

Determine Population Size of Bangladesh Considering Land and Resources

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Conducted by



Human Development Research Centre

Dhaka: August 2014

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FOREWORD

The National Institute of Population Research and Training (NIPORT) under the Research, Survey and Development activities of the approved Operational Plan of “Training, Research and Development”, HNPSDP of the Ministry of Health and Family Welfare (MOHFW) have been assigned to float the study entitled “Study to Determine Population Size of Bangladesh Considering Land and Resources” in 2014. The Human Development Research Centre (HDRC), through competitive bidding was entrusted with the responsibility to conduct this almost unexplored in the past, complex and nationally significant research study. The HDRC has taken the challenge and carried out the study with an aim to determine optimum population size for Bangladesh considering land and resources.

The study has analyzed the changing pattern of total land area, cultivable land and forest area in Bangladesh; food production and consumption gaps; available resources in terms of productive human capital, gross domestic product (GDP) with share of various sectors and other resources using a twenty-one year time series data. It has developed model to determine optimum population and estimated optimum population size for Bangladesh considering assumptions on land size and available resources deploying a number of different scenarios.

I am grateful to the researchers of HDRC, guided by Professor Dr. Abul Barkat, who have devoted their fullest possible intellect, time and all out efforts to complete this methodologically complex and nationally vital research report.

I express my gratitude to the professionals of NIPORT for their sincerest efforts in publishing this report.

Director General
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PREFACE

The research study titled “Study to Determine Population Size of Bangladesh Considering Land and Resources” conducted during the year 2014 is an outcome of highest order intellectual effort of the researchers of Human Development Research Centre (HDRC) guided by a top grade researcher in Bangladesh and outside, Professor Dr. Abul Barkat. This research study was conducted with an aim to determine optimum population size for Bangladesh considering land and resources. The NIPORT has been a collaborator to this study of high national significance.

The study has used secondary data to analyse the changing pattern of total land area, cultivable land and forest area in Bangladesh; food production and consumption gaps; available resources in terms of productive human capital, gross domestic product (GDP) with share of various sectors and other resources and developed models to determine optimum population in Bangladesh, and finally, determined the optimum population of Bangladesh using these models.

I must express my indebtedness to Professor Dr. Abul Barkat, the Team Leader of the study and his research team members at HDRC for their performing the complex research job on the subject and finally to come up with the estimates of Optimum Population Size of Bangladesh which will guide the population and development plans and strategies of Bangladesh.

I am deeply indebted to the professionals of the Research unit of NIPORT for their sincerest assistance extended to the HDRC research team towards timely completion of the study maintaining highest possible quality.

(Md. Rafiqul Islam Sarker)

ACKNOWLEDGEMENT

NIPORT has awarded us at the Human Development Research Centre (HDRC) to conduct a very complex, previously unexplored and intellectually challenging research study titled “Study to Determine Population Size of Bangladesh Considering Land and Resources”. The accompanying report is the outcome of that intellectual challenge.

The successful administration of the Research Study would not have been possible without the commitment and dedication of all those researchers of HDRC who were involved in this challenging process.

The commendable enthusiasm of Director General, NIPORT, and Line Director, Training, Research and Development, Operational Plan of HPNSDP, NIPORT towards the study is highly appreciated and I am highly indebted to him. I am thankful to Md. Rafiqul Islam Sarker, Director, Research and, Program Manager (R, S & D) NIPORT, for his positive support towards the study. I am indebted to Mr. Subrata Kumar Bhadra for his providing us with thoughtful inputs and unstinted support at various necessary stages of this study.

The in-house staff members of HDRC worked untiringly at all the stages. I thank all those uncomplaining souls at HDRC.

Prof. Abul Barkat, *PhD*
Study Team Leader
&
Chief Advisor (Hon.), HDRC

Dhaka: August 2014

Abbreviations and Acronyms

ADP	Annual Development Programme
Ar	Area
ASMTO	Area Shown More Than Once
BANBEIS	Bangladesh Bureau of Educational Information & Statistics
BBS	Bangladesh Bureau of Statistics
BCF	Billion Cubic Feet
BCS	Bangladesh Civil Service
BiA	Bangladeshis in Abroad
BoT	Balance of Trade
CBR	Crude Birth Rate
CDR	Crude Death Rate
CF	Current Fallows
CLF	Civilian Labor Force
const.	Constant
CPR	Contraceptive Prevalence Rate
CW	Cultivable Waste
DSSAT	Decision Support System for Agro-technology Transfer
EAP	Economically Active Persons
ECNEC	Executive Committee of National Economic Council
est.	Estimated
FER	Foreign Exchange Reserve
FP	Family Planning
FR	Fertility Rate
GDP	Gross Domestic Product
GNI	Gross National Income
GNP	Gross National Product
GoB	Government of Bangladesh
Govt.	Government
GRR	Gross Reproduction Rate
GWH	Gigawatt Hour
HDRC	Human Development Research Centre
HNPSDP	Health Population and Nutrition Sector Development Program
IC	Installed Capacity
IMR	Infant Mortality Rate

IQL	Index for Quality of Life
kWh	Kilowatt Hour
LEB	Life Expectancy at Birth
LFS	Labor Force Survey
LPL	Lower Poverty Line
MMR	Maternal Mortality Rate
MOHFW	Ministry of Health and Family Welfare
MR	Mortality Rate
MW	Megawatt
MWRA	Married Woman in Reproductive Age
NAC	Net Availability for Consumption
NAfC	Land Not available for cultivation
NCA	Net Cropped Area
NIPORT	National Institute of Population Research and Training
NMR	Neonatal Mortality Rate
NRR	Net Reproduction Rate
PE	Public Expenditure
PEDA	Population-Environment-Development-Agriculture
per.cap	per capita
POP	Population
PPP	Purchasing power parity
Pro	Production
RH	Reproductive Health
Rmt	Remittance
ser.	Services
SME	Small & Medium Enterprise
SSCA	Senate Standing Committee Australia
TCA	Total Cropped Area
TFR	Total Fertility Rate
TP	Total Production
U5M	Under five Mortality
UN	United Nations
UPL	Upper Poverty Line
WI	Welfare Index

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Executive Summary

The concept of optimum population size is one of the most debatable and contentious areas of thoughts having very little consensus among the population-development community. Whatever the nature and essence of the debate is, the relevant researchers hold more or less an agreement that the optimum population size is situation-specific, need-specific, time-specific, and policy-specific. There is a severe dearth of research pursuit in **modeling optimum population size** in the global level, let alone in Bangladesh. Various models pertaining to different types of population projections and associated methodologies are available in the relevant literature. However, to the best of our knowledge, there exists a distinct dearth of model to estimate optimum population considering changing pattern of land and allied resources and outcomes, human capital, sectoral shares in GDP, and other variables and resources. In the context of this epistemological vacuum, Human Development Research Centre (HDRC) has been commissioned by National Institute of Population Research and Training (NIPORT) to determine the optimum population size for Bangladesh considering assumptions on land and available resources.

Attempts have been made to develop two independent models. After a rigorous review of relevant literature and consultations with the pertinent experts, appropriate variables have been identified for specifications of the desired models. The First Model enjoys the freedom of considering the eligible variables while the Second Model is developed considering the objective constraint of the study. In each of the models, optimum population has been estimated for the period between 2011 and 2020, on the basis of different projected scenarios of population for the same 10 years period.

The proposed First Model is a three-stage model, comprising interlinked three models – Demographic model, Production model and Welfare Index. The projected size of the optimum population in this model has been estimated assuming 8 per cent and 10 per cent rise (according to the perspective plan of Bangladesh which targets annual real GDP growth rate to rise to 8% by 2015, and further to 10% by 2021) in per capita GNI. With the assumptions, the projected optimum population sizes of Bangladesh by year, between 2011 and 2020, are as follows:

Table: Estimates of supportable optimum population using desired welfare index indicators

Year	Estimated optimum population (in million) for different welfare indicators					Optimum population (<i>Geometric mean of estimated optimum populations</i>)
	GNI	Government expenditure on health	Government expenditure on education	Food consumption expenditure	Total consumption expenditure	
2011-12	153.1	150.3	150.3	150.6	150.7	150.5
2012-13	153.9	151.0	150.9	151.5	151.8	151.3
2013-14	154.1	151.6	151.5	152.4	152.9	152.1
2014-15	153.8	152.3	152.1	153.4	153.9	152.9
2015-16	152.9	152.9	152.7	154.3	155.0	153.7
2016-17	151.5	153.6	153.3	155.2	156.1	154.5
2017-18	149.5	154.2	153.9	156.2	157.2	155.4
2018-19	147.0	154.9	154.5	157.1	158.3	156.2
2019-20	144.1	155.5	155.1	158.1	159.4	157.0
2020-21	140.6	156.2	155.7	159.1	160.5	157.9

As can be seen in the First Model, the projected population of Bangladesh ranges between 150.3 million in 2011-12 and reaches 160.5 million in 2020-21. The optimum population sizes for 2020-21 in this Model range between a low at 139.2 million which is most unlikely in real-life situation and a high at 160.5 million which is logically more likely, other values of optimum population sizes are in between these two. However, what is most striking here to note is that the optimum population size of Bangladesh in 2020-21 according to the highest value (most likely situation) estimated using the First Model (160.5 million) and that using the Second Model (160.6 million) were very much close (the difference is only 0.1 million). It is worthwhile to mention here that the population projection, conducted twenty years ago from now (in 1994-95) for the Ministry of Health and Family Welfare, came up with a projected population size of 164.3 million for the year 2020 under the Family Planning Quality Projection Scenario (Barkat et al, 1996). This means, for the year 2020, we have three different projected population sizes, 160.5 million and 160.6 million under the present 2014 study and 164.3 million under 1994-95 study. The differences are not much significant.

The approach of the Second Model applied in case of Bangladesh was originally developed by Jeong and Chang (2007) to estimate an optimum population for sustainable development in South Korea. After necessary modifications, a multiple linear regression analysis, which is able to estimate B coefficient for each selected independent variable, is applied to develop the model for estimating optimum population size in the context of Bangladesh. The size of the optimum population of Bangladesh for the period between 2011 and 2020 determined using this Second model is shown in the table below:

Table: Estimated optimum population using second model

Year	Projected population (in millions)	Optimum population (in millions)	Gap between Projected and Optimum population (in millions)	Optimum population as percentage of projected population
2011	151.6	151.0	0.6	99.6
2012	153.6	152.5	1.1	99.3
2013	155.6	153.8	1.8	98.8
2014	157.6	155.1	2.5	98.4
2015	159.7	156.3	3.4	97.9
2016	161.7	157.4	4.3	97.3
2017	163.8	158.4	5.4	96.7
2018	166.0	159.3	6.7	96.0
2019	168.1	160.0	8.1	95.2
2020	170.3	160.6	9.7	94.3

In both of the models, it is to note that the projected population increases over time, e.g., the projected population, in the First Model increases from 151.4 million in 2011 to 167.2 million in 2020, and that in the Second Model from 151.6 million in 2011 to 170.3 million in 2020; the difference in the projected population for 2020 is only 3.1 million if the two model results are compared. However, the situation is different between the two models in terms of estimates of optimum population size – the population sizes show increasing gap over the years with wider gap in case of the Second Model. The gap between projected and optimum population in the Second Model increases steadily over time and the maximum gap of about 10 million people is evident in 2020.

Seeking a number through optimum population modeling may have diverse policy implications. Considering the projected population and optimum population, a renewed thrust over population programme can be suggested from the fascinated anti-natalist policy advocates. But as believer of humane development and peer observer of the country's

demographic evolution, the present research team strongly believes that population is not and/or will not be a problem as often termed this as “overpopulation”, or “population boom”, or “population as liability” – for the country considering our resource base and high potentials to transform population number in to human resources. It is however, most likely that, the growing living standard will impact negatively on the population growth in the long run. In the medium run, distributive justice should be considered to better accommodate the needs of the people. Present or future level of population should not be considered as burden or liability for the country’s development rather a human resource approach to population will accelerate the process of development of the country towards human development with more distributive justice, which will make the vision of equitable society – a reality.

Finally, it is absolutely necessary to note here three broad perspectives pertaining to the growing population as such and the optimum population. First, the countries which will be the most fast growing in the next 2-3 decades are those having relatively higher population size (not the opposite). But that will not be an automatic process, rather be an outcome of conscious efforts towards new way of managing resources, namely human (implying transforming human numbers into human resources or human capital), physical (roads, highways, bridges, power and all other infrastructure), and natural (land, river, sea, gas, coal, and all other mineral resources). Second, containing population to a reduced size or optimum size requires people’s informed choice in terms of reproductive health including family planning (where coercion will be counterproductive). And, third, containing optimum population will require simultaneously addressing issues pertaining to the three broad reasons for incremental population between now and 2020, which are (1) the issue of Population Momentum, (2) the issue of Unwanted or Unintended Fertility, and (3) the issue of High Desired Family Size (or in essence, the issue of son preference). Most scientific way of addressing these issues related to the incremental population should be to vigorously pursue well designed and coordinated programmatic (implying health, family welfare, family planning interventions) and non-programmatic (implying education especially female education, employment – both male and female, women empowerment changes in the legal inheritance laws in favour of women, and overall development) interventions, nationwide. These joint concurrent interventions of programmatic and non-programmatic nature are necessary, because in terms of family planning programme performance Bangladesh has most likely achieved the soft target in the contraceptive prevalence rate (CPR).

CHAPTER 1

BACKGROUND AND OBJECTIVES OF THE STUDY

1.1 Introduction and Rationale

Bangladesh is in the third stage of demographic transition, experiencing the fastest population growth between 1961 and 1991 accumulating population size doubled in just 30 years. While in the following 20 years, population size increased only by 35 per cent and expected to decline further (Nabi 2011 cited in Bangladesh Bureau of Statistics, BBS 1994 and 2011). The projection done by the Bangladesh Bureau of Statistics (BBS) showed that the total population of Bangladesh was 152.5 million in mid-2012 with a density of 1,034 person per sq. km (BBS 2011). Almost two decades before this BBS projection, the population projection done in 1994 for the Ministry of Health and Family Welfare by Barkat. et.al (1996), using three different family planning-related scenario, namely base projection scenario, intender projection scenario and quality projection scenario¹ came up with projected population sizes under each scenario for a relatively longer time period of 30 years between 1994 and 2024. In Barkat et al, 1996, the projected population size shown for the year 2012 was 172.1 million under base projection scenario, 161.3 million under intender projection scenario, and 153.2 million under the quality projection scenario (Barkat et al, 1996, pp. 17, 24, 33). The latest version of World Population Prospects (2012 revision: medium variant) revealed that the population of Bangladesh will add up to 34 per cent more and increase to maximum 203.7 million in 2060 and will begin to decline later (UN Population Division 2013). Here, in order to show the relevance of our own Bangladesh work actually conducted in 1994 and published in 1996 on a 30-year long projection of population, it is worth mentioning that for the year 2024 the projected population for Bangladesh was 216.9 million according to the base projection scenario, 190.2 million according to the intender projection scenario, and 168.6 million according to the quality projection scenario key (Barkat et al., pp. 17, 24, 33). The key reasons for presenting the projected population of Bangladesh using different scenarios pertaining to family planning and associated reproductive health is just to convey the message that family planning matters; and what matters most in family planning is not just the family planning programme *per se* but knowledge based programme facilitating peoples informed choices, which in turn, is a real possibility if programme is designed in a way which will do everything, in addition to sustaining the current level of contraception use, undertake innovative measures to transform the intenders into users, raise continuation rates, impose use effectiveness, and shift toward use of longer-acting methods (for details see, Barkat et al, 1996, pp. 36-46).

Bangladesh Population Policy 2012 aims to attain a healthy, happy and prosperous Bangladesh through planned development and control of population size (MOHFW 2012). Limiting population size into a tolerable level is one of the major bases for updating the existing population policy. Keeping same line of action, the ECNEC undertook a crucial decision to determine an optimum population size for Bangladesh considering limited but highly fertile geographic landscape and growing resources of the country (ECNEC decision on August 23, 2011). However, it's a valid concern how much population can be afforded by our land and resources, which are often considered to be depleted on environmental and

¹ Details about the content of these scenarios are presented in Chapter 2 dealing with Literature Review and in section 5.1 of Chapter 5.

ecological degradation ground. This is the concept close to the concept of populations “*carrying capacity*”².

The total land area of Bangladesh is fixed like other sovereign geographical territory with regular conversion among the land types. This conversion is much more prevalent in the case of agricultural land. Both inter-conversion (agricultural land converted to non-agricultural uses) and intra-conversion (conversion among crop land, water body, forest land etc.) of agricultural land are taking place having logical concerns for food security, resource utilization and maintenance. Against the backdrop of the aforementioned issue, determination of optimum population size can be a desirable policy variable which may facilitate future resource (productive human capital, GDP with share of various sectors and other resources) mobilization and utilization plan.

For the optimization of the population size at a particular point of time, we need to know our primary resource base which can afford minimum living standard (at least above poverty line) for the common people. In this respect, analysis of the changing pattern of total land area (including cultivable land and forest area) will aid us to trace the resource dynamics; which can also be complemented with the analysis of available resources in terms of productive human capital and GDP compositions.

1.2 Objectives

The present study aims to determine optimum population size for Bangladesh considering land and resources. Specifically the study has moved forward with the following objectives:

1. Analyse the changing pattern of total land area, cultivable land and forest area in Bangladesh;
2. Analyse food production and consumption gaps;
3. Analyse available resources in terms of productive human capital, gross domestic product (GDP) with share of various sectors and other resources; and
4. Estimating optimum population size for Bangladesh considering assumptions on land size and available resources.

