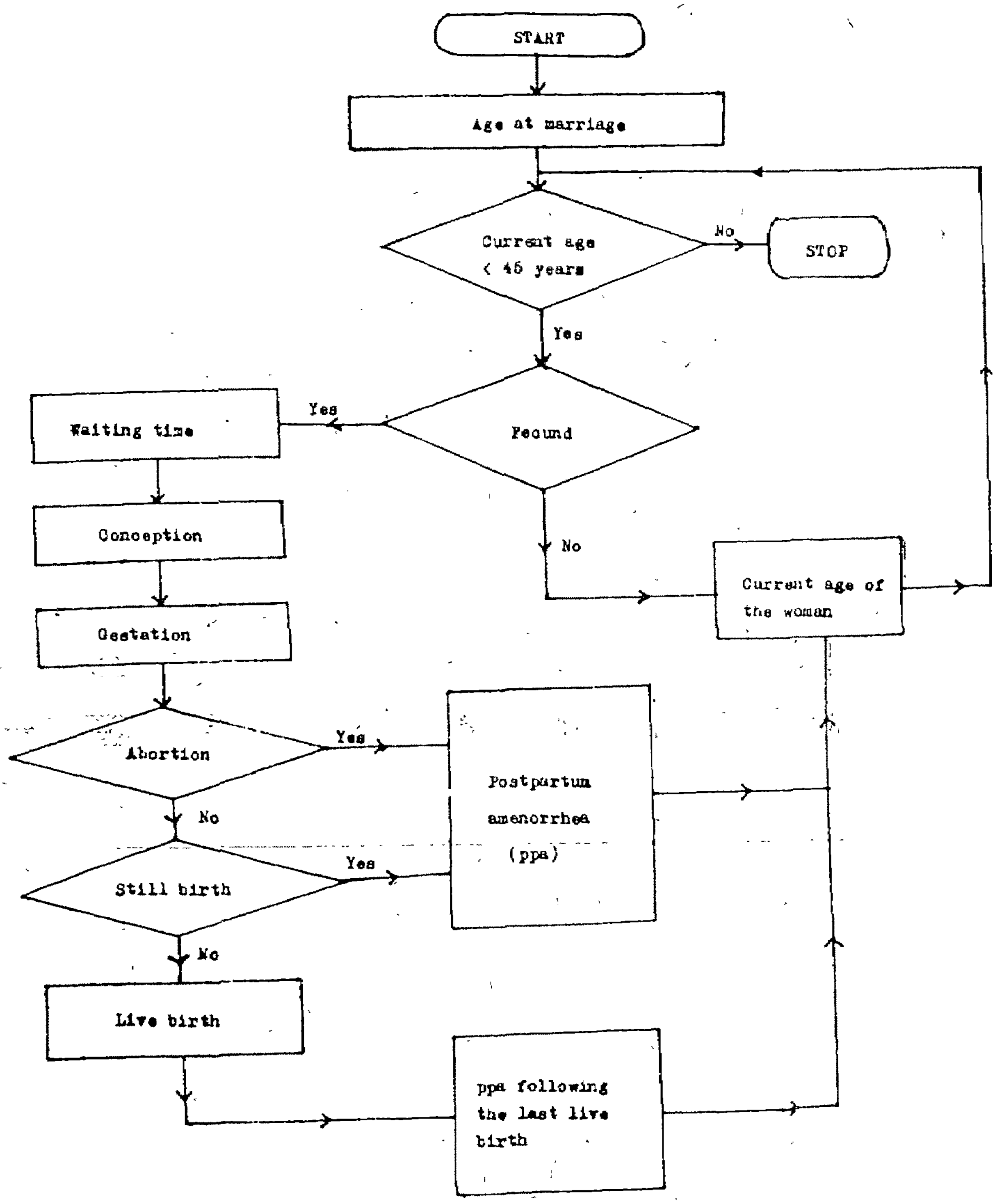
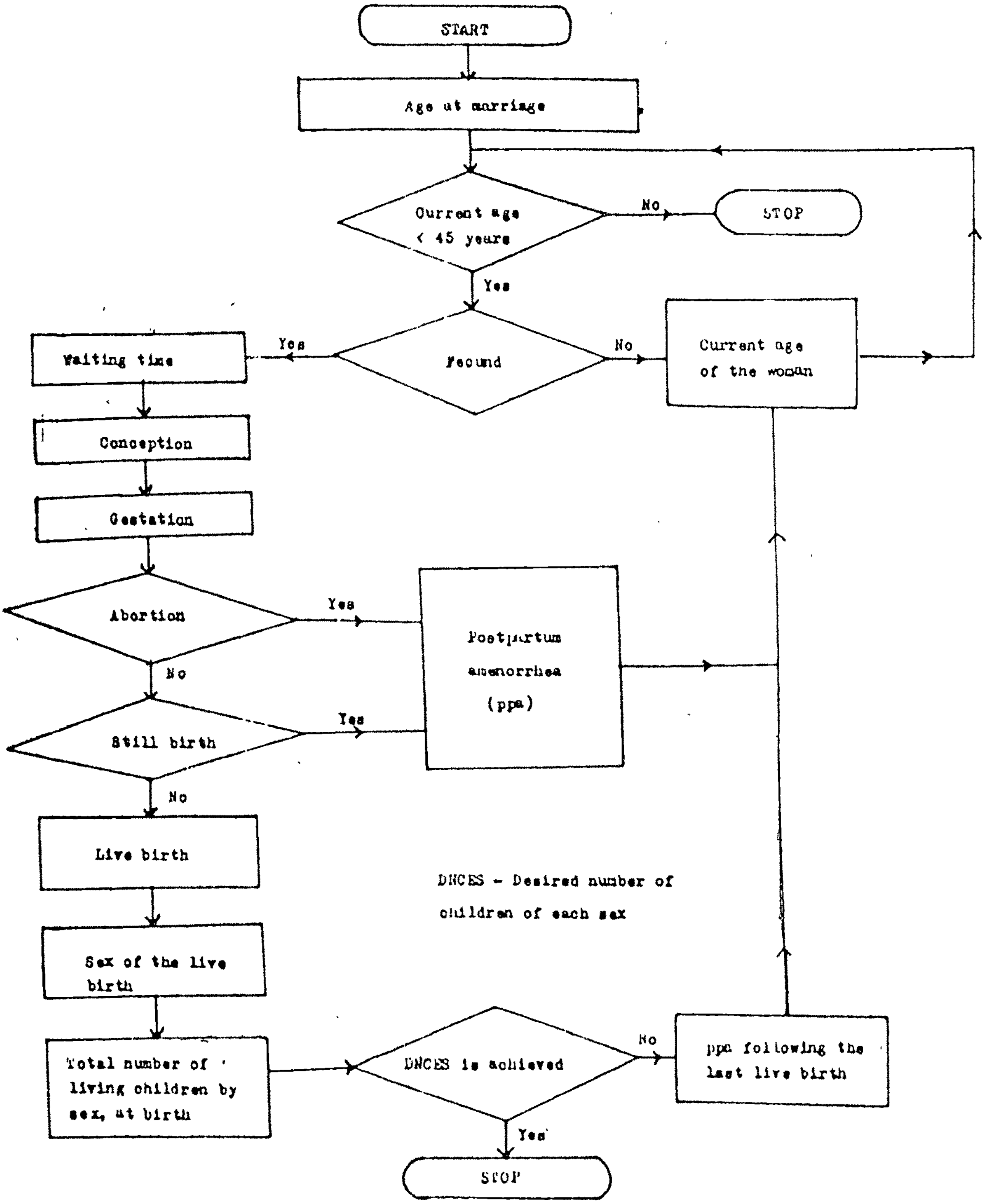


Figure M.1 Flow Chart Showing the Sequence of Events that Can Take Place While Simulating the Fertility History of a Married woman Under the Experimental Set :



15 years as the initial age of fertility. The age at menopause for all women is taken to be 45 years.

(2) The unit of time is considered as a month, which is nearly equal to the mean inter-menstraum.

(3) Women are assumed to have identical biological parameters, i.e., they are homogeneous.

(4) Mortality of the woman has been ignored (it is taken care of separately).

(5) Probability of a woman becoming sterile is assumed to vary by her age.

(6) Fecundability is assumed to vary with age of a woman, although it does not change with parity.

(7) A conception is assumed to terminate either in a live birth, a stillbirth or an abortion, and the probability of the occurrence of each is assumed to vary over age.

(8) The termination of gestation periods leading to a live birth, stillbirth or abortion, are assumed to occur according to specified discrete probability distributions which are assumed to be constant for all ages and parities. Similarly, postpartum amenorrhea periods are assumed to follow specified probability distributions.

(9) Probability of a male and female birth to survive at a point of time depends on his/her age, at that point of time.

(10) Birth control is complete. Couples stop reproduction as soon as the desired sex composition and/or size

(in terms of b surviving sons and g surviving daughters and/or a total of s surviving children) is achieved.

Assumption (10) is meant for the experimental group where it is assumed that a couple has a preference for a fixed minimum number of boys and a fixed minimum number of girls. The expected fertility is obtained under the assumption that sex preference can only increase, not decrease, fertility. The adcuracy of the results depends on the validity of this assumption, in a population under study. In any case, the present measure is useful to know the maximum possible impact of sex preference on fertility.