1.3 Scopes

The study primarily aims to estimate optimum population size for Bangladesh considering assumptions on land size and available resources. Here we are offering two independent models. The proposed first model is a three-stage-model, comprising three interlinked models- Demographic model, Production model, and Welfare Index. The second model adopted here was developed and applied by Jeong and Chang (2007) to estimate an optimum population size for sustainable development in South Korea. After necessary modifications of this second model, a multiple linear regression analysis, which is able to estimate B coefficient for each selected independent variable, is applied to develop the model for estimating optimum population size in the context of Bangladesh. We have analyzed the major resources with a time span of twenty one years, from 2000 to 2020 as background work of the warranted optimum population models.

² There exist at least 26 different definitions of human carrying capacity published since 1975 (Cohen., J.E. 1995, p. 232). Some details about the concept of human carrying capacity as it is related with the determination of optimum population size is presented in Chapter 2.

1.4 Limitations

As already mentioned, the determination of population size considering land and other relevant resources or, in other words, the determination of optimum population size is a difficult-to-accomplish task – both methodologically and in real life situation due to various exogenous and endogenous reasons. The task accomplished in this research study was not free of limitations; and the limitations presented below are serious by nature:

1. The selection of resources is highly constrained by the limited objectives of the study. Considerations have been confined to primary resource base which can afford minimum living standard (at least above poverty line) for the common people.
2. The assumptions made in the process of determining optimum population, may not hold in the following years.
3. The regression coefficients have been considered constant over time. More experiments and analysis are required to determine whether they vary over time.
4. It is most likely that, fine tuning the modeling strategies adopted and explained in this study including inclusion of more variables in the framework of interdependent structure could provide more precise estimates.
5. Some variables, not significantly correlated to population, have been considered for objective restrictions.
6. Any similar kind of model was hardly available to be taken as guide.
7. The operational definitions of various variables are different in different sources, from where data have been collected. This has been an unavoidable constraint.

CHAPTER 2

LITERATURE REVIEW

The discourse of optimum population was inaugurated in the discipline of economics. Reverend Thomas Robert Malthus FRS, an English cleric and scholar, was a key figure in this area (Dasgupta 1969) whose theory was based on *a two-variable dynamic model of the interconnected effects of income and population*. In economics, overpopulation is not merely a numerical demographic fact describing ‘too many people’, rather it is about production arising from the manner in which land and other resources are used (McNicoll 2005). Optimum population is defined in the discipline as the population that achieves *a given aim in the most satisfactory way*. Optimum population will be different according to the aim that one seeks to achieve in considering ‘the most satisfactory way’. However, overpopulation has been argued as a central reason for weakening the potential of sustainable development. Nonetheless, it is not commonplace to undertake theoretical and/or empirical research on optimum population in relation to sustainable development (Jeong and Chang 2007).

Jeong and Chang (2007) attempted to estimate an optimum population in terms of sustainable development of South Korea. The study used population as the dependent variable, and the states of the natural and human-made environment as the independent variables. The impact of each variable on the determination of optimum population size was expected to be different, which was defined as ‘relative importance of each variable’. The relative importance was considered when the optimum population size was estimated. Regression analysis and factor analysis, which derived the relative importance of a variable, required a set of time-series data. The variables, whose correlation coefficients with population are higher than 0.900 at a significant level of 0.001, were identified from forty-five variables of the Korean statistical yearbooks. Nine were selected as the final explanatory variables determining population in the order of a high correlation coefficient, as the number of the explanatory variables in regression analysis should be less than the sample size (The study used a ten-year time series data set which corresponded to a sample size of 10). However, two methods were developed, using multiple regression analysis. The first method concerned the objective states of environmental components. The second was drawn from questionnaire survey data that measured public consensus on the desirable states of the environmental components. A different number for optimum population was estimated by the former according to the scenarios; as the optimum population for sustainable development is not a fixed number, rather it is dependent upon the values of the variables included in the estimation.

An Australian Senate Committee – the Senate Standing Committee Australia or SSCA (1994) – has estimated the optimum population in Australia in terms of *carrying capacity* using the main empirical concept of sustainable development, including technology options, possible patterns of resource use and quality of life. Pimentel et al. (1994) argue that the earth’s long-term sustainability calls for a population of less than half its present level, in particular, with a focus on resources as a sub category of the natural environment. Lutz et al. (2002) have developed the PEDDA (Population-Environment-Development-Agriculture) model on the basis of the interactions between population growth, education, land degradation, agricultural production and food insecurity. On the other hand, McNicoll (2005, pp. 4-5) argues that the built-in environment and subjective welfare of the average inhabitants should be included in estimations of the optimum population.

Singer (1972) explored different approaches to develop a methodology that will allow a calculation of "optimum levels of population". Singer's discussion is confined to the United States, but the methodology is broad enough to handle experiences of other countries, including less-developed countries. The study is primarily based on hard core economics, but it draws major inputs from other areas, such as technology, natural resources management, environmental effects, and demography. The general approach has been to develop an Index for Quality of Life (IQL or Q-index) and to maximize this index as a function of level and distribution of population. The technique consists of a reshuffling of national income accounts so as to be able to go from the Gross National Product (GNP) to the index for quality of life, plus a careful discussion of what is and what is not to be included. The initial part of Singer's study consists of a projection of the index for quality of life as population level increases and as population distribution changes, under the assumption of various technologies, particularly as these relate to the consumption of minerals, energy, and other natural resources. One would expect that as economic growth continues, an increasing fraction of expenditures would be for the diseconomies of scale produced by population growth and economic growth. This study should be useful by providing a rational base for governmental policies regarding population, both in the United States and abroad. Another application of the study is related to technology assessment, by measuring the impact on economic well-being through the introduction of new technologies. Therefore, one can gauge the necessary and desirable investments in certain new technologies. In general, mathematical models resulting from Singer's study can become useful diagnostic tools to analyze the consequences of various public and private policy decisions.

Gretchen et al. (1994), in their paper, raised six critical points to reach a conclusion on the understanding of optimum global population. Those six points are as follows:

Firstly, an optimum population size is not the same as the maximum number of people that could be packed onto Earth at one time, nurtured, as they would have to be, by methods analogous to those used to raise battery chickens. Rather, almost everyone who puts value on human life appreciates the importance of quality of life. Obviously, many more human beings could exist if a sustainable population were maintained for thousands to millions of years than if the present population overshoot were to destroy much of Earth's capacity to support future generations.

Secondly, an optimum population size should be small enough to make it possible to provide the minimal physical ingredients of a decent life to everyone (e.g., Ehrlich *et al*, 1993), given both the inequitable distribution of wealth and resources and uncertainty regarding rates of long-term, sustainable resource extraction and environmental impacts. Nathan Keyfitz (1991) is agreeable: "If we have one point of empirically backed knowledge, it is that bad policies are widespread and persistent. Social science has to take account of them." The grossly inequitable distribution of wealth and basic resources prevailing today is highly destabilizing and disruptive. ... A further downward adjustment in the optimum should be made to ensure against both natural and human-induced declines in the sustainable flow of resources from the environment into the economy and increases in anthropogenic flows of wastes, broadly defined, in the opposite direction.

Thirdly, basic human rights in the social sphere (such as freedom from racism, sexism, religious persecution, and gross economic inequity) should be secure from problems generated by the existence of too many people. Everyone should have access to education, health care, sanitary living conditions, and economic opportunities; but

these fundamental rights are difficult to assure in large populations, especially rapidly growing ones. Political rights are also related to population size, although this is seldom recognized (Parsons 1977). Democracy seems to work best when populations are small relative to resource bases; personal freedom tends to be restricted in situations of high population density and/or scarce resources.

Fourthly, an optimum population size should be large enough to sustain viable populations in geographically dispersed parts of the world to preserve and foster cultural diversity. It is by no means obvious that the dominant and spreading "Western" culture has all the secrets of long-term survival (Ehrlich 1980) – to say nothing of cornering the market on other values. Cultural diversity is an important feature of the species in and of itself. Unfortunately, many cultures borne by small groups of people are in danger of being swamped by the dominant culture with its advanced technologies and seductive media, or worse, of being destroyed deliberately because of social intolerance or conflicts over resources.

Fifthly, an optimum population size would be sufficiently large to support a "critical mass" in each of a variety of densely populated areas where intellectual, artistic, and technological creativity would be stimulated. While creativity can also be sparked in sparsely populated areas, many cultural endeavors require a level of specialization, communication, and financial support that is facilitated by the social infrastructure characteristic of cities.

Sixthly, an optimum population size would also be small enough to ensure the viability of biodiversity. This criterion is motivated by both selfish and ethical considerations. Humanity derives many important direct benefits from other species, including aesthetic and recreational pleasure, many pharmaceuticals, and the basis and health of agriculture. Furthermore, the human enterprise is supported in myriad ways by the free services provided by healthy natural ecosystems, each of which has elements of biodiversity as key working parts (Ehrlich and Ehrlich 1992).

Joel Cohen (1996) in his seminal work titled "How Many People Can the Earth Support?" has dealt with many critical dimensions related to the Optimum World Population and relevant methodological issues. As to the projection methods and limitation of demographers, Cohen wrote "Popular and professional accounts of population matters often fail to make clear to the real uncertainty about the demographic future ... Here is one of the best-kept secrets of demography: most professional demographers no longer believe they can predict precisely the future growth rate, size, composition and spatial distribution of population... This uncertainty derives from the way demographers try to develop knowledge about the future population ... All approaches to population prediction assume that some mechanism (whether deterministic or partially random) that has operated in the past will continue to operate in the future... Attempts to predict total population size have followed three main paths. Mathematical extrapolation assumes that future population sizes are determined by present and past population sizes, and nothing more ... In most instances, the mathematical formula has no visible connection to the observable mechanisms of human population growth. A second approach, called the cohort-component method, assumes that the composition or distribution of the population according to age and sex plus past age-specific and sex-specific rates of birth, death and migration are enough to predict the future size of each subgroup of the population and hence the populations' growth and size... Finally, system models, while typically ignoring the detailed age and sex composition of the population, posit quantitative interactions of population growth and size with non-

demographic factors such as industrialization, agriculture, pollution and natural resources ... the most ambitious efforts so far show that present knowledge is not up to the task” (see details, Cohen, 1996, pp.109-111). In responding to the question of ‘what do we know for sure about the future of global population’, Cohen maintains, “The Law of Prediction asserts: the more confidence someone places in an unconditional prediction of what will happen in human affairs, the less confidence you should place in that prediction ... Nevertheless, a few modest but important certainties emerged from our critical look into the future ... (those can be summarized under four headings): uncertainty, zero population growth, momentum and Methuselah’s choice. The future of human population growth is uncertain; that much is sure! What we do not know for sure exactly how uncertain. There is no reliable way (so far) to construct 90 per cent confidence interval for the population or population growth rate of the United States, Thailand or the World in the year 2025 ... The Earth’s human population must ultimately approach a long-term average growth rate of zero... [As to the momentum aspect] The remaining things we know for sure about the future of population are conditional predictions... Methuselah’s choice: *average length of life is a stationary population = 1/birth rate*... People cannot have both a high birth rate and a long life expectancy, and still have a stationary population” (Cohen 1996, pp.153-157). In terms of highly contentious methodological issues pertaining to the projection of optimum world population, it would be worthwhile to mention the following as stated by Cohen:

- (a) In 1970, world population approached 3.7 billion people. In that year, H.R. Hulett estimated that the *optimal* population of the world must be less than one billion people. No surprising advances in data or theory occurred between 1967 and 1970. The difference of more than 1,000-fold between the numbers obtained by De Wit and Hulett results from radically different approaches and assumptions (see Cohen 1996, p.179).
- (b) In 1992, the United Nations published seven projections of regional and world population to the year 2150. All seven projections used the cohort-component method with five-year intervals of age and time. The seven projections differed only in their assumptions about fertility. Here the fun began. Like the speed shown on your car’s speedometer, the total fertility rate is not a prediction; it is only an indicator. American women are unlikely to have their life time fertility described by the 1990 total fertility rate (TFR) of the United States. The total fertility rate measures the current rate or level of fertility. The two most interesting projections assumed, first, that fertility would remain constant at its present levels and, second, that fertility would drop to the replacement level instantaneously (see Cohen 1996, pp. 136-137).
- (c) The projections of the United Nations, the World Bank and Frejka (all upto year 2150) all assumed business as usual: continuous social and economic development, no large-scale epidemics, famines or wars, no agricultural or environmental crises, no surprising developments in technology or social organization that would greatly reduce the desire for children and no radical changes in government’s population policies. Such projections provided an image of gradual change that is comforting to the public and to politicians, more comforting than the facts can guarantee (see Cohen 1996, pp.146-147).

In ‘Limits to Growth’, Meadows and Meadows constructed a computer model using five variables – population, food, industrialization, non-renewable resources, and pollution – to compute the consequences of various population-related assumptions about the future (Meadows et al, 1972). They have computed various scenarios and presented those as *conditional* predictions. The commonness in all the scenarios was that the first, both population and industrialization showed upward movement and then fell sharply downward. Meadows et al. denoted the pattern as “overshoot and collapse” (known as World3 model financially supported by Club of Rome) and they have concluded these as fundamental properties both of their model and of the world itself. The key points they mentioned are as follows: “The basic behavior mode of the world system is exponential growth of population and capital, followed by collapse ... [T]his behavior mode occurs if we assume no change in the present system or if we assume any number of technological changes in the system... The unspoken assumption behind all of the model runs we have presented ... is that population and capital growth should be allowed to continue until they reach some ‘natural’ limit” (Meadows et al, 1972, p.149).

Most of the population projections and especially the projections about the *optimum* size of population concentrate on certain variables of interest (mostly chosen by those who project or predict) assigning same or different weights to different variables are intended to come up with various scenarios on the size of future population of a country or a region or the world etc. in a time line (by year or appropriate to say, for mid-year population), which carries implicit or explicit notion of *carrying capacity* of the absolute number of people that a space (country or region or continent or sub-continent or world) can support considering various demographic, economic, environmental, social, technological variables – either in static or in dynamic situations. Hence, it would be of most appropriate necessity to delve deeper into the very concept of population’s *carrying capacity*, along with the problems of operationalizing the concept and making projections (estimations) based on the concept. First of all, from logical and scientific points of view it should be made clear that any scientific concept to be truly scientific must have the trait to be measured and calculated. Here, as already noted, Joel Cohen found 26 verbal definitions of human carrying capacity published since 1975 (see, Cohen 1995, p. 232). Second, before presenting some of those concepts of human carrying capacity, it would be plausible to mention here that the definitions vary extremely widely; often contradict one another; lack single generally accepted meaning; vary widely in addressing the issue of the time horizon; lack inadequate power of recognizing unlimited inner potentials of human being; lack consensus about the non-predictability of knowledge and technology; some are static some are dynamic, some are deterministic some are stochastic; some are based on a single limiting factor some are based on several limiting factors and some others reflect a combination of both.³

Now let us see first what are the major definitions of the concepts of human *carrying capacity* and then the problems associated with operationalization and measurement of population size or optimum population size using those concepts as philosophical basis. Some of the major definitions of the concept of human *carrying capacity* are as follows:

³ In order to ensure better clarity on these, the following are in order: In static systems the values of all variables are constant through time, while dynamic estimates allow for changes with time. Deterministic estimates assume fixed values for all parameters, while stochastic estimates include random variations in at least some of the parameters with the result that the probability of an outcome is less than one. Based on these dimensions of the concept of carrying capacity Fearnside concluded that, since the real world is characterized by both changes with time and variability, dynamic stochastic estimates should lead to the most realistic estimates of carrying capacity (for details, see, Fearnside 1986, p.70).

- (a) “The carrying capacity, however, is not given exogenously; it is determined endogenously. This implies that development strategies, encompassing interrelated sets of goals and policy measures, can make it possible to have a continuing expansion of carrying capacity” (United Nations 1980, reprinted in Ghosh 1984, p.74).
- (b) “Because of increases in knowledge, the earth’s ‘carrying capacity’ has been increasing throughout the decades and centuries and millennia to such an extent that the term ‘carrying capacity’ has by now no useful meaning. These trends strongly suggest a progressive improvement and enrichment of the earth’s natural resource base, and of mankind’s lot on earth” (Simon and Kahn 1984, p.45).
- (c) “In sum, the closer a low-income agricultural region or country is to having no trade, only marginal technological improvements available for adoption, no effective institutional base for spreading such improvements as are known and warranted, no vent for surplus [population] in the face of declining marginal returns to incremental arable land, and population growth more rapid than productivity growth, the closer it is to the simple model of a country approaching its carrying ceiling [T]he key is the speed with which the constraints are pushed back” (Muscat 1985, p.20).
- (d) “The *carrying capacity* of a particular region is the maximum population of a given species that can be supported indefinitely, allowing for seasonal and random changes, without any degradation of the natural resource base that would diminish this maximum population in the future” (Kirchner et.al 1985, p.45).
- (e) “The basic definition of sustainable carrying capacity ... is: the maximum number of persons that can be supported in perpetuity on an area, with a given technology and set of consumptive habits, without causing environmental degradation” (Fearnside 1986, p.73).
- (f) “In its simplest form, carrying capacity can be expressed as the size of population which may be sustained by a given territory at a given physical standard of living. The concept is, of course, an extension of the biological definition; but when applied to human societies, it becomes infinitely more complex, infinitely more subtle. Not only do cultural, economic and political factors come into play; human societies have the possibility of expanding their carrying capacity through the deliberate selection and pursuit of development options which allow for the enhancement and sustainable use of physical resources while ensuring that economic growth is not surpassed by population growth and the material demands of individuals” (King 1987, p.7)
- (g) “As applied to human populations, the concept of carrying capacity is obviously a slippery one. Man is a tool making animal, capable of squeezing out of his environment more than undisturbed nature would provide for his needs... in contrast to the case of animal ecology, the capacity of a given environment to support human populations can expand relatively rapidly. On the other hand ... for humans, a physical definition of needs may be irrelevant. Human needs and aspirations are culturally determined...” (Demeny 1988, pp.215-216).
- (h) “Carrying capacity can be defined as ‘the number of people that the planet can support without irreversibly reducing its capacity to support people in the future’. While this is a global-level definition, it applies at [the] national level too, albeit with many qualifications as concerns international relationships of trade, investment, etc. In fact it is a highly complex affair, reflecting food and energy supplies, eco-system services, human capital, people’s lifestyles, cultural constraints, social institutions,

political structures, and above all public policies among many other factors, all of which interact with each other” (Myers 1992, pp.18-19).

- (i) “The carrying capacity is the size of population that can be sustained by the environment indefinitely For human populations the term ‘carrying capacity’ is much more complex because of the many kinds of resources people take from the environment, the many kinds of wastes they return, and the great variability in technology, institutions, and lifestyles. Carrying capacity is a dynamic concept” (Meadows et. al 1992, p.261).
- (j) “Carrying capacity refers to the number of individuals who can be supported in a given land area over the long term without degrading the physical, ecological, cultural and social environment.... Although the advent of technology permits humans to exceed natural carrying capacity limits in some respects, the ultimate use of any human population is still constrained by amounts of arable land, potable water, and other resources” (Miller 1992, p.81).
- (k) “For human beings, the matter [of carrying capacity] is complicated by two factors: substantial individual differences in types and quantities of resources consumed and rapid cultural (including technological) evolution of the types and quantities of resources supplying each unit of consumption. Thus, carrying capacity varies markedly with culture and level of economic development” (Daily and Ehrlich 1992, p.762)
- (l) “The carrying capacity of the earth is not a natural constant – it is a dynamic equilibrium, essentially determined by human action” (Heiling 1994, p.255).
- (m) “Carrying capacity is the largest number of any given species that a habitat can support indefinitely ... The earth’s capacity to support humans is determined not just by our most basic food requirements but also by our levels of consumption of a whole range of resources, by the amount of waste we generate, by the technologies we choose for our varied activities, and by our success at mobilizing to deal with major threats” (Postel 1994, pp.3-4).

The definitions of the concept of human carrying capacity presented above are both controversial and useful in understanding and measuring optimum population size. The related controversies and complexities have already been mentioned. However, to conclude on this issue, it would be useful to raise the question which is already raised by Joel Cohen that, the estimates of how many people the Earth can support vary from less than one billion to more than 1,000 billion (Cohen 1995, p.212). Cohen argued that the low estimates indicate that more people are already on the Earth than can be supported (for some time period, usually not stated, in some mode of life considered plausible or desirable by the estimator). As to the high estimates, Cohen argues that, high estimates indicate that the Earth could sustain substantially more than 10 billion or 15 billion people, even as many as 10 or 100 times more – once again, for some unstated time period in some mode of life considered plausible or desirable by the estimator. In explaining further the scientific essence of the highest number estimates, Cohen, using a figure, plotted the estimates as a function of time, on a logarithmic scale of population size, and finally came up with two striking features. The first striking feature is that, there is no clear increasing or decreasing trend in the estimated upper bounds. And the second striking feature is that the scatter among the estimates seems to be increasing with passage of time, as more and more extreme (both high and low) estimates are proposed, challenged and defended. The argument then boils down to the methods of estimation, where it is most important to note that though the numerical details of each

estimate are unique, the methods fall into a few broad groups: categorical assertion, curve fitting, generalizations from observed population density, constraint by single resource, constraint by multiple resources converted to a single resource, constraint by multiple independent resources, and system models (for details about all abovementioned, see, Cohen, 1995, pp. 213-232).

Although there exist documents – some are official, some others are unofficial – containing population projection of Bangladesh, most are projections based on cohort-component method which incorporates variables related to the composition or distribution of the population according to age and sex plus past age-specific and sex-specific rates of birth, death and migration; and most importantly all those projections, in their mathematical extrapolation and in their models, assume that what has operated in the past will continue to operate in the future. These are just static models, which have no power to see the reality of dynamic changes in the relevant variables used in the model. All these projections are usual and simple projections aiming at estimating the possible sizes of future population under different scenarios (as defined by the projectionists themselves or by the officially guided need-mostly needs of political nature). Hence, most of these projections although contain some indicative elements of optimum population, they are in reality not at all projections aimed at estimating the Optimum Population size of Bangladesh. However, in this plethora of projection exercises one exception is evident in a rigorous projection exercise done 20 years back titled “Strategic Directions of the Bangladesh National Family Planning Programme: 1995-2005” in Bangladesh (projection exercises were done in 1994-95 and published in 1996) under the auspices of the Ministry of Health and Family Welfare (for details see, Barkat et al, 1996). In this population projection exercise, the exceptionality lies not only in the innovative nature of the projection model, but also in the fact that the model used can be denoted, to a large extent, as a model projecting optimum population size of Bangladesh based on two scenarios using a mix of cohort-component method in a dynamic fashion and various variables related to the national family planning programme. The two scenarios worked out in this model have been termed by the authors as (1) Intender scenario and the projection as “Intender Projection”, and (2) Quality scenario and the population projection as “Quality Projection”. Accordingly, in order to realize each scenario, appropriate programme strategies have also been devised, which included set of both programmatic and non-programmatic interventions along with implementation action steps to be pursued by the government, non-government agencies, private sector, and the development partners (for details, see, Barkat et al, 1996, pp. 21-46). One of the major innovations of this projection was to develop the concept of ‘intender’ as opposed to the traditionally used and widely accepted concept of “unmet need” (for family planning or for contraception). The study argued that the concept of “unmet need” for family planning or contraception is flawed since this concept of “unmet need” is researchers’ defined and not defined by the ‘clients’ themselves. To the contrary, the new concept first time appeared in the relevant literature which is discovered by Barkat et al.⁴ (based on the in-depth secondary analysis of the Bangladesh Demographic and Health Survey 1993-94) – the family planning “intender” concept is the concept defined by the clients themselves and has nothing to do with the researchers’ defined flawed but extensively used concept. As opposed to the people who fall under the unmet need or unmet demand categories who may or may not have expressed any intention to use family planning methods or contraceptives (in the survey), the ‘intenders’ are those who have expressed their intention to use family planning methods or contraceptives –

⁴ Barkat., A., Howlader, SR., Khuda, B, and Bose., ML. (1996b). Family Planning Unmet Need in Bangladesh: Basis for a Prototype Family Planning Programme. Prepared for The Futures Group International, Inc., USA, Dhaka: University Research Corporation Bangladesh.

either to space or to stop child birth, either in immediate future or in near future or after a few years – and may or may not fall under the researcher’s defined concept of ‘unmet need’. Pertaining to this, the secondary analysis of BDHS 1993-94 conducted by the authors have revealed that a large number of women (two-thirds) in the ‘unmet need’ and “non-user non-unmet-need” categories have expressed their intention to use some contraceptive method, and most of the unmet-need women – 65 per cent – expressed their future intention to use contraception (for details see, Barkat et al, 1996b). The projected population size, which, to a large extent, may be termed as optimum population size was the size compatible with the programmatically higher order scenario, denoted in the study as “Quality Scenario”. This scenario comprises all elements of intender scenario i.e., do comply with the intender’s intention to use contraception, or, in other words, convert intenders into users plus all elements emphasizing substantial improvement in the quality of family planning services for all users implying gradual improvements in contraceptive continuation rate, effectiveness rate, and gradual shift in contraceptive method mix towards longer-acting methods and all based on informed choice of the people for which vigorous efforts on behavioral communication changes along with development in economic (e.g; employment, social safety net programmes, public health services etc.) and social fronts are necessary. After conducting all these complex and innovative exercises, the projected population size (which may be termed as close-to-optimum size, as can be seen in the Introduction of Chapter 5) under the “Quality Projection” was 153.2 million in 2012 and the same for 2024 was 168.6 million (see, Barkat et al, 1996, p.33).

This is based on the recent declining wanted fertility rate, the UN global population projection shows that Bangladesh population may be stabilized in 2051 with the population of about 195 million under the condition that current wanted fertility rate which is as low as 1.6 TFR far below replacement level will be achieved as early as possible (Neaz 2013).

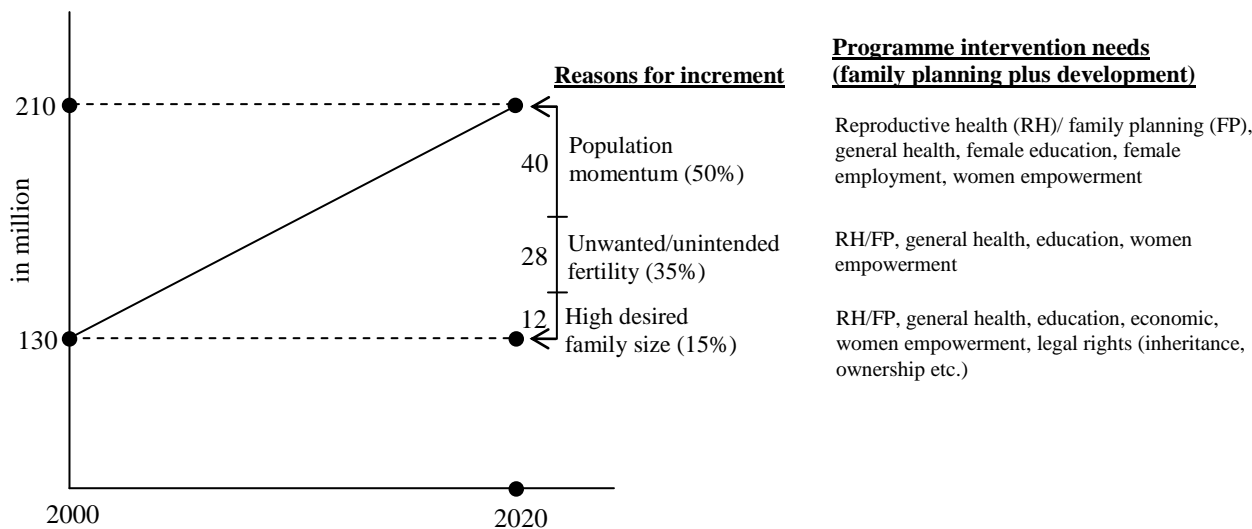
Conducting digital interpretation of satellite image, a study by Hasan et al, 2013 has attempted to quantify land availability in 1976, 2000 and 2010. The amount of total land, comprising of both agricultural and non-agricultural land, increased from 3,57,83,529.7 acre in 1976 to 3,60,07,094.4 acre in 2010. The agricultural land use declined annually by 0.25 per cent with the concomitant annual rise in the non-agricultural land use by 3.03 per cent during the study period. The study has also explored the changing pattern of crop and which included land under cultivated, cultivable waste and current fallow. The total area under crop land was estimated at 2,41,10,781.5 acre in 1976 (67.38% of total land area) and at 2,16,17,284.4 acre in 2010 (60.04% of total land area) with annual decline of 0.304 per cent, posing grave food insecurity implication for a vast number of population in the medium run. A most recent study on increasing commercialization of agricultural land also notes the same findings in the household level observations (Barkat, Suhrawardy and Osman 2015). Nearly one-fifth (19.9%) of the households decreased their crop land and a 12.6 per cent amount of crop land underwent intra-conversion of land to other agricultural subsectors. The declining trend was also observed in the case of forest, from 43,34,645 acre in 1976 to 35,42,316 acre in 2010, with an annual fall of 0.54 per cent.

The gap between demand (consumption) and production of rice due to climate change was analyzed by Basak (2012) through simulation study under five different scenarios, which found a significant demand-production gap of rice during 2050, 2070 and 2100. Decision Support System for Agro-technology Transfer (DSSAT) model predicted that rice yield may be reduced from 4.95 per cent to 24.66 per cent. The study also projected percentage of deprived population from rice under different climate scenarios.

The Labor Force Survey 2010 (LFS 2010) reported that economically active population of the country was 56.7 million in 2010 of which 6.8 million were employed in the formal sector (mostly skilled and semi-skilled) and 47.3 million people got employment in the informal sector (mostly semi-skilled and unskilled).

Before concluding the literature review, it would be pertinent to address the issue of reasons for incremental population in Bangladesh, as well as indicate the type and nature of necessary interventions to ameliorate those reasons. Again, while the broad reasons for incremental population in Bangladesh is more or less known, the relative share of each reason attributable to the increment is debatable (there is no consensus on this). As early as in 2001, Barkat argued, that assuming that the Bangladesh population of 130 million in the year 2000 is projected to reach 210 million in 2020⁵, the broad key reasons attributable to the 80 million increment of population in 20 years' time (between 2000 and 2020) will be threefold, namely, (1) the population momentum effect, (2) the unwanted /unintended fertility, and (3) the high desired family size (see, Barkat 2001, p. unnumbered). According to this estimate, out of the 80 million incremental population – a 50 per cent (i.e; 40 million) will be attributable to the population momentum effect, 35 per cent (i.e; 28 out of 80 million) will be attributable to the unwanted/unintended fertility, and the rest, 15 per cent (i.e; 12 out of 80 million) will be attributable to the high desired family size (see, Figure 2.1).

Figure 2.1: Bangladesh population in 2020 – How much will be the increment, why (reason), what can be done?



Source: Barkat 2001, p. unnumbered

In explaining the essence of each of the broad reasons and programmes to be undertaken to address each reason, and thereby reduce the incremental population, Barkat argued the following:

First, The most important attributable reason – the population momentum effect is the issue with those who are already born. The fact is that, due to the young age structure of the population, the population size of Bangladesh is expected to increase for some time

⁵ Which may not be the case in real life situation is terms of projected population size in 2020, however, the key point here is not the projected absolute size of the population – the point is reasons attributable to the increment, the share of each broad reason in the total increment, and things to do to address the reasons.

even after attainment of replacement level fertility. Thus, even after attaining the replacement level fertility, the number of women entering the reproductive age continuum (15-49 years) will be higher than the number of women leaving that continuum. About half of the total female population comprises those who are not married and who are in the age group of 0-19 years. The size of the female population of this age group is at least 30 million, and they would be entering the marriage cohort during the next 20 years. Assuming that those women who are 48 years old in this year will be out of the reproductive age continuum by end of this year, the number entering the reproductive age continuum in the next year, would be about 1 million and the number leaving the reproductive age continuum in the same year would be 0.3 million. Thus, the total number of married women in reproductive ages (MWRAs) in next year would be about 0.7 million higher than those in this year. The main question, therefore, is what should be done in order to be able to minimize the annual net entry of this additional 0.7 million women into the net of MWRAs? In order to minimize this "momentum effect", as indicated in Figure 2.1, it would be necessary to implement, among other things, the following: strictly enforce the legal age at marriage for females; further raise the female age at marriage; meet the unmet need for reproductive health; ensure high quality RH services as well as expand the demand for those services; vigorously implement the female secondary stipend programme; introduce female stipend for higher education; further strengthen the complementary and supplementary role of the NGOs and the private sector; and involve elected representatives and community leaders in activities directed toward acceleration of the process of population stabilization through ensuring high quality life.

Second. The reduction of unwanted/unintended fertility has various dimensions which include all the components of reproductive health and socio-cultural norms, values, traditions, as well as economic reasons. In the family planning sphere, the demand for fertility regulation and unmet need for contraception and services have several implications. Assuming that there are about 30 million MWRAs (excluding those in fecund and menopausal), the existing demand for fertility regulation amounts to 23 million (17 million users plus 6 million unmet need). This absolute number of unmet need (6 million) population in Bangladesh is almost equal to the total number of married women in the reproductive ages in each of the countries such as Australia, Peru, Kenya, Venezuela, Malaysia. About 90 per cent (i.e., 5.5 million out of 6 million) of those with unmet need live in the rural areas. The unmet need is relatively high among young couples and in the low performing areas. Thus, considering the absolute increasing size, innovative and multi dimensional program efforts are needed (See, Figure 2.1).

Third. Although apparently the relative weight of high desired family size in incremental population is low, in reality this may not be the case. The impact-factor may be much higher than the estimated appearance. This is important to know that the population stabilization cannot be brought about by family planning and health efforts alone. In this regard, investments in human capital, especially those efforts which accelerate the process of women's empowerment as well as the process of mortality decline, especially among infant and child, are quite effective. It should be noted here that the desired family size in Bangladesh is much less than the actual size. This desired family size is one of the lowest in the developing world. This gap between the desired and actual family size indicates that every third birth is an unplanned one. On the other hand, the low desired family size reflects the rising aspiration for small family size by the poor women. The fact is that about 50 million poor women are employed

in textile and readymade garment industries, organized under microcredit, and small income generation activities; mobility has increased, aspiration for better quality of life is showing up, which cannot be achieved through unplanned birth and unintended pregnancies. Also, research findings in Bangladesh clearly show that educated women have different reproductive behavior than those not educated: educated women have better employment opportunities; educated women have lower fertility; educated women have more modern outlook; etc. (see, Barkat 2001, p. unnumbered) Literacy, access to credit and productive resources, and employment are the major interventions through which women's empowerment can be brought about.