Input :

To simulate fertility history at micro level, it is necessary to obtain age specific sterility rate, age specific fecundability, age specific probabilities of conception terminating in a live birth, a stillbirth, or an abortion, probability of termination of pregnancy periods and post-partum amenorrhea periods associated with each conception termination and the survival probability of a birth to a particular age by sex. Each of these input probabilities used in the simulation model are presented and discussed in Chapter V.

The current age and age at marriage specific birth probabilities are obtained on the basis of 100 women simulated at each of the single years 15, 16 ...... 35. That is, 2100 women histories are used to yield one birth matrix ($f_{x,y}$, x = 15, 16, ... 44, y = 15, 16 .... 35 where $x \geq y$). This set of 2100 women forms one replicate. Fertility histories were generated in two replicates of 2100 women in each. Replications were mainly for testing internal consistency of the output. Between the replicates the differences in important rates were not much. Therefore, the results are presented for the pooled data. The matrix of birth probabilities ($f^c_{x,y}$) obtained by assuming usual reproductive behaviour (where reproduction is, by and large at the observed level, i.e. unaffected by any specific planning) gives the age and age at marriage specific birth probabilities corresponding to the control assumption. Using the same simulation model and all the input values, and adding an assumption for stopping after achieving certain specified family size composition, the matrices of birth probabilities ($f^e_{x,y}$) corresponding to each specific stopping rule under experimental set are obtained. The same twelve hypothetical cases under the experimental set, giving the rules when a couple would stop, have been considered for comparison of the present results with those based on probability model. Several other stopping rules may be framed, and the birth matrix can be computed. The twelve stopping rules here are described below.

Couples stop reproduction as soon as they have :

Rule 1 : two living children

Rule 2 : three living children

Rule 3 : four living children

Rule 4 : one living son and one living daughter

Rule 5 : two living sons

Rule 6 : one living son and two living daughters

Rule 7 : two living sons and one living daughter

Rule 8 : two living sons and two living daughters

Rule 9 : three living sons and one living daughter

Rule 10: one living son and one living daughter or three living children

Rule 11: two living sons and one living daughter or four living children

Rule 12: two living sons or three living children.

It is seen that Rules 1 to 3 are framed without any allowance for sex preference. Rules 4 to 9 are meant for those couples who wish to continue reproduction until a desired minimum number of children by sex is achieved. The remaining three stopping rules (Nos. 10 to 12) regarding sex preference are framed considering that it may be unrealistic to assume that couples will continue reproduction until they achieve the desired minimum number of children of each sex.

8.2.2 Derivation of Current Fertility Rates

Having obtained the estimates of age and age at marriage specific birth probabilities under control and various stopping rule assumptions, the corresponding birth rates and other measures of current fertility and their trends during 1981-96 are derived by the method discussed earlier (Chapter IV, Section 4.2.2). The results are summarised in Tables 8.1 to 8.5. It may be noted that the results are based on the pooled results of the two independent calculations made with the two birth probability matrices. As mentioned earlier, each one of the two matrices for the control and experimental sets, is obtained on the basis of 2,100 simulated cohort fertility histories. In order to indicate the amount of sampling error one can expect if the fertility rates are based on only one birth probability matrix, TMFRs are computed for the two independent sample matrices for the control set and for all the stopping rules under the experimental set, and are presented in Table 8.1. It is evident from this table that the differences in TMFRs between sample I and II are not large for each of the stopping rules and control assumptions, indicating that the above analysis could have been made without any serious error on the basis of only a single birth probability matrix.

8.3 RESULTS

The findings are basically consistent with those based on the probability models presented earlier. This becomes evident when each of the current fertility indices derived through simulation model under control and experimental set are examined. The interpretation of the results in Tables 8.1 to 8.5 is more or less similar to **that** based on probability models (Tables 7.1 to 7.10).

8.3.1 Total Fertility

Table 8.1 also shows the pooled Total Marital fertility Rate (TMFR) for the control set and the experimental set. Since TMFRs for the period 1981-96 remain stable under the control set and under each stopping rule (for details refer Chapter IV, Section 4.2.2), they are presented for a year. The effect of sex preference on current fertility is clearly evident when TMFRs under different stopping rules are compared in Table 8.1. For a given size of family (number of total living children desired) the lowest fertility would be achieved if there was no sex preference. The next lowest TMFR is when the preference is for equal numbers of each sex. Similarly, when the desired number of surviving sons is greater than the desired number of surviving daughters the corresponding TMFR is greater than when the preference is for equal numbers of each sex. The maximum is reached when

Table 8.1 : Total Marital Fertility Rates Obtained for the Control Set and for Different Stopping Rule Assumptions under the Experimental Set, Making Use of Two Independent Age and Age at Marriage Specific Birth Probability Matrices Derived by Simulating 2100 Cohort Fertility Histories for each Matrix.

	Total Marital Fertility Rate*		
	Sample I	Sample II	Combined
<u>Control Set</u>	5.30	5.37	5.34
<u>Experimental Set</u>			
Rule 1	2.11	2.11	2.13
Rule 2	3.21	3.24	3.22
Rule 3	4.13	4.21	4.17
Rule 4	2.84	3.01	2.93
Rule 5	3.64	3.64	3.64
Rule 6	4.15	4.31	4.23
Rule 7	4.05	4.22	4.13
Rule 8	4.80	4.91	4.85
Rule 9	4.96	4.97	4.97
Rule 10	2.63	2.70	2.67
Rule 11	3.83	4.02	3.92
Rule 12	2.96	3.01	2.98

* Based on single year age specific marital fertility rate which remains the same during the period 1981-96

the desired minimum family size consists of one sex only (all combinations are not shown in the Table). Thus, the level of TMFR increases with the increasing preference for one sex over the other, indicating that the results are basically consistent with those obtained through probability models discussed earlier.

As done in the case of the results obtained through probability models, TMFRs obtained here under the control set and under different stopping rules are compared to understand the implications of allowing couples to attain the desired size and/or its sex composition, on the level of current fertility. It is evident from Table 8.1 that the level of fertility prevailing at present in the country, can substantially be reduced even if all couples are allowed to have one living son and one living daughter (Rule 4) or two living sons and one living daughter (Rule 7). The expected TMFR under stopping Rules 4 and 7 is estimated to be 2.93 and 4.13 respectively, while it is as high as 5.34 under the control set. In other words, the current level of fertility can be reduced by about 45.1 percent even if couples wish to have one living son and one living daughter and continue to have children until they achieve this desired composition. Even under Rule 7, where couples cease childbearing as soon as they have two living sons and one living daughter, the total fertility rate of the population is expected to reduce by about 22.7 percent. The corresponding reduction in total fertility is obviously expected to be much higher in case of Rule 1 (60.1 percent) and Rule 2 (39.7 percent) where couples cease childbearing at two and three living children respectively, without regard to the sex composition. It can, however, be seen from Table 8.1 that the TMFR under Rule 9 (three living sons and one living daughter) is as high as 4.97. It is more than that obtained under any of the other hypothetical cases illustrated here since greater preference for size and sex (boys) is shown. For Rule 8, where a couple gives equal preference for sex (two living sons and two living daughters), the TMFR is still less (4.85) than that obtained under Rule 9. It is only for Rule 5, that the desire for one sex only is shown. The total fertility rate is expected to be relatively very high if couples wish to have children of one sex only and are allowed to have this desired minimum, without any limit on the total living children.

If couples are allowed to satisfy their desired family size composition subject to a certain limit on their total children, the total fertility is expected to be relatively low (see Table 8.1). This is shown under Rules 10 to 12 where couples are allowed to satisfy their sex preferences subject to a maximum of three or four living children. Hence the expected TMFRs under Rules 10, 11 and 12 are relatively less than the corresponding TMFRs under Rules 4, 7 and 5 respectively, where the couples are otherwise allowed to satisfy the same sex preference without any upper limit on their total living children.

8.3.2 Net Reproduction Rate

Table 8.2 shows the Net Reproduction Rate (NRR) for the control set and for the various stopping rules under the experimental set during the period 1981-96. The NRRs are however not presented for each year of the period of projection, but are given for each year that falls at an interval of 5 years during 1981-96. The estimates of NRRs during this period are as such more or less stable except for a tendency to increase slightly over a period of time as a result of changes in the level of mortality. The interpretation of Table 8.2 is facilitated by having evaluated the results based on TMFRs (Table 8.1). The effect of sex preference on NRR is clearly evident when NRRs obtained under different stopping rules are compared. It is quite satisfying to note that the changes in the values of NRR are in conformity with the changes in the values of TMFR.