Finally, the above analysis of reasons for incremental population and need to address the reasons through various programmatic and non-programmatic interventions, it is pertinent in connection with determination of optimum population size to raise and remind the following: This is true that remarkable successes have been achieved in the population program without significant changes in the economic life of the millions of people. But we are confronted with the question that, can this apparent momentum be sustained? One can argue that the 'easy' population targets have already been reached and that reducing family sizes still further will be much more difficult. This question can be raised very justifiably because of the following reasons: infant, child and under-5 mortality levels are still high and parents can still expect similar number of children to die; to poor parents children bring practical benefits-especially in terms of security (old age support, protection against disaster or destitution); parents may want children because of the income they add to the poor families; parents possess son preference (parents without sons are less likely to practice family planning); confined role of women (purdah); social and cultural obstacles to reproductive health including family planning in some areas.

Bangladesh's demographic future is still fraught with difficulties: in the next 30 years the country will have to cope with an inevitable doubling of population. The cumulative effect of all those factors mentioned above can be summarized as below: the population pressure has already created additional demands on the already scarce land, water, and other non-renewable resources, thereby making it increasingly difficult to support the increasing number of human beings; the declining land-man ratio as well as the limited absorptive capacity of agriculture and lack of agrarian reform (e.g. distribution of khas land to the poor) have pushed a vast number of people from the rural to the urban areas and that without any concomitant industrialization and creation of urban amenities and facilities, most of the migrants end-up in low productivity, informal sector jobs, and live in deplorable conditions in slums and shanty towns. All the above stated analysis alongwith complex dynamics of development warrants proactive thinking about the determination of a population size of Bangladesh considering land and other resources, i.e; the optimum population for Bangladesh.

The review of literature related to the relevant data and information needed for population projection and especially for the projection of optimum population size or the projection of population size of Bangladesh considering land and other resources permits to conclude that there exists a clear dearth of such data and information in Bangladesh. However, it is also true that Bangladesh, as compared to many other countries with similar level of economic development (measured in terms of per capita GDP, per capita GNI or human development index) is better positioned in terms of population related data necessary for population projection using cohort-component approach.

CHAPTER 3

METHODOLOGY AND ANALYTICAL MODEL

3.1 Introduction

Concept of optimum population is situation-specific, need-specific, and policy-specific. It should be taken care in determining optimum population size, so that it is based on some criteria such as its acceptability, unambiguity and calculations ease. We need to address whether we shall be better-off or worse-off as our population increases by specified amount. Considering this setting, the present study aims to develop empirical model for estimating optimum population, based on secondary data analysis.

The study has involved a combination of “Ex-post Facto Research” and “Analytic Research”. Exploratory Research has also been a part of the Research Design. Principally Quantitative approach has been adopted. However, some qualitative approaches like *Experts’ opinions* are also used for the study purpose. Separate discussions and combined brain storming sessions have been arranged with relevant experts.

Reviewing secondary literature in line with the study objectives has been an important task. This has enabled the research team to understand critical appraisals for the study. The study team has reviewed literatures from pertinent journals, reports, working papers, books, web resources etc.

3.2 Resource Base Analysis

This study has analyzed variables relevant to various categories of land availability, land use due to different social, economic, and socioeconomic purposes and available resources in Bangladesh. For such purpose, pertinent data have been collected from secondary sources and analyzed. Time series data over twenty-one years (1990-2010) have been used in this respect.

Available resources in Bangladesh have been filtered, considering their importance, necessity, accessibility, and affordability since the list of available resources is not an exhaustive one. Natural and human resources have been considered separately. Selection of resources has been done through an expert opinion pool where knowledgeable persons have ranked Bangladesh’s resources according to significance, requirement, ease of access, and affordability. Such rank analysis has enabled us to select resources to be considered for this study and collect necessary secondary data.

3.3 Technical Approach of the *First Model*: Model Interlinking Demographic Model, Production Model and Welfare Index

As there is no universal definition of optimum population and it depends on the purpose, we have attempted to obtain some estimates for optimum population using some welfare indices as defined below. At first we present the basic models we need to encounter.

Demographic Model

Demographic model included population projection based on past population growth rate. According to population growth rate of census 2011, population has been projected for 2011-2020 and named as projected population.

Production Model

GNI = f (cultivated land, total national investment, and total employed population)

For estimating such production function, log-linear model (following Cobb-Douglas model) has been used. Now, in order to obtain projected figures, we fed the projected values of the independent variables for predetermined periods. Such period was 20 years to avoid deviations over time.

$$Y = \beta_0 * \beta_1^{x_1} * \beta_2^{x_2} * \dots * \beta_n^{x_n} * u$$

The parsimonious log-linear model was then used to estimate projected GNI for each year (2011-20). This process included projection of each independent variable for each year (2011-20) using estimated growth rate for past 20 years of each independent variable. The projected values of independent variables (2011-20) were then fed to the log-linear model to estimate projected GNI for each year (2011-20).

Welfare Index (WI)

WI = f (Goods and services, Govt. expenditures etc.)

A simplistic approach has been adopted to define welfare index where basic needs for survival of people have been considered. Welfare index included five variables relevant to people’s welfare, namely; GNI, Government expenditure on health, Government expenditure on education, household consumption expenditure on food, and total consumption expenditure of households. The following six steps has been followed in estimating projected population using welfare index:

- Step 1: Growth rate of all selected indicators for welfare index was estimated.
- Step 2: Estimated growth rate was then used to estimate the projected values of all selected indicators for welfare index.
- Step 3: Projected values of all selected indicators for welfare index was divided by projected population to find per capita projected estimates.
- Step 4: Desired estimates of all selected indicators for welfare index was done applying government intended GNI growth rate as per Perspective plan of Bangladesh 2010-2021.
- Step 5: Desired values of all selected indicators for welfare index was divided by projected population to find per capita desired estimates.
- Step 6: Optimum population was estimated dividing projected values of indicators by per capita desired estimates.

$$OP (X_i) = \frac{\text{Estimated projected value of } X_i \text{ using growth rate}}{\text{Estimated per capita desired value of } X_i \text{ using gov.intended growth rate}}$$

3.4 Technical Approach of the Second Model: Model of Optimum Population for Sustainable Development

The following three-step method has been followed in developing the second model for estimating optimum population size.

Step 1: Defining Optimum Population

Optimum population has been defined as the population that achieves a given aim in the most satisfactory way. Optimum population may be different according to the aim that one seeks to achieve in considering ‘*the most satisfactory way*’.

Step 2: Selecting Appropriate Variables

The study has used population as the dependent variable, and the states of the natural and human resources as the independent variables. Optimum population is considered as a function of available resources, in line with the stipulated objectives, and defined as follows:

$$\text{Optimum Population} = f(\text{D\&H Resources, Economic Resources, L\&A Resources})$$

Where, D&H= Demography and Human, L&A= Land and Agriculture

A ten-year time series data set (from 2001 to 2010), including population, has been used. The impact of each variable on the determination of optimum population size will be different, which can be defined as ‘*relative importance*’ of each variable. The *relative importance* has been considered when the optimum population size is estimated. Such *relative importance* has been taken into account in developing a model for estimating optimum population size. Regression analysis and factor analysis have been used to derive the relative importance of a variable.

One hundred and eighteen variables including population were available from the statistical yearbooks of various issues. Few of such variables were dropped in consultation with the experts. The remaining variables were examined to find out their *relative importance*. The variables, whose correlation coefficients with population are higher than 0.85 at a significant level of 0.001, have been identified. Though the land resource variables have not fulfilled the mentioned criteria, we have considered those for the objective constraint.

Step 3: Analytic Technique

A multiple linear regression analysis, which is able to estimate B coefficient as the relative importance of each variable, has been applied for estimating optimum population size.

3.5 Variables: Selection, Categorization, and Data Sources

From the literature survey (Chapter 2) we have come to know that numbers of factors affect change in population over time. Considering the diversity of factors primarily we have selected 118 variables (Annexed). From that comprehensive list we have shortlisted variables (Table 3.1) on the basis of resource implications. However, we have sub grouped those variables into three resource categories like demography and human resources, economic resources, and land and agricultural resources. We have considered 10 years’ observations for our model estimation, consisting of 8 explanatory variables which have been selected from this list according to their statistical significance.

Table 3.1: Categorization of Variables

Categories	Variable name	Variable label
Demography and human resources	CBR	Crude Birth Rate (per 1,000)
	TFR	Total Fertility Rate (per woman)
	CDR	Crude Death Rate
	Adult mortality rate (female)	Mortality rate, adult, female (per 1,000 female adults)
	Adult mortality rate (male)	Mortality rate, adult, male (per 1,000 female adults)
	LEB	Life Expectancy at Birth
	POPEN	Population (in million)
	BiA	Bangladeshis in Abroad (000)
	Expatriates	Number of Expatriates (in thousands)
	EAP	Economically Active Persons (000)
	CLF	Civilian Labor Force (in million)
	Doctors	Number of registered doctors
	Students	Number Enrolment in secondary school
Economic resources	GDP_const	GDP at constant market price (in crore taka)
	GDP_PPT	GDP in PPT dollar (Billions)
	GDP_per.cap	GDP per capita at constant price (in Tk)
	Savings (%GDP)	Total Savings as % of GDP at constant price
	Investment (%GDP)	Total Investment as % of GDP at constant price
	GNP	Gross National Product (in crore taka)
	GNI (at constant price)	Gross National Income (in crore taka)
	GNI_atlas	GNI per capita, Atlas method (World bank)
	ADP	Annual Development Programme Expenditure (In crore Taka)
	Education_GoB_dev_exp	GoB Development Expenditure in Education (Million Taka)
	Health_GoB_dev_exp	GoB Development Expenditure in Health (Million Taka)
	PE	% of Public Expenditure
	FER	Foreign Exchange Reserves (Million US\$)
	Rmt	Remittance (in million US\$)
	Remittance	Remittance (Crore taka)
	Improved_Sanitation_coverage	Percentage of improved sanitation coverage
	Improved_water_coverage	Percentage of improved water source coverage
	Percapita_elec_cons	Per capita electricity consumption (kWh)
	Electricity_maxdemand	Electricity -Maximum demand (MW)
Electricity_TG	Electricity -Total Generation (GWH)	
GAS_cons.	Total consumption of Gas (BCF)	
Land and agricultural resources	Forest	Total forest area (000 acres)
	NAfC	Land Not available for cultivation (000 acres)
	CW	Cultivable Waste Land (000 acres)
	CF	Current fallows land (000 acres)
	NCA	Net Cropped Area (000 acres)
	ASMT0	Area shown more than once (000 acres)
	TCA	Total Cropped Area (000 acres)
	Culti_land	Cultivable land (000 acres)
	Pulsetot_Ar	Pulse (total) Cultivation Area (in '000' acres)
	Ricetot_Ar	Rice (total) Cultivation Area (in '000' acres)
	Pulsetot_Pro	Pulse (total) Production (in '000' tons)
	Ricetot_Pro	Rice (total) Production (in '000' tons)
	NAC_foodgrain	Net Availability of food grains excluding minor cereals for consumption ('000' tons)
	NAC_pulse	Net Availability of pulse for consumption ('000' tons)

Data Sources

For the primary variable list, consisting of over hundred variables, various hard and soft sources have been explored, among which the following are the prime ones:

1. Bangladesh Bureau of Statistics (BBS), Statistics and Informatics Division, Ministry of Planning, Government of People's Republic of Bangladesh, Dhaka, Bangladesh, Statistical Year Book of Bangladesh (various issues)
2. Economic Adviser's Wing, Finance Division, Ministry of Finance, Government of People's Republic of Bangladesh, Dhaka, Bangladesh, Bangladesh Economic Review (various issues)
3. Bangladesh Bureau of Statistics (BBS), Statistics and Informatics Division, Ministry of Planning, Government of People's Republic of Bangladesh, Dhaka, Bangladesh, Household Income and Expenditure Survey (various issues)
4. Bangladesh Bank, Economic data: retrieved from <http://www.bangladesh-bank.org/econdata/index.php> on 2 June 2014
5. World Bank, Country, Bangladesh, Data: retrieved from: <http://data.worldbank.org/country/bangladesh> on 15 June 2014
6. Index Mundi, Factbook, Bangladesh: retrieved from <http://www.indexmundi.com/bangladesh/> on June 2014
7. BANBEIS, Data: retrieved from <http://banbeis.gov.bd/data/index.php> on 20 June 2014

CHAPTER 4

ANALYSIS OF RESOURCE BASE

4.1 Introduction

Resources of a country comprise human resources, natural resources, capital, and technology and entrepreneurship (Samuelson and Nordhaus 2009). Population at present and in future both are dependent on the simultaneous interactions of the mentioned resources. This section explores changing pattern of particular resources, from 1990 to 2010, which pose considerable implications for optimum population.

4.2 Changing Pattern of Total Land Area, Cultivable Land and Forest Area

Total land area of Bangladesh is 56,977 sq miles (147,570 km²). This entire land area can be divided into two broad groups - cultivable and non-cultivable. Cultivable land is the summation of cultivable waste, total cropped area, and current fallows. Cultivable waste is the area suitable for cultivation but lying fallow for more than one year. Current fallow is the area already brought under cultivation, but not cultivated during the year.

Table 4.1: Changing pattern of cultivable land and forest area, 1991-2010

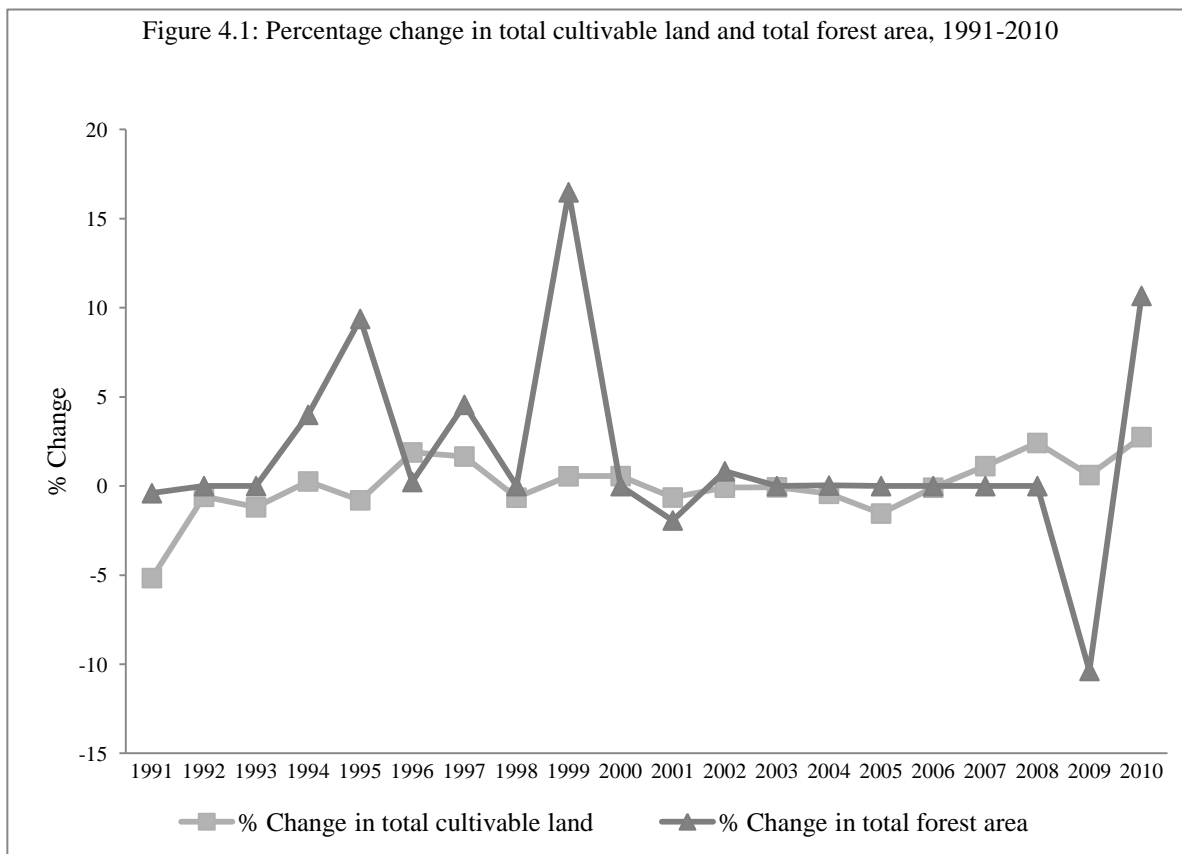
Year	Total cultivable land (000' acres)	% Change (Year by year)	Total forest area (000' acres)	% Change (Year by year)
1990	38,501	-	4,693	-
1991	36,515	-5.16	4,674	-0.40
1992	36,296	-0.60	4,674	0.00
1993	35,865	-1.19	4,674	0.00
1994	35,960	0.26	4,861	4.00
1995	35,674	-0.80	5,317	9.38
1996	36,347	1.89	5,329	0.23
1997	36,949	1.66	5,572	4.56
1998	36,708	-0.65	5,572	0.00
1999	36,910	0.55	6,490	16.48
2000	37,116	0.56	6,490	0.00
2001	36,880	-0.64	6,365	-1.93
2002	36,847	-0.09	6,418	0.83
2003	36,822	-0.07	6,418	0.00
2004	36,665	-0.43	6,420	0.03
2005	36,102	-1.54	6,420	0.00
2006	36,070	-0.09	6,420	0.00
2007	36,474	1.12	6,420	0.00
2008	37,357	2.42	6,420	0.00
2009	37,589	0.62	5,754	-10.37
2010	38,621	2.75	6,368	10.67

Source: Various issues of Statistical Year Book of Bangladesh

Total cultivable land of the country has not remained fixed, though not very unusual, during the time span of twenty one years, from 1990 to 2010 (Table 4.1). The highest cultivable land was available in 2010 (3,86,21,000 acres) and the lowest in 1995 (3,56,74,000 acres). Year to year change shows highest decline in 1991 (5.16%) and highest rise in 2010 (2.75%).

Compared to the cultivable land, there appear more ups and downs in the amount of forest area. In almost half of the years of the study period, forest land was the same, which results in nothing of year-to-year change. However, there were some years with unusual annual hike in the amount of forest area. Total forest area has increased by more than one-thirds (35.69%) from 1990 to 2010.

Following figure depicts slow and steady change of cultivable land and erratic change of forest land during 1990 to 2010.



4.3 Food Production and Consumption Analysis

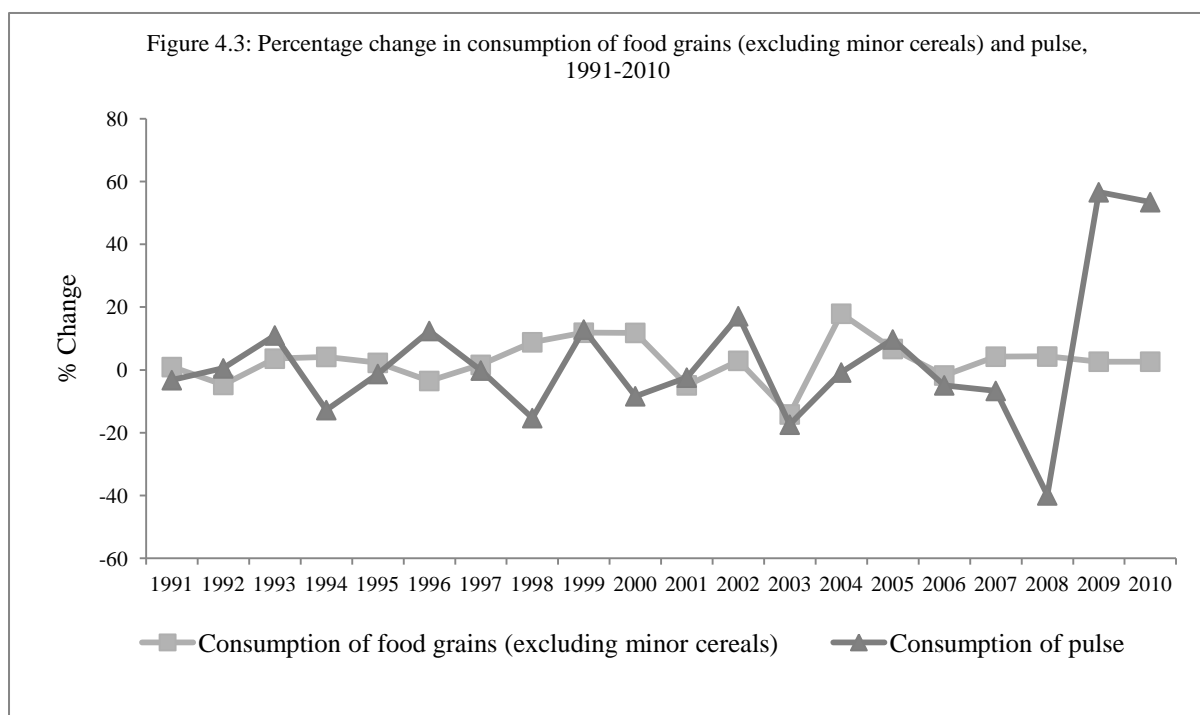
Food grain (excluding minor cereals) production have been almost double from 1991 (1,88,56,000M.tons) to 2010 (3,45,14,000 M.tons). And the opposite trend is observed in case of pulse production, more than 50 per cent production decline in 2010 from 1990 (Table 4.2). 1999 is the year, followed by a heavy flood year, when grain production underwent a maximum of annual increase of 13.76 per cent, might be favored with natural silts and comprehensive public fiscal interventions. In most of the years, from 1991 to 2010, pulse production experienced negative growth with the highest decline in 2007 (20.93%) and in 1998 (19.65%).

Table 4.2: Changing pattern of food grains and pulse production, 1991- 2010

Year	Production of food grains excluding minor cereals (in '000' M.tons)	% Change (Year by year)	Production of pulse (in '000' M.tons)	% Change (Year by year)
1990	18,856	-	523	-
1991	19,337	2.55	519	-0.76
1992	19,518	0.94	517	-0.39
1993	19,172	-1.77	530	2.51
1994	18,083	-5.68	534	0.75
1995	19,056	5.38	523	-2.06
1996	20,337	6.72	525	0.38
1997	20,665	1.61	519	-1.14
1998	21,893	5.94	417	-19.65
1999	24,906	13.76	384	-7.91
2000	26,759	7.44	366	-4.69
2001	25,906	-3.19	344	-6.01
2002	26,694	3.04	349	1.45
2003	27,443	2.81	333	-4.58
2004	26,133	-4.77	316	-5.11
2005	27,274	4.37	279	-11.71
2006	28,055	2.86	258	-7.53
2007	29,775	6.13	204	-20.93
2008	32,166	8.03	196	-3.92
2009	32,876	2.21	218	11.22
2010	34,514	4.98	232	6.42

Source: Various issues of Statistical Year Book of Bangladesh





Food grain consumption has increased from 1,99,81,000 M.tons in 1990 to 3,37,60,000 M.tons in 2010, though there were several years when food grain consumption declined compared to that of the previous year, with the highest fall in 2003 (14.14%). Pulse consumption increased drastically in the last two years (2009 and 2010) of the study period with several falls in the preceding years (Table 4.3).

Table 4.3: Changing pattern of food grains and pulse consumption, 1991- 2010

Year	Consumption of food grains (excluding minor cereals) (in '000' M.tons)	% Change (Year by year)	Consumption of pulse (in '000' M.tons)	% Change (Year by year)
1990	19,981	-	588	-
1991	20,169	0.94	569	-3.23
1992	19,215	-4.73	572	0.53
1993	19,910	3.62	635	11.01
1994	20,742	4.18	554	-12.76
1995	21,215	2.28	547	-1.26
1996	20,476	-3.48	615	12.43
1997	20,814	1.65	614	-0.16
1998	22,653	8.84	520	-15.31
1999	25,347	11.89	587	12.88
2000	28,345	11.83	538	-8.35
2001	26,961	-4.88	525	-2.42
2002	27,753	2.94	615	17.14
2003	23,828	-14.14	508	-17.40
2004	28,100	17.93	504	-0.79
2005	29,983	6.70	553	9.72
2006	29,463	-1.73	526	-4.88
2007	30,715	4.25	491	-6.65
2008	32,035	4.30	295	-39.92
2009	32,886	2.66	462	56.61
2010	33,760	2.66	709	53.46

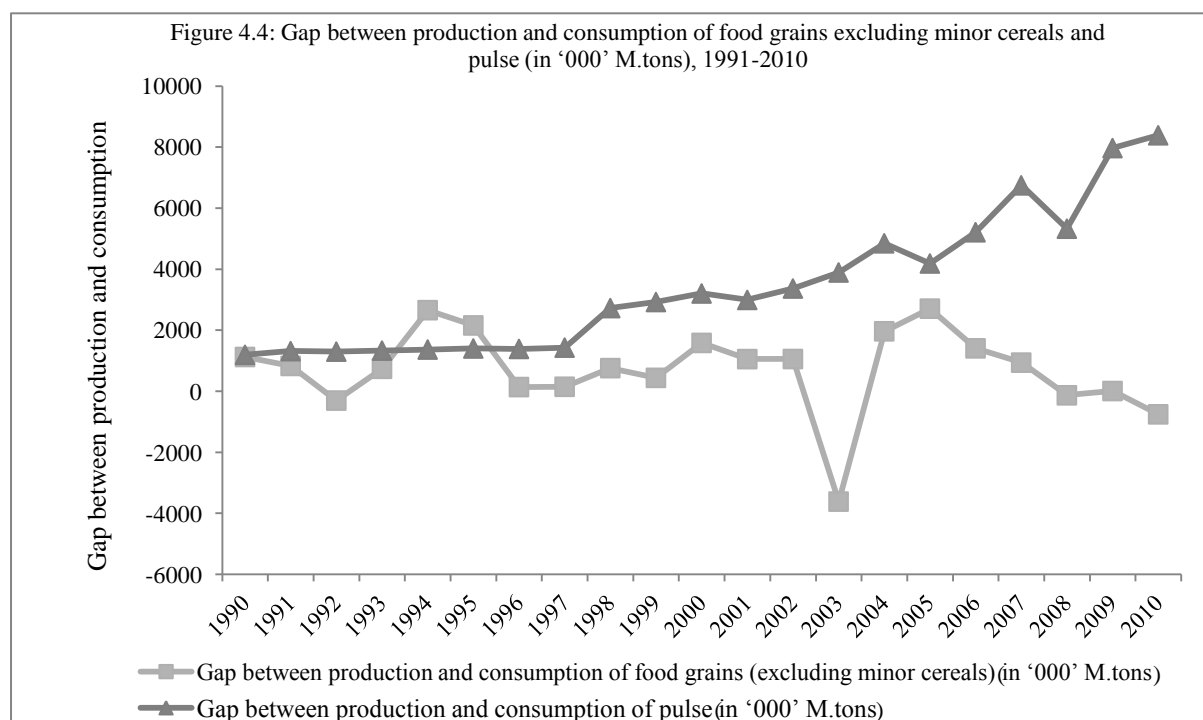
Source: Various issues of Statistical Year Book of Bangladesh

Gap between production and consumption is very much usual in any small open economy like Bangladesh. Only four years (1992, 2003, 2008 and 2010) were available in the study period where production of food grains was higher than consumption, while the remaining 16 years experienced excess consumption over production. Pulse consumption has always been excess over production during the study period.

Table 4.4: Changing pattern of gap between consumption and production of food grains and pulse, 1991-2010

Year	Gap between production and consumption of food grains excluding minor cereals (in '000' M.tons) (consumption- production)	% Change (Year by year)	Gap between production and consumption of pulse (in '000' M.tons) (consumption- production)	% Change (Year by year)
1990	1125	-	1197	-
1991	832	-26.04	1317	10.03
1992	-303	-136.42	1301	-1.21
1993	738	-343.56	1335	2.61
1994	2659	260.30	1369	2.55
1995	2159	-18.80	1404	2.56
1996	139	-93.56	1389	-1.07
1997	149	7.19	1432	3.10
1998	760	410.07	2728	90.50
1999	441	-41.97	2927	7.29
2000	1586	259.64	3207	9.57
2001	1055	-33.48	2996	-6.58
2002	1059	0.38	3369	12.45
2003	-3615	-441.36	3895	15.61
2004	1967	-154.41	4851	24.54
2005	2709	37.72	4190	-13.63
2006	1408	-48.03	5213	24.42
2007	940	-33.24	6751	29.50
2008	-131	-113.94	5330	-21.05
2009	10	-107.81	7972	49.57
2010	-754	-7469.87	8392	5.27

Source: Various issues of Statistical Year Book of Bangladesh



4.4 Analysis of Human Capital, GDP and its Compositions, and other Productive Resources

Except the landed resources and crop production, there are some other resources like human resources, fishing, mining and quarrying, manufacturing, electricity, gas, water supply etc. and other trade and industrial activities, which are directly linked with population dynamics.

GDP is the mostly used, though debated, measurement of assessing country's economic progress. Per capita GDP is the widely used, and criticized, dimension of measuring people's economic ability. Annual average GDP (at constant price) growth rate during the study period was 5.48 per cent, with maximum growth in 2010 (6.71%) and minimum growth in 1993 (4.08%). While annual average GDP (at Purchasing-Power-Parity) growth rate during the study period was 7.69 per cent, with maximum growth in 2006 (9.97%) and minimum growth in 1998 (6.24%).

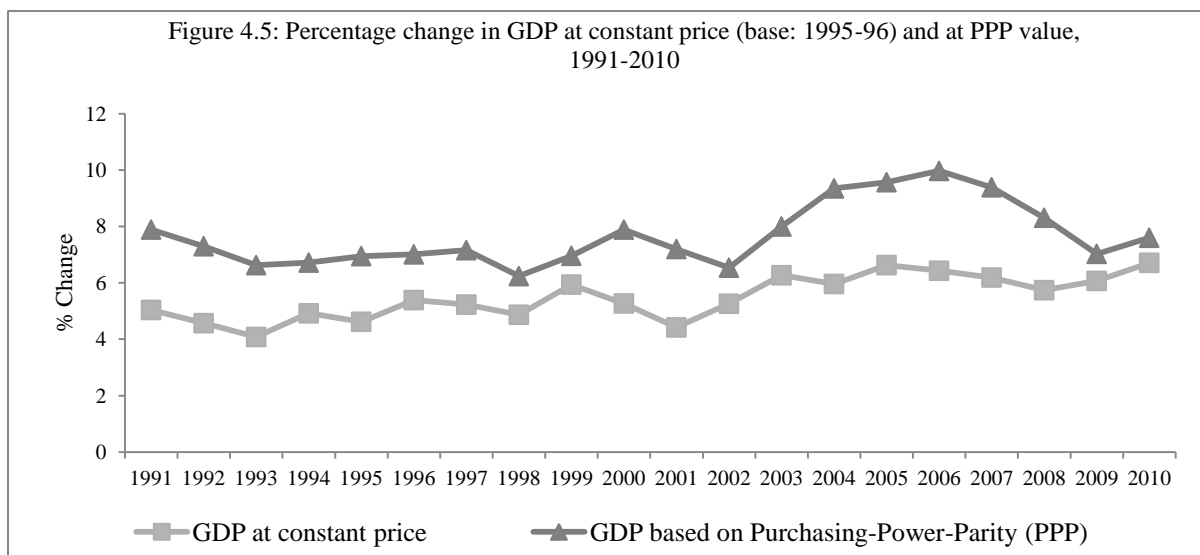
Table 4.5: Changing pattern of GDP and per capita GDP based on constant price and purchasing-power-parity, 1991-2010

Year	GDP at constant price (in crore taka) (Base: 1995-96)*	% Change (Year by year)	GDP per capita at constant price (Base: 1995-96)	% Change (Year by year)	GDP based on Purchasing-Power-Parity (PPP) (valuation in Billion US\$**)	% Change (Year by year)	Per capita GDP based on Purchasing-Power-Parity (PPP) (in US\$)	% Change (Year by year)
1990	132,522	-	12,091	-	59.32	-	541.2	-
1991	139,201	5.04	12,496	3.35	64.00	7.89	574.5	6.15
1992	145,568	4.57	12,859	2.90	68.67	7.30	606.6	5.59
1993	151,514	4.08	12,873	0.11	73.22	6.63	622.1	2.56
1994	158,976	4.92	13,259	3.00	78.14	6.72	651.7	4.76
1995	166,324	4.62	13,622	2.74	83.57	6.95	684.4	5.02
1996	175,285	5.39	14,102	3.52	89.43	7.01	719.5	5.13
1997	184,448	5.23	14,581	3.40	95.83	7.16	757.6	5.30
1998	193,429	4.87	15,088	3.48	101.81	6.24	794.1	4.82
1999	204,927	5.94	15,788	4.64	108.90	6.96	839.0	5.65
2000	215,736	5.27	16,608	5.19	117.49	7.89	904.5	7.81
2001	225,261	4.42	17,117	3.06	125.95	7.20	957.1	5.82
2002	237,101	5.26	17,537	2.45	134.19	6.54	992.6	3.71
2003	251,968	6.27	18,392	4.88	144.93	8.00	1,057.9	6.58
2004	266,974	5.96	19,473	5.88	158.48	9.35	1,155.9	9.26
2005	284,672	6.63	20,510	5.33	173.64	9.57	1,251.0	8.23
2006	302,971	6.43	21,548	5.06	190.95	9.97	1,358.1	8.56
2007	321,726	6.19	22,584	4.81	208.88	9.39	1,466.2	7.96
2008	340,197	5.74	23,592	4.46	226.24	8.31	1,568.9	7.00
2009	360,845	6.07	24,698	4.69	242.14	7.03	1,657.3	5.63
2010	385,050	6.71	25,721	4.14	260.54	7.60	1,740.4	5.01

Source:

*Bangladesh Bank Web site. Downloaded from: <http://www.bangladesh-bank.org/econdata/index.php>

**Downloaded from: http://www.indexmundi.com/bangladesh/gdp_%28purchasing_power_parity%29.html



Per capita registered physician is a health indicator to assess the provision of population to access basic and necessary health services. Annual average growth rate of the registered doctors in the study period was 4.95 per cent, with maximum growth rate in 2006 (11.15%) and minimum growth rate in 1991 (0.0%).