Table 8.2 further reveals that the long term demographic goal of NRR equal to 1 by 1996-2001, as spelt out in the National Population Policy (Govt. of India, 1981), cannot be achieved if couples are allowed to have a minimum of one living son and one living daughter. Under this

Table 8.2 : Net Reproduction Rate for the Control Set and for the Different Stopping Rule. Assumptions Under the Experimental Set, 1981-96

	Net Reproduction Rate+			
	1981	1986	1991	1996
Control Set	2.12	2.19	2.27	2.34
Experimental Set				
Rule 1	0.88	0.91	0.94	0.96
Rule 2	1.31	1.35	1.39	1.43
Rule 3	1.68	1.74	1.80	1.85
Rule 4	1.19	1.23	1.27	1.30
Rule 5	1.47	1.52	1.57	1.61
Rule 6	1.69	1.75	1.81	1.86
Rule 7	1.66	1.72	1.77	1.82
Rule 8	1.93	2.00	2.06	2.12
Rule 9	1.96	2.02	2.09	2.16
Rule 10	1.09	1.13	1.16	1.19
Rule 11	1.58	1.63	1.68	1.73
Rule 12	1.22	1.26	1.30	1.33

\+ The net reproduction rate is defined as $\sum_{x=1}^{6} {}_5b_x^f \, ({}_5L_x/l_o)$,

Where ${}_5b_x^f$ represents the rate of female births during a year, to women of age x, where x is an interval of five years, and ${}_5L_x/l_o$ is the number of person years lived per woman (from life table) pattern of reproduction (Rule 4), the level of NRR by 1996 can be expected to be about 1.30 in India. The level of NRR equal to 1 would be achieved if there was no sex preference and a couple would stop reproduction as soon as a family size of two living children is attained (Rule 1).

8.3.3 Age Specific Marital Fertility Rate

The Age Specific Marital Fertility Rate (ASMFR) in the conventional quinquennial age groups is shown in Table 8.3. This is presented corresponding to the control set and experimental set for the year 1986. This is because the pattern of ASMFR for any other year within 1981-96 is quite close to that of 1986, for the control set and for each of the stopping rules under the experimental set. The impact of adopting stopping rules on ASMFR is clearly evident, especially in the later age groups. It is seen that all the ASMFRs under the experimental set are smaller than or equal to those of the control set for any age group. The ASMFRs for the later age group, in case of each of the stopping rules under the experimental set, are particularly much smaller than the corresponding ASMFR of the control set, the chances of satisfying the desired sex composition being relatively much higher by the time couples reach the later age groups. Thus the greater reduction in total fertility is obtained because of reduction in fertility in the middle and older age groups.

Table 8.3 : Age Specific Marital Fertility Rate (ASMFR) for the Control Set and for the Different Stopping Rule Assumptions under the Experimental Set for the Year 1986.

	ASMFR (Births per 1000 Married Women) under Age Group					
	15-19	20-24	25-29	30-34	35-39	40-44
Control Set	123.85	277.45	274.34	204.85	145.12	76.93
Experimental Set						
Rule 1	114.23	212.40	93.31	19.18	5.26	1.81
Rule 2	117.35	267.41	185.27	68.65	23.01	6.20
Rule 3	118.48	272.16	260.10	135.33	55.44	25.14
Rule 4	116.02	240.84	149.59	64.59	25.48	10.25
Rule 5	125.22	243.66	198.91	111.96	48.48	26.69
Rule 6	122.17	264.19	237.91	146.09	71.86	29.72
Rule 7	121.14	254.12	239.22	139.18	66.40	33.77
Rule 8	122.48	261.69	270.91	188.83	105.15	50.73
Rule 9	123.44	269.25	265.05	194.84	105.04	61.73
Rule 10	110.94	237.92	142.24	44.38	14.51	4.21
Rule 11	112.22	257.29	237.03	122.99	60.83	20.60
Rule 12	122.18	242.72	169.59	60.20	18.48	6.35

8.3.4 General Marital Fertility Rate & Crude Birth Rate

Table 8.4 shows General Marital Fertility Rates (GMFR), while Table 8.5 shows the Crude Birth Rates (CBR) during the period 1981-96. This is shown for the control set and for each of the stopping rules, considered under the experimental set. It can be seen from Tables 8.4 and 8.5 that the GMFR/CBR for the period 1981-96 are more or less stable, except for a tendency to decrease slightly in the initial years and then to increase slightly in the later years. This is due to the interaction between the changing age structure of the population and fertility rates. The interpretation of the results in Tables 8.4 and 8.5 is more or less similar to that of Table 8.1.

The impact of sex preference on current fertility is clearly evident from Tables 8.4 and 8.5 for a given family size, the lowest GMFR/CBR would be achieved if there were no sex preferences. It is also evident from these tables that the level of GMFR/CBR in India could be greatly reduced by an effective campaign of limiting family size to three or less. For example, in 1986, a birth rate of 31.80 per 1000 population reduces by 58.2 percent under Rule 1 where couples interrupt their childbearing at two living children, and by 36.8 percent under Rule 2 where couples cease childbearing as soon as they have three living children, without regard to the sex composition. Similarly, the level of GMFR which

Table 8.4 : General Marital Fertility Rate (GMFR) for the Control Set and for the Different Stopping Rule Assumptions Under the Experimental Set, 1981-96