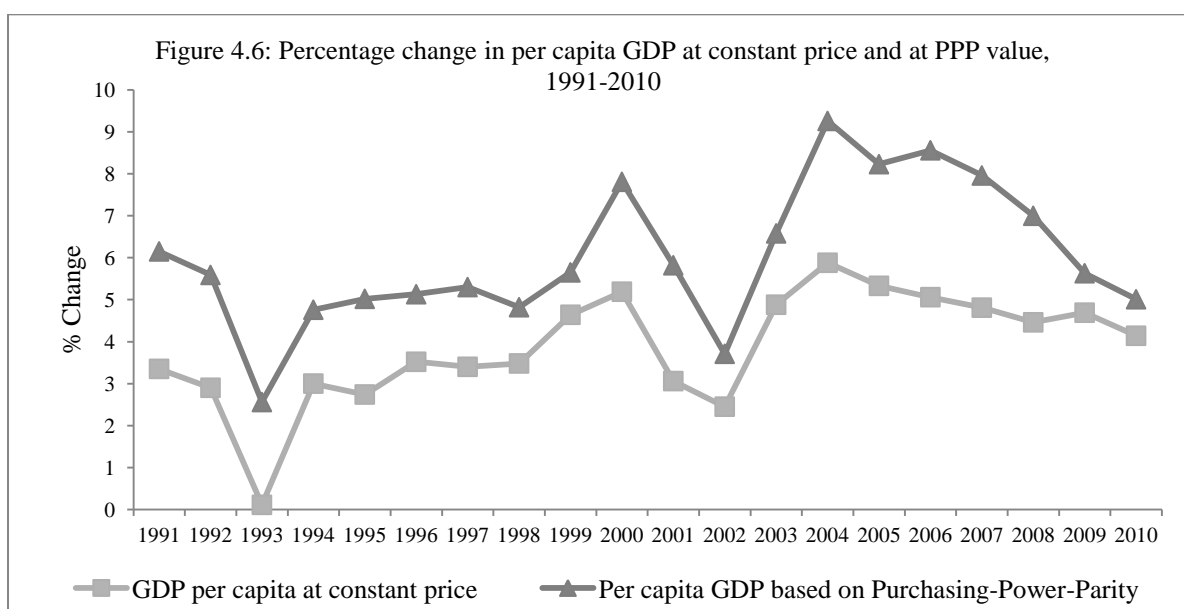


Table 4.6: Changing pattern of number of registered doctors, 1991- 2010

Year	Number of registered doctors*	% Change (Year by year)
1990	20,396	-
1991	20,396	00
1992	21,455	5.19
1993	21,749	1.37
1994	23,805	9.45
1995	24,338	2.24
1996	26,535	9.03
1997	27,546	3.81
1998	28,312	2.78
1999	30,864	9.01
2000	31,952	3.53

Year	Number of registered doctors*	% Change (Year by year)
2001	32,498	1.71
2002	34,502	6.17
2003	36,576	6.01
2004	40,210	9.94
2005	42,010	4.48
2006	44,632	6.24
2007	49,608	11.15
2008	51,993	4.81
2009	52,884	1.71
2010	53,063	0.34

Source:
*Bangladesh Economic review 2012
**Downloaded from: http://banbeis.gov.bd/data/index.php?option=com_content&view=article&id=316&Itemid=171

Attainment of universal primary education let the enrolment of secondary school to be an effective pointer for education entitlement of the population. Annual average growth rate of secondary enrolment in the study period was 4.87 per cent, with maximum growth rate in 1991 (18.75%).

Table 4.7: Changing pattern of enrolment in secondary school, 1991- 2010

Year	Enrolment in secondary school**	% Change (Year by year)
1990	2,993,730	-
1991	3,156,119	5.42
1992	3,748,042	18.75
1993	4,151,490	10.76
1994	4,534,802	9.23
1995	5,115,461	12.80
1996	5,585,806	9.19
1997	6,124,325	9.64
1998	6,769,078	10.53
1999	7,236,939	6.91
2000	7,646,885	5.66
2001	7,887,010	3.14
2002	8,162,134	3.49
2003	8,126,362	-0.44
2004	7,503,247	-7.67
2005	7,398,552	-1.40
2006	7,419,179	0.28
2007	7,119,464	-4.04
2008	6,819,748	-4.21
2009	7,356,793	7.87
2010	7,465,774	1.48

Source:
*Bangladesh Economic review 2012
**Downloaded from: http://banbeis.gov.bd/data/index.php?option=com_content&view=article&id=316&Itemid=171

Most of the expatriate workers are either semi-skilled or skilled, adding the future skilled section of the CLF, with potential transfer of skill and technology. Annual average growth rate of the number of expatriates in the study period was 12.8 per cent, with maximum growth rate in 2006 (93.81%).

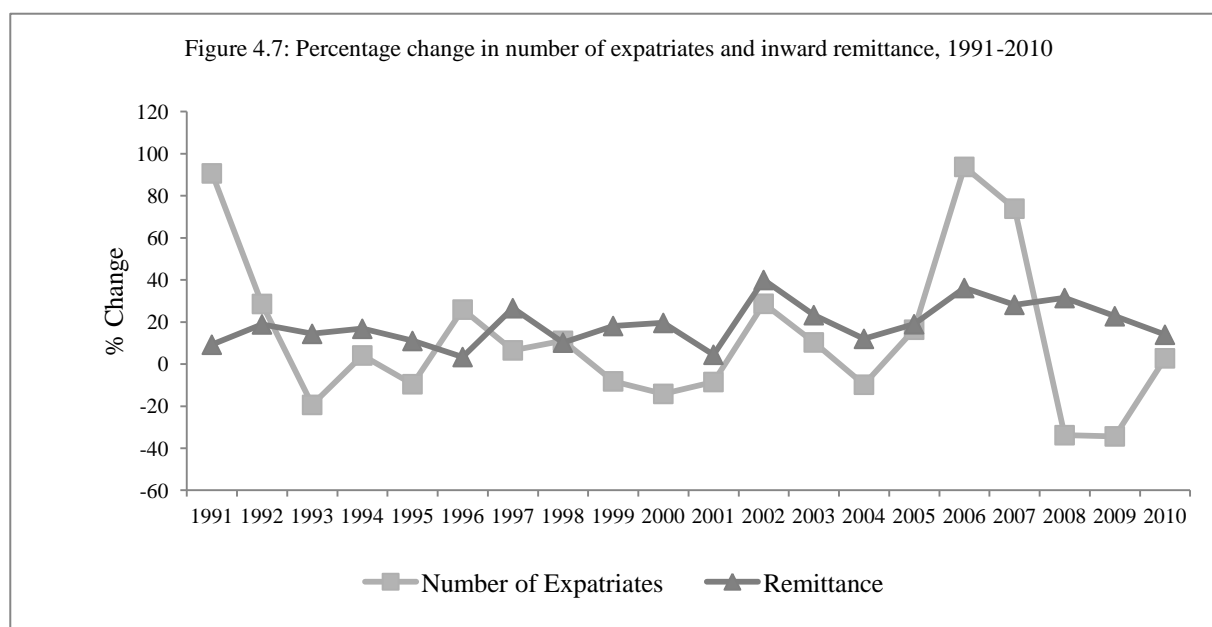
Remittance plays a crucial role in boosting aggregate demand through local saving, investment and consumption beyond its spontaneous role in macroeconomic stability through a comfortable foreign reserve-led favorable balance of payment situation. Annual average

growth rate of remittance in the study period was 19.01 per cent, with maximum growth rate in 2002 (40.04%) and minimum growth rate in 1996 (3.41%).

Table 4.8: Changing pattern of number of expatriates and inward remittance, 1991-2010

Year	Number of Expatriates ('000 ³)	% Change (Year by year)	Remittance (in Crore Tk.)	% Change (Year by year)
1990	97	-	2,495	-
1991	185	90.72	2,726	9.26
1992	238	28.65	3,242	18.93
1993	192	-19.33	3,710	14.44
1994	200	4.17	4,335	16.85
1995	181	-9.50	4,814	11.05
1996	228	25.97	4,978	3.41
1997	243	6.58	6,304	26.64
1998	270	11.11	6,951	10.26
1999	248	-8.15	8,213	18.16
2000	213	-14.11	9,825	19.63
2001	195	-8.45	10,266	4.49
2002	251	28.72	14,377	40.04
2003	277	10.36	17,730	23.32
2004	250	-9.75	19,870	12.07
2005	291	16.40	23,647	19.01
2006	564	93.81	32,211	36.22
2007	981	73.94	41,304	28.23
2008	650	-33.74	54,293	31.45
2009	427	-34.31	66,675	22.81
2010	439	2.81	76,011	14.00

Source: Bangladesh Economic Review 2012



In the face of lower level of private investment, public investment through ADP is one of the important instigators for employment generation and growth augmentation. ADP expenditure declined in four years in the study period with the highest decline in 2001 (12.76%). Highest increase in ADP expenditure, on the basis of year to year change, was available in 1993 (37.15%); while the annual average growth of the ADP expenditure in Bangladesh from 1991 to 2010 was 10.28 per cent.

Table 4.9: Changing pattern of Annual Development Programme (ADP) expenditure, 1991- 2010

Year	Annual Development Programme (ADP) expenditure (in crore Tk.)	% Change (Year by year)
1990	5,269	-
1991	6,024	14.33
1992	6,550	8.73
1993	8,983	37.15
1994	10,303	14.69
1995	10,016	-2.79
1996	11,041	10.23
1997	11,037	-0.04
1998	12,509	13.34
1999	15,471	23.68
2000	16,151	4.40
2001	14,090	-12.76
2002	15,434	9.54
2003	16,817	8.96
2004	18,771	11.62
2005	19,473	3.74
2006	17,916	-8.00
2007	18,455	3.01
2008	19,668	6.57
2009	25,917	31.77
2010	33,007	27.36

Source: Bangladesh Economic Review 2012

Electricity is key to development. Annual average growth rate of total generation of electricity in the study period was 6.93 per cent, with maximum growth rate in 1998 (12.17%). 2006 is the exceptional year of the twenty years which experienced negative growth rate in generation of electricity.

Table 4.10: Changing pattern of total generation of electricity, 1991-2010

Year	Total generation of electricity (in GWH)	% Change (Year by year)
1990	8,270	-
1991	8,894	7.55
1992	9,206	3.51
1993	9,784	6.28
1994	10,806	10.45
1995	11,474	6.18
1996	11,858	3.35
1997	12,882	8.64
1998	14,450	12.17
1999	15,563	7.70
2000	17,021	9.37
2001	18,221	7.05
2002	19,179	5.26
2003	20,820	8.56
2004	22,006	5.70
2005	23,703	7.71
2006	23,268	-1.84
2007	24,946	7.21
2008	26,533	6.36
2009	29,247	10.23
2010	31,355	7.21

Source: Various issues of Statistical Year Book of Bangladesh

Growth distribution can be observed through decomposing the annual growth of different sectors of GDP. Table 4.11 shows sector compositions of Gross Domestic Product of Bangladesh at constant market price and the following table draws the year to year change.

Table 4.11: Gross Domestic Product at constant market price (Base: 1995-96) by Sectors – FY 1990-91 to 2010-11 (in crore Taka)

Year	Agriculture and Forestry	Fishing	Mining and Quarrying	Manufacturing	Electricity, Gas and Water Supply	Constructions	Wholesale and Retail Trade	Hotel and Restaurants	Transport, Storage and Communication	Financial Intermediations	Real Estate, Renting and Business Activities	Public Administration and Defense	Education	Health and Social Works	Community, Social and Personal Services
1990-91	31,755	5,883	1,157	16,613	1,784	7,541	15,891	767	11,813	2,038	12,797	2,698	2,534	2,990	12,487
1991-92	32,197	6,368	1,233	17,839	1,897	7,989	16,767	805	12,245	2,115	13,215	3,045	2,690	3,125	12,825
1992-93	32,632	6,909	1,343	19,377	2,030	8,467	17,283	845	12,617	2,175	13,661	3,494	2,892	3,291	13,174
1993-94	32,420	7,455	1,412	20,955	2,163	9,252	18,243	888	13,124	2,284	14,116	3,691	3,083	3,444	13,535
1994-95	31,793	7,961	1,548	23,152	2,277	10,137	19,695	932	13,774	2,400	14,607	3,856	3,222	3,543	13,907
1995-96	32,438	8,550	1,669	24,635	2,401	10,999	20,608	978	14,483	2,517	15,104	4,017	3,304	3,639	14,294
1996-97	34,246	9,200	1,729	25,880	2,447	11,950	21,737	1,027	15,280	2,646	15,638	4,237	3,462	3,781	14,693
1997-98	34,808	10,026	1,828	28,091	2,497	13,083	23,038	1,094	16,149	2,786	16,233	4,487	3,742	3,954	15,112
1998-99	35,937	11,024	1,852	28,988	2,646	14,250	24,538	1,166	17,102	2,937	16,853	4,743	4,030	4,136	15,558
1999-00	38,425	12,002	2,028	30,368	2,826	15,459	26,328	1,247	18,142	3,098	17,499	5,026	4,342	4,335	16,033
2000-01	40,551	11,458	2,225	32,398	3,035	16,796	28,021	1,335	19,580	3,270	18,096	5,321	4,651	4,548	16,538
2001-02	40,300	11,713	2,326	34,174	3,267	18,243	29,868	1,427	20,863	3,489	18,715	5,636	5,004	4,789	17,073
2002-03	41,627	11,986	2,493	36,480	3,529	19,719	31,687	1,527	22,292	3,722	19,374	5,932	5,384	5,057	17,640
2003-04	43,449	12,356	2,684	39,069	3,849	21,346	33,770	1,635	23,676	3,983	20,068	6,351	5,798	5,371	18,340
2004-05	44,230	12,807	2,909	42,269	4,192	23,120	36,155	1,751	25,552	4,338	20,801	6,860	6,256	5,768	19,082
2005-06	46,545	13,308	3,178	46,820	4,513	25,042	38,596	1,881	27,592	4,707	21,569	7,420	6,822	6,217	19,863
2006-07	48,730	13,850	3,443	51,372	4,607	26,796	41,700	2,023	29,809	5,139	22,380	8,044	7,433	6,693	20,773
2007-08	50,157	14,429	3,751	55,077	4,919	28,318	44,543	2,176	32,357	5,596	23,221	8,543	8,013	7,163	21,731
2008-09	52,215	15,029	4,120	58,754	5,210	29,931	47,309	2,341	34,949	6,099	24,106	9,142	8,658	7,678	22,753
2009-10	55,117	15,652	4,482	62,571	5,589	31,730	50,088	2,519	37,637	6,809	25,045	9,906	9,458	8,300	23,826
2010-11	57,923	16,474	4,698	68,482	5,960	33,795	53,249	2,709	39,778	7,466	26,037	10,864	10,343	8,993	24,947

Source: Bangladesh Bank Web site.

Downloaded from: <http://www.bangladesh-bank.org/econdata/index.php>

Table 4.12: Percentage change in Gross Domestic Product at constant market price (Base: 1995-96) by Sectors – FY 1991-92 to FY 2010-11

Year	Agriculture and Forestry	Fishing	Mining and Quarrying	Manufacturing	Electricity Gas and Water Supply	Constructions	Wholesale and Retail Trade	Hotel and Restaurants	Transport, Storage and Communication	Financial Intermediations	Real Estate, Renting and Business Activities	Public Administration and Defense	Education	Health and Social Works	Community, Social and Personal Services
1991-92	1.39	8.24	6.57	7.38	6.33	5.94	5.51	4.95	3.66	3.78	3.27	12.86	6.16	4.52	2.71
1992-93	1.35	8.50	8.92	8.62	7.01	5.98	3.08	4.97	3.04	2.84	3.37	14.75	7.51	5.31	2.72
1993-94	-0.65	7.90	5.14	8.14	6.55	9.27	5.55	5.09	4.02	5.01	3.33	5.64	6.60	4.65	2.74
1994-95	-1.93	6.79	9.63	10.48	5.27	9.57	7.96	4.95	4.95	5.08	3.48	4.47	4.51	2.87	2.75
1995-96	2.03	7.40	7.82	6.41	5.45	8.50	4.64	4.94	5.15	4.88	3.40	4.18	2.55	2.71	2.78
1996-97	5.57	7.60	3.59	5.05	1.92	8.65	5.48	5.01	5.50	5.13	3.54	5.48	4.78	3.90	2.79
1997-98	1.64	8.98	5.73	8.54	2.04	9.48	5.99	6.52	5.69	5.29	3.80	5.90	8.09	4.58	2.85
1998-99	3.24	9.95	1.31	3.19	5.97	8.92	6.51	6.58	5.90	5.42	3.82	5.71	7.70	4.60	2.95
1999-00	6.92	8.87	9.50	4.76	6.80	8.48	7.29	6.95	6.08	5.48	3.83	5.97	7.74	4.81	3.05
2000-01	5.53	-4.53	9.71	6.68	7.40	8.65	6.43	7.06	7.93	5.55	3.41	5.87	7.12	4.91	3.15
2001-02	-0.62	2.23	4.54	5.48	7.64	8.62	6.59	6.89	6.55	6.70	3.42	5.92	7.59	5.30	3.23
2002-03	3.29	2.33	7.18	6.75	8.02	8.09	6.09	7.01	6.85	6.68	3.52	5.25	7.59	5.60	3.32
2003-04	4.38	3.09	7.66	7.10	9.07	8.25	6.57	7.07	6.21	7.01	3.58	7.06	7.69	6.21	3.97
2004-05	1.80	3.65	8.38	8.19	8.91	8.31	7.06	7.09	7.92	8.91	3.65	8.01	7.90	7.39	4.05
2005-06	5.23	3.91	9.25	10.77	7.66	8.31	6.75	7.42	7.98	8.51	3.69	8.16	9.05	7.78	4.09
2006-07	4.69	4.07	8.34	9.72	2.08	7.00	8.04	7.55	8.03	9.18	3.76	8.41	8.96	7.66	4.58
2007-08	2.93	4.18	8.95	7.21	6.77	5.68	6.82	7.56	8.55	8.89	3.76	6.20	7.80	7.02	4.61
2008-09	4.10	4.16	9.84	6.68	5.92	5.70	6.21	7.58	8.01	8.99	3.81	7.01	8.05	7.19	4.70
2009-10	5.56	4.15	8.79	6.50	7.27	6.01	5.87	7.60	7.69	11.64	3.90	8.36	9.24	8.10	4.72
2010-11	5.09	5.25	4.82	9.45	6.64	6.51	6.31	7.54	5.69	9.65	3.96	9.67	9.36	8.35	4.70

After the decade of stagnation (the autocratic regime of 80's, coined by Sobhan ed. 1991), transition to democracy in the decade of 90's exerted positive impact on the growth pattern and compositions. As we noted in earlier analysis, that the last five years enjoy a higher growth momentum than the early years of the study period, which is expectedly reflected in the growth of subsectoral composition of GDP. Among the 15 broad subsectors, only Agriculture and Forestry, and Fishing sub-sectors experienced negative growth for couple of years. Except these two, the remaining sectors registered continuous growth, with an increasing trend in most of the cases. Even some sub-sectors, i.e. manufacturing sector, public administration and defense and financial intermediation, underwent double digit growth for several years and along with these, some other sub-sectors also recorded near-double digit growth. With a positive structural change, share of agriculture in GDP has declined considerably though its growth continued. But the place left by agriculture was not expectedly occupied by the industrial subsectors in the absence of basic and large industries, though manufacturing subsector registered continuous growth with the twin wheels of apparel and SMEs. Instead of warranted industrial economy, the structural transformation of GDP signed the country to be turned out to service economy which is very much manifested in the robust growth of service subsectors.

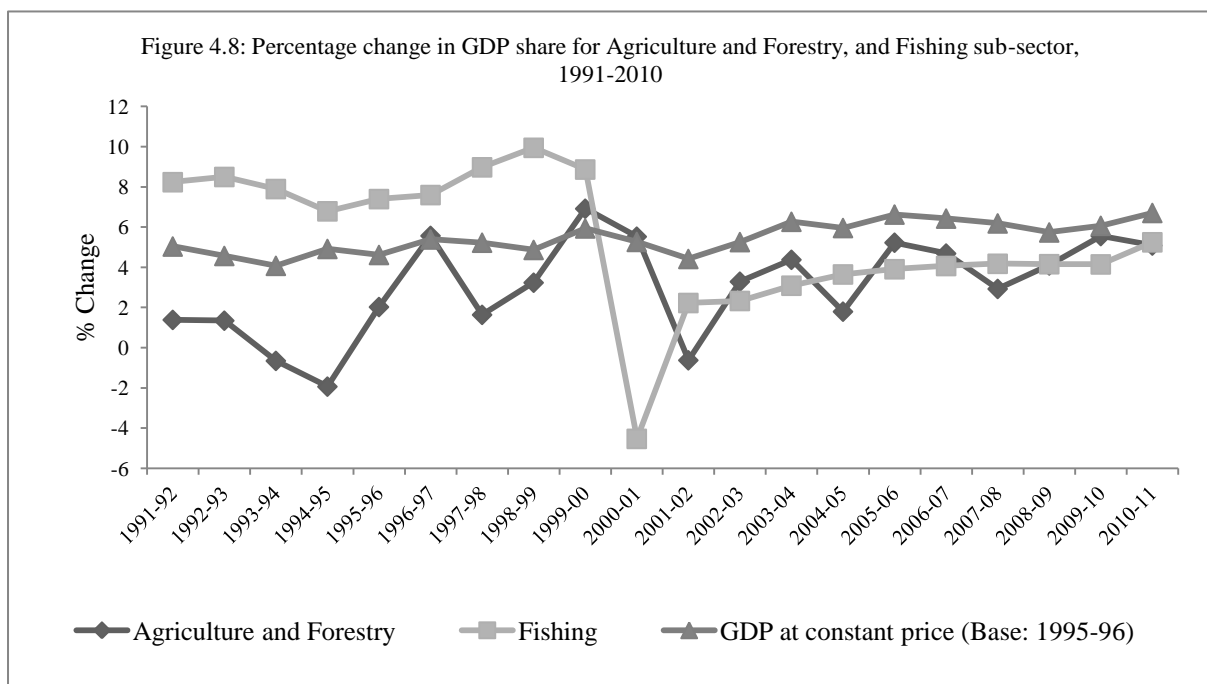


Figure 4.9: Percentage change in GDP share for Education, Health and Social works, Public administration and Defense, and Community, Social and Personal Services, 1991-2010

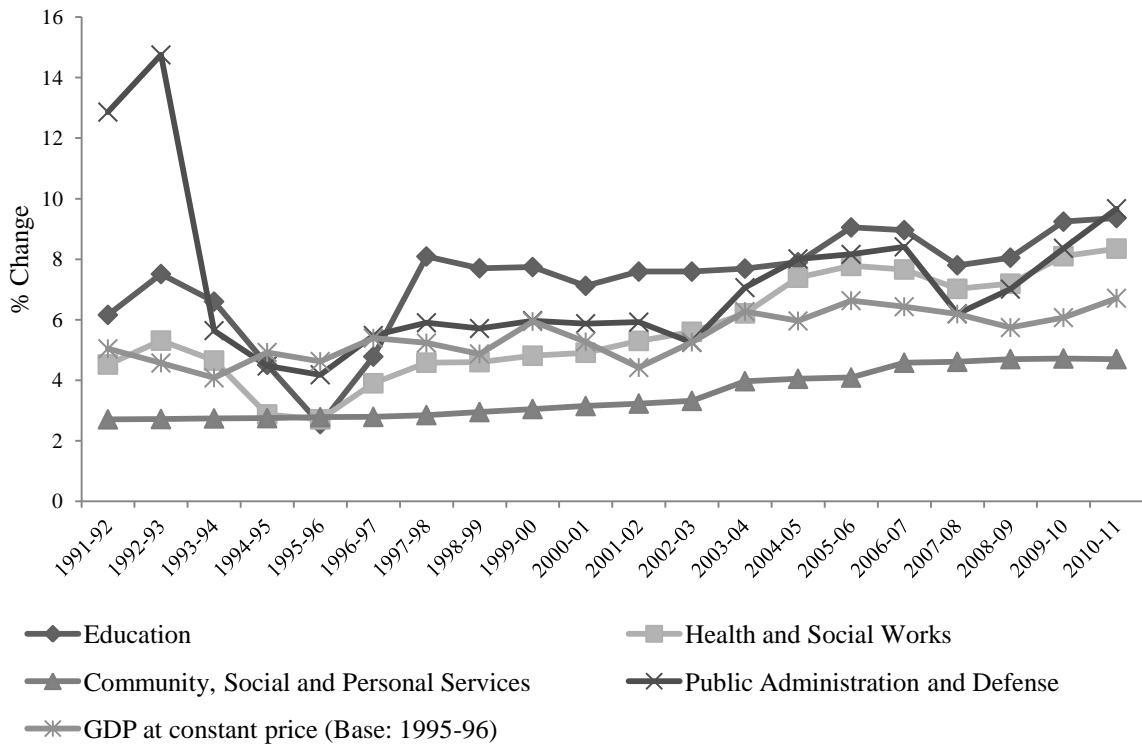


Figure 4.10: Percentage change in GDP share for Electricity, Gas and Water Supply; Transport, Storage and Communication; Mining and Quarrying, 1991-2010

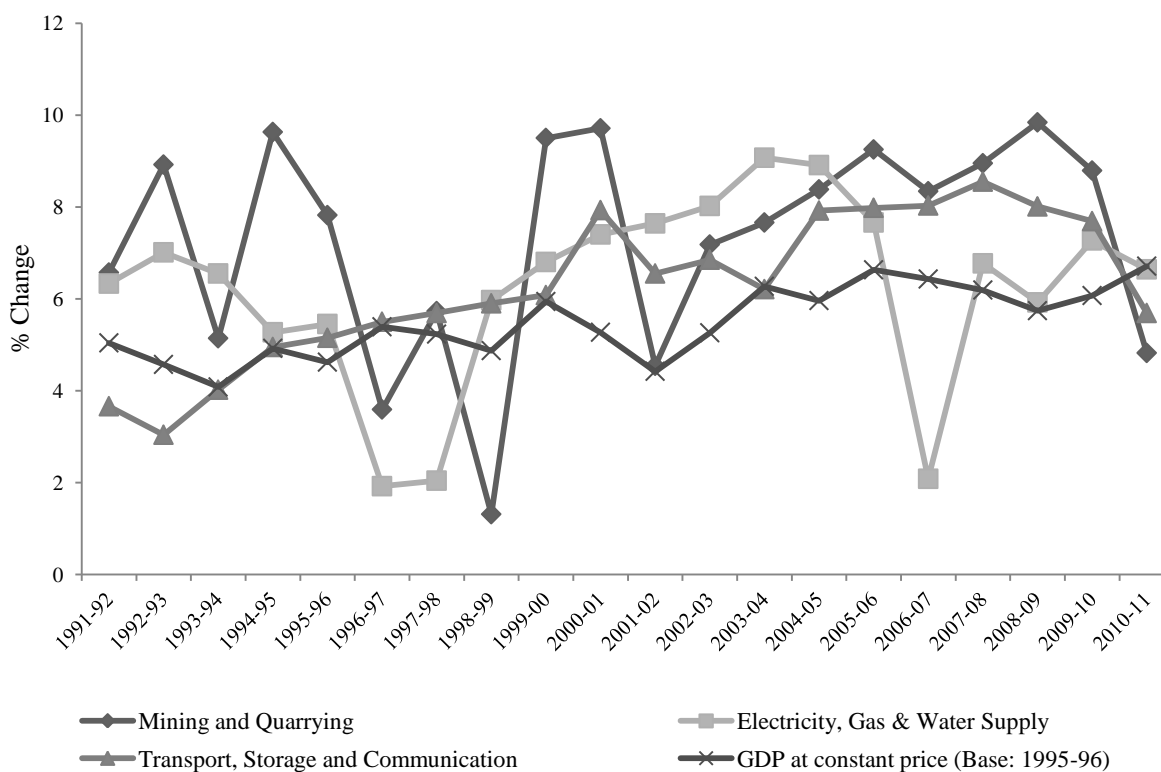
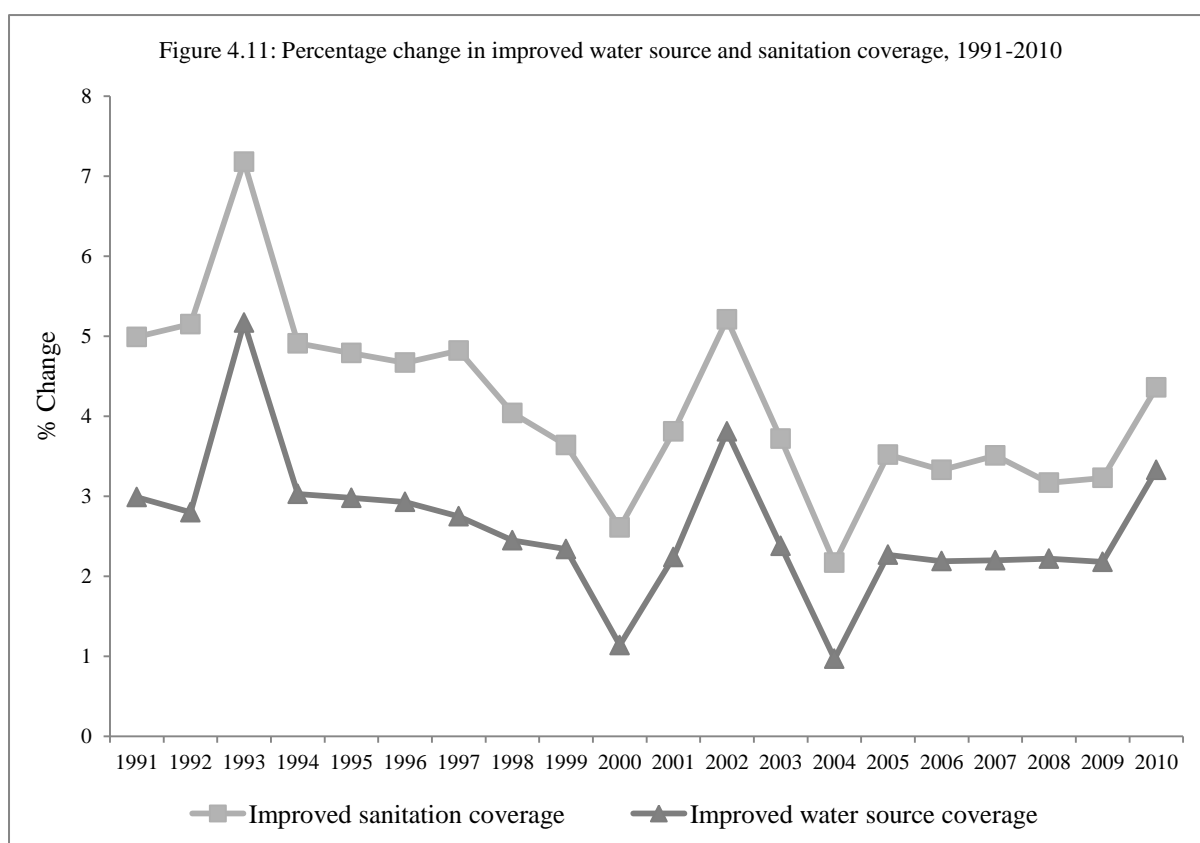


Table 4.13: Percentage change in improved sanitation and water source coverage, 1990-2010

Year	Improved sanitation coverage	% change in improved sanitation coverage	Improved water source coverage	% change in improved water source coverage
1990	33.4	-	68.0	-
1991	34.5	4.99	68.9	2.99
1992	35.7	5.15	69.7	2.80
1993	36.8	7.18	70.5	5.17
1994	37.9	4.91	71.3	3.03
1995	39.0	4.79	72.1	2.98
1996	40.1	4.67	72.9	2.93
1997	41.3	4.82	73.6	2.75
1998	42.4	4.04	74.4	2.45
1999	43.4	3.64	75.2	2.34
2000	44.5	2.61	76.0	1.14
2001	45.6	3.81	76.7	2.24
2002	46.7	5.21	77.5	3.81
2003	47.8	3.72	78.3	2.38
2004	48.8	2.17	79.0	0.97
2005	49.9	3.52	79.8	2.27
2006	50.9	3.33	80.5	2.19
2007	52.0	3.51	81.2	2.20
2008	53.0	3.17	82.0	2.22
2009	54.0	3.23	82.7	2.18
2010	55.0	4.36	83.4	3.33

Source: downloaded from: <http://data.worldbank.org/country/bangladesh> on 10 July 2014



CHAPTER 5

DETERMINING OPTIMUM POPULATION SIZE

5.1 Introduction

This section is the heart of this report containing, among others, the results and outcomes of the population projection exercises done for Bangladesh considering land and other resources. The projection conducted aimed at determining the optimum population size for Bangladesh for each year of the time period extending between 2011 and 2020 (now-on-ward will be termed as population projection 2014 or projection 2014, or as shown in Box 5.1). In this study, attempts have been made to develop two different models and then deploying each model optimum population size determination exercises have been done keeping in view, among others, the dynamics of land and other resources. The First Model is a model combining demographic model, production model and welfare index; and this model enjoys the freedom of considering the eligible variables. The Second Model is a model of optimum population for sustainable development. In addition to the results and implications of these two models, the results of another population projection exercise conducted by a team deployed by the MoHFW (in 1994) with Prof. Abul Barkat as the team leader, twenty years ago from now, has been presented. In order to ease readability of these models, for each model, some synonyms or acronyms have been interchangeably used to denote that model. This is presented in the Box 5.1 below.

Box 5.1: Acronyms and synonyms for each population projection model used in the study
<p>1. <u>First Model</u> = Model to determine optimum population size for Bangladesh (for the period between 2011 and 2020) = Model interlinking population model, production model and welfare index = <u>Model A</u>. Model A considers total and per capita GNI, per capita total household consumption expenditure, per capita household consumption expenditure on food, Government expenditure on Health, and Government expenditure on education. The scenario, unless otherwise mentioned will be termed as <u>Model A</u>.</p>
<p>2. <u>Second Model</u> = Model for determination of optimum population for sustainable development of Bangladesh = <u>Model B</u>.</p>
<p>3. <u>Third Model</u> = This is the population projection exercise conducted in 1994-95 and <u>published in 1996</u> by the MoHFW. The author of this study was the team leader of the 11-member team of <u>high level</u> experts drawn from both home and abroad (for names see Barkat et al, 1996) and the report titled “Strategic Directions for the Bangladesh National Family Planning Program 1995-2005”. The model projected population size of Bangladesh for the time period between 1995 and 2024. This model had three scenarios, namely Base Scenario, Intender Scenario, and Quality Scenario. This model, unless otherwise mentioned, will be termed as <u>Model C</u> or <u>Model MoHFW 1996</u>, or <u>MoHFW 1996</u>, or <u>Barkat et al, 1996</u>. The three scenarios of this model will be termed, in this study as, <u>Model C – Base Scenario</u> or <u>Model C1</u> (to represent base scenario), <u>Model C – Intender Scenario</u> or <u>Model C2</u> (to represent intender scenario), and <u>Model C – Quality Scenario</u> or <u>Model C3</u> (to represent quality scenario or, in other words, projected population under this scenario)</p>

Now, before presenting our 2014 projection in the subsequent two sub-sections it would be of high utility to present the results and outcomes of an in-depth population projection exercise conducted 20 years ago (in 1994-95 for the MOHFW, which MOHFW published in 1996) by an 11-member team of high level expert drawn from both home and abroad (for the names and affiliations of each members of that team, see, Barkat et al, 1996). There exist, manifold reasons for presenting the results of that model (termed in this study as *Model C* or *Model MOHFW 1996* or *Model Barkat et al, 1996*). Among other reasons, the four key reasons for presenting the results and outcomes of that model worth mentioning are as follows: First, the model was the first of its kind in Bangladesh. Although used cohort-component approach in projecting population, the model to a large extent, contains traits of optimum population projection model. Second, the results in terms of absolute size of populations of the 3rd scenario adopted in that model, i.e., the Quality Program Scenario (Model C3) is very close to those determined in the present 2014 exercise (both with Model A and Model B). Third, the model provides not only the results in terms of projected population sizes by three different scenarios (Model C1, Model C2, and Model C3), but also, more importantly provides estimates of both necessary human resources demand exercise and financial costing exercises (i.e; amount of money to be needed in-phases) to materialize or implement each scenario of the model. And, fourth, the 1996 model provided not only the projection of population sizes but also implications there on including forwarded feasible and implementable appropriate suggestions and approaches – both in terms of family planning and family welfare related programmatic and non-programmatic ones. The key results of population projection of 1996 Model of MOHFW (Model C or Model MOHFW 1996 or Model Barkat et al, 1996) are presented in Table 5.1. To facilitate comparability with the present 2014 study, the Table 5.1 presents only the projected population size by scenarios for each year between 2011 and 2020.