	GMFR (Births per 1000 Married Women)			
	1981	1986	1991	1996
<u>Control Set</u>	198.57	188.25	188.96	191.95
<u>Experimental Set</u>				
Rule 1	82.50	77.17	83.77	86.93
Rule 2	126.01	117.50	122.33	127.45
Rule 3	160.32	151.26	152.55	157.85
Rule 4	112.91	106.19	110.89	114.82
Rule 5	139.06	131.25	133.95	138.19
Rule 6	161.31	152.12	154.25	158.60
Rule 7	157.79	148.67	150.25	155.12
Rule 8	183.15	173.47	173.53	177.67
Rule 9	186.27	176.69	176.92	180.64
Rule 10	104.07	97.08	102.17	106.65
Rule 11	151.38	141.88	143.99	149.03
Rule 12	115.87	108.60	113.18	118.34

Table 8.5 : Birth Rate for the Control Set and the Different Stopping Rule Assumptions Under the Experimental Set, 1981-96

	Crude Birth Rate per 1000 Population			
	1981	1986	1991	1996
Control Set	33.52	31.80	31.97	30.60
Experimental Set				
Rule 1	14.21	13.29	14.43	15.03
Rule 2	21.53	20.09	20.93	21.89
Rule 3	27.24	25.71	25.97	26.96
Rule 4	19.34	18.12	19.08	19.76
Rule 5	23.71	22.39	22.88	23.68
Rule 6	27.32	25.86	26.25	27.09
Rule 7	26.82	25.29	25.59	26.51
Rule 8	31.00	29.38	29.44	30.25
Rule 9	31.51	29.90	29.99	30.73
Rule 10	17.85	16.66	17.56	18.38
Rule 11	25.76	24.16	24.55	25.50
Rule 12	19.84	18.60	19.40	20.31

is observed to be 188.25 per 1000 currently married women under the control set during 1986, is expected to reduce by about 59.0 percent under Rule 1 and 37.6 percent under Rule 2. Considering the degree of sex preference that prevails in a developing country like India, even if those couples who are not satisfied with the sex composition of their two or three living children, are allowed to continue reproduction until they achieve the desired minimum of each sex, the current level of GMFR/CBR can still be reduced significantly. For example, if all couples are allowed to have one living son and one living daughter but stop reproduction as soon as they achieve this desired composition (Rule 4), the same GMFR (188.25)/CBR (31.80) would still decline by about 43-44 percent, while the corresponding reduction is about 20-21 percent under Rule 7 where couples cease childbearing when they have two living sons and one living daughter. Similarly, the implications of allowing couples to have four living children and/or its various sex composition on the GMFR/CBR can be seen from Tables 8.4 and 8.5. The results further reveal that if each couple is allowed to have two living sons and one living daughter subject to a maximum of four living children (Rule 11), the GMFR/CBR is lower than that obtained under its corresponding stopping rule (Rule 7), which has no upper limit on the total number of children. Thus the expected reduction in GMFR/CBR, from its current level in a population, is more in the case of Rule 11 than that obtained under Rule 7. Similarly, the reduction under Rules 10 and 12 would be higher than that under their corresponding Rules 4 and 5, respectively.

8.3.5 <u>The Overall Effect of Sex Preference on Current Fertility</u>

So far, the implications of adopting a particular stopping rule regarding sex preference on the level of current fertility in a population like India, have been examined. In other words, if the sex preferences within the population are homogeneous and all the couples are allowed to achieve this desired minimum, its effect on current fertility can be seen from the results presented in the previous sections. However, since sex preferences do differ even within a population, an attempt is made here to estimate the overall effect of these varied sex preferences on the level of current fertility in the country. This is done by the following procedure.

Basically the approach is similar to that used earlier (see Section 8.2). Apart from the current level of fertility obtained under the control set, two sets of fertility rates are obtained under the experimental set, one allowing couples to satisfy their respective desired sex composition and the other allowing couples to satisfy their respective desired family size.

Based on an all India survey carried out by ORG, Baroda during 1980 (see Chapter III, Section 3.4, for details) it is assumed that Indian couples have the following sex preference patterns: (i) one son (desired by 2.11 percent of the couples), (ii) one daughter (0.71 percent), (iii) one son and one daughter (25.55), (iv) two sons (6.44), (v) two sons and one daughter (34.41), (vi) one son and two daughters (5.13), (vii) three sons (2.41), (viii) three sons and one daughters (6.04) and (ix) two sons and two daughters (17.20)[1].

Assuming that the above sex preferences are stable, nine stopping rules (R_1, R_2, ..., R_9) are accordingly framed[2]. It is assumed that stopping rules R_1, R_2 ...., R_9 are followed by $P(R_1)$, $P(R_2)$ ....., $P(R_9)$ proportion of the couples respectively to satisfy their individual sex preference.

Then

$$P(R_1) + P(R_2) + ... + P(R_9) = 1$$

Having obtained, by the same procedure, simulated current age (x) and age at marriage (y) specific birth

1. Any other categories of sex preference which consist of less than one percent, are excluded from the total cases to obtain percentage distribution of these categories.

2. These stopping rules imply that a couple will stop reproduction as soon as the specified number of living children by sex is achieved. The nine stopping rules are as follows: R_1: 1 son; R_2: 1 daughter; R_3: 1 son & 1 daughter; R_4: 2 sons; R_5: 2 sons & 1 daughter; R_6: 1 son & 2 daughters; R_7: 3 sons; R_8: 3 sons & 1 daughter; R_9: 2 sons & 2 daughters.

matrix ($f_{x,y}$, $x = 15, 16, \ldots, 44$, $y = 15, 16, \ldots, 35$ where $x \geqslant y$) corresponding to each of these stopping rules ($R_1, R_2, \ldots, R_9$) under the experimental set, the pooled birth matrix can be obtained by

$$f^{e}_{x,y}(1) = f^{R_1}_{x,y}\, P(R_1) + f^{R_2}_{x,y}\, P(R_2) + \ldots + f^{R_9}_{x,y}\, P(R_9)$$

$$= 0.0211 f^{R_1}_{x,y} + 0.0071 f^{R_2}_{x,y} + 0.2555 f^{R_3}_{x,y} + 0.0644 f^{R_4}_{x,y}$$

$$+ 0.3441 f^{R_5}_{x,y} + 0.0513 f^{R_6}_{x,y} + 0.0241 f^{R_7}_{x,y} + 0.0604 f^{R_8}_{x,y}$$

$$+ 0.1720 f^{R_9}_{x,y}$$

Similarly, the corresponding birth matrix in the absence of sex preference is derived for the same experimental group as follows. Since the sex of children would no longer be important, couples will stop reproduction as soon as their respective family size in terms of total living children desired is achieved. not clear The distribution of couples, by their reported sex preference pattern will therefore take the following form in the absence of such a preference: (i) one child - 2.82 percent (2.11+0.71), (ii) two children - 31.99 (25.55+6.44), (iii) three children - 41.95 (34.41+5.13+2.41) and (iv) four children - 23.24 (6.04+17.20), assuming that the sum of the desired number of sons and daughters is the total family size desired by the couples.

Accordingly, another set of four stopping rules R_1', R_2', R_3' and R_4', are framed under the experimental group[3]. It is assumed that stopping rules R_1', R_2', R_3' and R_4' are followed by 2.82, 31.99, 41.95 and 23.24 percent of the couples, respectively. Having obtained the simulated birth matrices corresponding to each of the four stopping rules under the experimental set, the pooled birth matrix can similarly be obtained by

$$f^{e}_{x,y}(2) = .0282\, f^{R_1'}_{x,y} + .3199\, f^{R_2'}_{x,y} + .4195\, f^{R_3'}_{x,y} + .2324\, f^{R_4'}_{x,y}$$

The estimates of $f^{e}_{x,y}(1)$ and $f^{e}_{x,y}(2)$ are used to derive the corresponding birth rate and other measures of current fertility for the experimental sets by the method discussed earlier (Chapter IV, Section 4.2.2). The fertility rates based on $f^{e}_{x,y}(1)$ refer to stopping rules regarding sex preference (experimental set I), while those based on $f^{e}_{x,y}(2)$ refer to stopping rules in the absence of sex preference (experimental set II). A difference in the fertility rates of the two sets is a measure of the overall

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3. Each of these four stopping rules implies that a couple will stop reproduction as soon as a specified number of living children, irrespective of their sex, is achieved. The four stopping rules specifically refer to having : (i) one living child (R_1'), (ii) two living children (R_2'), (iii) three living children (R_3') and (iv) four living children (R_4').

effect of sex preference on current fertility in the population under study. On the other hand, a difference in the fertility rates between the control set and the experimental set is a measure of the impact of allowing all couples to attain their respective desired family size or its sex composition on fertility. The results of these analyses are summarised in Table 8.6.

It is evident from Table 8.6 that sex preference in India seems to have a significant effect on current fertility. In the light of the present pattern of sex preferences in India, if all couples continue reproduction in order to satisfy their respective desired family size composition but stop as soon as their desired minimum is achieved, the total marital fertility of the population is expected to be 3.92 per woman (under experimental set I). In the absence of sex preference, it is estimated that this figure would decrease to 3.03 (under experimental set II). In other words, if couples cease childbearing as soon as their minimum desired family size (irrespective of sex)is achieved, TMFR is expected to be 3.03 only. Thus the overall effect of sex preference is to increase total fertility by about 29 percent. An almost similar increase is also noted when considering other measures of current fertility (see Table 8.6). Considering the aggregate effect of sex preference on fertility it appears that a significant decrease in fertility could be

Table 8.6 : The Overall Effect of Sex Preference+ on the Birth Rate and Other Current Fertility Indices in India, 1981-96

Fertility Indices/ Year	Control Set	Experimental Set-I (Based on sex preference)	Experimental Set-II (In the absence of sex preference)
TMFR*	5.34	3.92	3.03
NRR			
1981	2.12	1.57	1.23
1986	2.19	1.63	1.27
1991	2.27	1.68	1.32
1996	2.34	1.73	1.35
CBR			
1981	33.52	25.40	20.08
1986	31.80	23.97	18.83
1991	31.97	24.40	19.63
1996	32.60	25.22	20.46
GMFR			
1981	198.57	149.40	117.52
1986	188.25	141.01	110.14
1991	188.96	143.23	114.70
1996	191.95	147.49	119.11

+ The distribution of the couples by their desired family size composition is as follows: one son (2.11 percent), one daughter (0.71), one son and one daughter (25.55), two sons (6.44), two sons & one daughter (34.41), one son & two daughters (5.13), three sons (2.41), three sons & one daughter (6.04) and two sons and two daughters (17.20).

* It is shown for a year, as it is independent of the year and remains stable during the period of projection. TMFR presented here is based on single year ASMFR.

achieved in the complete absence of any sex preference, which is an unlikely circumstance in the near future. Nevertheless, the results further reveal that even if all couples are allowed to satisfy their respective sex preferences but stop reproduction as soon as the desired minimum is achieved, the level of fertility in India could still be reduced by about one-fourth from its current level. For example, a TMFR of 5.34 as observed under the control set, reduces to 3.92 as observed earlier under the experimental set I. Similarly in 1986 the birth rate of 31.80 per 1000 population is expected to reduce to 23.97 while GMFR of 188.25 per 1000 married women reduces to 141.01 under the same strategy. The corresponding values of NRR are 2.19 and 1.63 respectively.

8.4 CONCLUSIONS

The main findings that emerge are basically consistent with those based on the probability model. The analysis of Indian data through simulation once again confirms that sex preference affects the current fertility of a population. If sex preference is stable, current fertility as measured through TMFR, GMFR or CBR, increases with increasing preference for one sex over the other. For a given size of family, the lowest fertility is achieved if there is no sex preference, while the maximum is obviously reached when the desired minimum consists of one sex only. Even if couples wish to have a minimum of one living son and one living daughter and keep having children to attain this, the total fertility or the birth rate of a population would always be higher than it would be if they stop at two children, irrespective of the sex. Nevertheless, in a population like India, the current fertility can be greatly reduced even if couples are allowed to have one child of each sex, but stop reproduction as soon as they attain this minimum. For example, a birth rate of 32 per 1000 population, which is observed during 1986, under the control set, reduces by more than two-fifth (43 percent) under such a strategy. Even if Indian couples wish to have two living sons and one living daughter (the most preferred combination), but stop reproduction as soon as they attain this, the birth rate in the country could still be reduced by about one-fifth from its current level.

It is further evident from the present analysis that the long term demographic goal of the country, i.e. NRR equal to one by 1996-2001, can not be achieved even if couples are allowed to have a minimum of one living child of each sex. The same can only be achieved if there was no sex preference and couples stop reproduction as soon as total of two living children is attained. However, in a society where sex of the children is still important to parents and suitable sex selection technology is not available for mass use, it is difficult to imagine a condition where couples would adhere to the two child norm and cease childbearing at two children irrespective of their sex. The achievement of the long term demographic goal of NRR equal to unity even to the revised date of 2006-11 (Govt. of India, 1985) still appears to be an unrealistic proposition.

In view of the varied size and sex preferences that prevail in India, an attempt has been made to estimate the aggregate effect of sex preference on current fertility. It is observed that the overall effect of sex preference is likely to increase total fertility or the birth rate of the population by as much as one-fourth. Considering the extent of the aggregate effect of sex preferences, it seems that a significant decrease in fertility could be achieved in the complete absence of sex preference, which is an unlikely circumstance in the near future. It is, however, interesting to note that even if all couples are allowed to satisfy their respective sex preference, but stop reproduction as soon as the desired minimum is achieved, India could still reduce its current level of fertility by about one-fourth. For example, a birth rate of 32 which is observed under the control set during 1986, is expected to reduce to 24 under this strategy. It may be noted that such a reduction is likely to be achieved under the present family planning programme, as it does not involve any additional efforts to alter the prevailing norm regarding size and sex preferences in India.