Table 5.1: Projected population size of Bangladesh for the period between 2011 and 2020 as per MOHFW 1996 study (Barkat et al, 1996; Model C)

Year	Projected Population (in million)		
	Base scenario (Model C 1)	Intended scenario (Model C 2)	Quality scenario (Model C 3)
2011	168.4	158.7	151.6
2012	172.1	161.3	153.2
2013	175.8	163.8	154.8
2014	175.4	166.3	156.3
2015	183.0	168.8	157.7
2016	186.7	171.2	159.2
2017	190.3	173.7	160.5
2018	194.0	176.1	161.8
2019	197.7	178.5	163.1
2020	201.4	180.8	164.3

Source: Barkat et al, 1996, pp.17,24, 33. Figures have been rounded after decimal point to next number.

5.2 First Model: Model Interlinking Demographic Model, Production Model, and Welfare Index

Demographic Model

Mathematical extrapolation has been done to project population from 2011 to 2020 using population growth rate. According to census 2011, population growth rate of Bangladesh is 1.39 percent.

Table 5.2: Data of population for 1990-2010 and projected population for 2011-2015

Year	Population (available data)	Year	Population (available data)	Year	Projected population*
1991-92	109.6	2001-02	131.60	2011-12	151.78
1992-93	111.4	2002-03	135.20	2012-13	153.89
1993-94	113.2	2003-04	137.00	2013-14	156.03
1994-95	117.7	2004-05	137.10	2014-15	158.20
1995-96	119.9	2005-06	138.80	2015-16	160.40
1996-97	122.1	2006-07	140.60	2016-17	162.63
1997-98	124.3	2007-08	142.46	2017-18	164.89
1998-99	126.5	2008-09	144.20	2018-19	167.18
1999-00	128.2	2009-10	146.10	2019-20	169.50
2000-01	129.8	2010-11	149.70	2020-21	171.86

*Projected values are based on growth rate provided by census 2011

Production Model

For production model, total Gross National Income (GNI) has been considered as function of total national investment (in crore Tk.), total cultivated land (in thousand acres), and total employed population (in millions). A log-linear model has been developed using above mentioned variables with a 20 year (1991-2010) time series data. After doing all validation tasks, we have obtained the parsimonious Model.

Box 5.2: Production Model (parsimonious model)

$$\text{Log}(Y) = 0.901 + 0.485 \log(X_1) + 0.172 \log(X_2) + 0.8 \log(X_3)$$

R = 0.998 R² = 0.997
Durbin-Watson statistic = 0.853

Y = Gross National Income (GNI) (in crore Tk.; Base: 1995-96)
X₁ = Total national investment (in crore Tk.; Base: 1995-96)
X₂ = Total cultivated land (in thousand acres)
X₃ = Total employed population (in millions)

Then the projected values for each of these regressors for the period 2011-2020 was obtained using their corresponding estimated growth rates. Plugging the projected values for the regressors in the parsimonious model we have obtained the projected GNI values for the period 2011- 2020.

Table 5.3: Data of GNI for 1990-2010 and projected for 2011-2020 using log-linear (Cobb-Douglas) production model

GNI (available data: in crore Tk.; at constant price Base: 1995-96)				Projected GNI (estimated using parsimonious production model)			
Year	GNI	Year	GNI	Year	Estimated Log (GNI)	Estimated GNI (anti log); in crore Tk. at constant price Base: 1995-96	Per capita estimated GNI (in taka at constant price Base: 1995-96)
1991-92	142,580	2001-02	235,603	2011-12	5.6544	451,232	29729.2
1992-93	149,530	2002-03	250,182	2012-13	5.6794	477,936	31056.9
1993-94	156,251	2003-04	265,251	2013-14	5.7043	506,220	32443.8
1994-95	163,824	2004-05	280,606	2014-15	5.7293	536,177	33892.7
1995-96	171,278	2005-06	303,303	2015-16	5.7543	567,908	35406.3
1996-97	180,956	2006-07	325,591	2016-17	5.7792	601,516	36987.5
1997-98	190,435	2007-08	350,248	2017-18	5.8042	637,114	38639.3
1998-99	200,079	2008-09	371,130	2018-19	5.8292	674,818	40364.9
1999-00	212,459	2009-10	394,420	2019-20	5.8542	714,753	42167.5
2000-01	223,259	2010-11	420,096	2020-21	5.8791	757,051	44050.6

Welfare Index

For welfare index, variables under consideration were total GNI, per capita government expenditure on health, per capita government expenditure on education, per capita household consumption expenditure, and per capita household consumption expenditure on food.

The projected values of all selected indicators for welfare index were estimated using their respective growth rates. Then per capita projected estimates were obtained.

Table 5.4: Projected estimates of regressors to be used for welfare index (based on annual growth rate)

Year	Projected estimates					Projected population	Per capita projected estimates				
	GNI (in crore Tk.; at const price Base: 1995-96)	Government expenditure on health (in crore Tk.; at const price Base: 1995-96)	Government expenditure on education (in crore Tk.; at const price Base: 1995-96)	Food consumption expenditure (in crore Tk.; at const price Base: 1995-96)	Total consumption expenditure (in crore Tk.; at const price Base: 1995-96)		GNI (in taka; at const price Base: 1995-96)	Government expenditure on health (in taka; at const price Base: 1995-96)	Government expenditure on education (in taka; at const price Base: 1995-96)	Food consumption expenditure (in taka; at const price Base: 1995-96)	Total consumption expenditure (in taka; at const price Base: 1995-96)
2011-12	451,232	31,501	53,144	170,545	311,438	151.78	29729.3	2,075.4	3,501.4	11,236.3	20,519.0
2012-13	477,936	34,633	57,884	179,384	327,874	153.89	31057.0	2,250.5	3,761.4	11,656.6	21,305.7
2013-14	506,220	38,077	63,047	188,680	345,176	156.03	32443.8	2,440.4	4,040.7	12,092.5	22,122.4
2014-15	536,177	41,862	68,671	198,457	363,391	158.20	33892.4	2,646.1	4,340.8	12,544.7	22,970.4
2015-16	567,908	46,025	74,796	208,742	382,568	160.40	35405.7	2,869.4	4,663.1	13,013.8	23,850.9
2016-17	601,516	50,601	81,467	219,559	402,757	162.63	36986.8	3,111.4	5,009.3	13,500.5	24,765.2
2017-18	637,114	55,632	88,734	230,937	424,011	164.89	38638.7	3,373.9	5,381.4	14,005.5	25,714.8
2018-19	674,818	61,164	96,649	242,905	446,387	167.18	40364.8	3,658.6	5,781.1	14,529.5	26,701.0
2019-20	714,753	67,245	105,269	255,493	469,943	169.50	42168.3	3,967.3	6,210.6	15,073.3	27,725.3
2020-21	757,051	73,932	114,659	268,733	494,743	171.86	44050.4	4,301.9	6,671.7	15,636.7	28,787.6

Desired estimates: Desired estimates of all selected indicators for welfare index was obtained in line with government intended GDP growth rate of 8.0 percent up to 2015 and 10.0 percent up to 2020. Then again, per capita desired estimates were obtained.

Table 5.5: Desired estimates of welfare indices using government intended growth rate of 8% up to 2015 and 10% up to 2020

Year	Desired estimates (welfare indices)					Projected population	Desired per capita estimate (welfare indices)				
	GNI (in crore Tk.; at const price Base: 1995-96)	Government expenditure on health (in crore Tk.; at const price Base: 1995-96)	Government expenditure on education (in crore Tk.; at const price Base: 1995-96)	Food consumption expenditure (in crore Tk.; at const price Base: 1995-96)	Total consumption expenditure (in crore Tk.; at const price Base: 1995-96)		GNI (in taka; at const price Base: 1995-96)	Government expenditure on health (in taka; at const price Base: 1995-96)	Government expenditure on education (in taka; at const price Base: 1995-96)	Food consumption expenditure (in taka; at const price Base: 1995-96)	Total consumption expenditure (in taka; at const price Base: 1995-96)
2011-12	447,318	31,804	53,671	171,871	313,577	151.78	29,471.5	2,095.4	3,536.1	11,323.7	20,660.0
2012-13	478,004	35,302	59,038	182,184	332,391	153.89	31,061.4	2,294.0	3,836.4	11,838.6	21,599.3
2013-14	512,612	39,185	64,942	193,115	352,335	156.03	32,853.4	2,511.4	4,162.1	12,376.8	22,581.2
2014-15	551,673	43,496	71,436	204,702	373,475	158.20	34,871.9	2,749.4	4,515.5	12,939.4	23,607.8
2015-16	595,807	48,280	78,580	216,984	395,883	160.40	37,145.1	3,010.0	4,899.0	13,527.7	24,681.0
2016-17	645,854	53,591	86,438	230,003	419,636	162.63	39,713.1	3,295.3	5,315.0	14,142.7	25,803.1
2017-18	702,690	59,486	95,082	243,803	444,815	164.89	42,615.7	3,607.6	5,766.4	14,785.8	26,976.5
2018-19	767,337	66,030	104,590	258,431	471,504	167.18	45,898.9	3,949.6	6,256.1	15,458.2	28,203.4
2019-20	841,001	73,293	115,049	273,937	499,794	169.50	49,616.6	4,324.1	6,787.6	16,161.5	29,486.4
2020-21	925,101	81,355	126,554	290,373	529,781	171.86	53,828.8	4,733.8	7,363.8	16,895.9	30,826.3

Optimum population was obtained for each welfare index indicator using their projected values and per capita desired value. It is to note that, different welfare indices provide different estimates of optimum population size. So, geometric mean of estimated different optimum populations for each year has been considered as the optimum population.

Table 5.6: Estimates of supportable optimum population using desired welfare index indicators

Year	Estimated optimum population (in million) for different welfare indicators					Optimum population (Geometric mean of estimated optimum populations)
	GNI	Government expenditure on health	Government expenditure on education	Food consumption expenditure	Total consumption expenditure	
2011-12	153.1	150.3	150.3	150.6	150.7	150.5
2012-13	153.9	151.0	150.9	151.5	151.8	151.3
2013-14	154.1	151.6	151.5	152.4	152.9	152.1
2014-15	153.8	152.3	152.1	153.4	153.9	152.9
2015-16	152.9	152.9	152.7	154.3	155.0	153.7
2016-17	151.5	153.6	153.3	155.2	156.1	154.5
2017-18	149.5	154.2	153.9	156.2	157.2	155.4
2018-19	147.0	154.9	154.5	157.1	158.3	156.2
2019-20	144.1	155.5	155.1	158.1	159.4	157.0
2020-21	140.6	156.2	155.7	159.1	160.5	157.9

In our conceptual framework we have discussed that optimum population is goal-specific. Such optimum population can be estimated in terms of leisure enjoyed by people. It can also be estimated by improvement in environmental status in a society. Similarly, optimum population can be related to availability of basic needs for survival of the people. While the third one is relatively easy, the first two are very complex from the view points of construction as well as estimation. But, all three ultimately are related to Welfare Index for a society. However, composite index is quite hard to construct. So, we have adopted a simplistic approach to define welfare index and it is in some way related to the third one

mentioned above. We emphasized that more income earnings increases the purchasing power of consumers and thereby, can bring more well-being and can improve the quality of life. We also exploit the ideas behind Engel’s Law namely, with increase in income people spend proportionately more on non-food consumption and less on food consumption and thereby, bring more luxuries in life to improve the standard and quality of life. So, after obtaining the projected values for crucial variables we have used two options for estimating optimum population. Given that population and GNI remain as it is, if per capita GNI is raised by some fraction, then the population size which can enable us to attain that is termed as optimum population. In doing this, we have assumed 8 per cent and 10 per cent rise (according to the Perspective Plan of Bangladesh targets annual real GDP growth rate to rise to 8% by 2015, and further to 10% by 2021) in per capita GNI. Then we have estimated which population allows us to have that increased per capita GNI given that total projected GNI remains fixed. The same tasks were also done for increase in per capita consumption expenditure on food items and total expenditure. We do not rule out the possibility that well-being can be increased with increased population also if total GNI can be expanded accordingly. This needs further research and elaboration. We have treated the population as an actor on resources and it grows independently. So, for a given level of resources, we need to identify which population size will enable us to be well-off.

Fine tuning our strategy incorporating more variables in the framework of interdependent structure can provide still more precise estimates for optimum population. However, we believe that our line of thought is indicative enough to show the pathway towards more perfect determination of optimum population in Bangladesh and elsewhere.

5.3 Second Model: Model of Optimum Population for Sustainable Development

The model has been developed applying a multiple liner regression analysis, which enables to estimate B coefficient for each selected independent variable for estimating optimum population size.

Assumptions:

- Population and available resources in 2010 are assumed benchmark
- Increase of development indicators are not consistent with population

10 years’ annual data have been utilized on 8 explanatory variables along with the dependent variable population.

Table 5.7: Pertinent variables and their data to develop the model

Year	Population	Cultivable land (in thousand acres)	Consumption of grain (in thousand M. tons)	Number of registered doctors	Total generation of electricity (GWH)
2000	129,900,000	37,116	28,345	31,952	17,021
2001	131,600,000	36,880	26,961	32,498	18,221
2002	135,200,000	36,847	27,753	34,502	19,179
2003	137,000,000	36,822	23,828	36,576	20,820
2004	137,100,000	36,665	28,100	40,210	22,006
2005	138,800,000	36,102	29,983	42,010	23,703
2006	140,600,000	36,070	29,463	44,632	23,268
2007	142,460,000	36,474	30,715	49,608	24,946
2008	144,200,000	37,357	32,035	51,993	26,533
2009	146,100,000	37,589	32,886	52,884	29,247
2010	149,700,000	38,621	33,760	53,063	31,355

Year	Total production of pulse (in thousand M. tons)	Annual Development Programme expenditure (In crore Taka)	Number of students enrolled in secondary school	Per capita GDP at constant price (Base: 1995-96) (in Taka)
2000	366	16,151	7,646,885	16,607.85
2001	344	14,090	7,887,010	17,117.10
2002	349	15,434	8,162,134	17,537.06
2003	333	16,817	8,126,362	18,391.82
2004	316	18,771	7,503,247	19,472.94
2005	279	19,473	7,398,552	20,509.51
2006	258	17,916	7,419,179	21,548.44
2007	204	18,455	7,119,464	22,583.60
2008	196	19,668	6,819,748	23,592.02
2009	218	25,917	7,356,793	24,698.49
2010	232	33,007	7,465,774	25,721.44

Table 5.8: Correlation coefficients of variables with population

Variable	Pearson Correlation	Sig. (2-tailed)
GDP at constant price (Base: 1995-96)	.964	.000
Consumption of grain (in thousand M.tons)	.927	.000
Sanitation coverage (population in millions)	.947	.000
Student in secondary schools	.861	.035
Annual Development Programme expenditure (in crore Taka)	.935	.000
Total generation of electricity (GWH)	.974	.000
Cultivable land (in thousand acres)	.269	.238

Estimation methodology

- Step 1: Population projection for 2011-2020 using population growth rate estimated for 2001-2010 period
- Step 2: Regress selected variables on population to obtain regression coefficients and prepare regression model
- Step 3: Prepare projection for 2011-2020 each selected variable using growth rate estimated for 2001-2010 period
- Step 4: Estimate optimum population for 2011-2020 using projected values of independent variables in regression model prepared in step 2.

The Multiple Regression Model

Box 5.3: Multiple Regression Equation

$Y = 45.836 + 0.367X_1 + 0.031X_2 + 0.005X_3 + 0.008X_4 + 0.695X_5 + 1.462X_6 + 0.259X_7$ <p style="text-align: center;">R = 0.995 R² = 0.992</p> <p>Y = Population (in millions) X₁ = Cultivable land (in million acres) X₂ = Annual consumption of grain (in million M.ton) X₃ = Annual Development Programme expenditure (In million Tk.; Base: 1995-96) X₄ = Gross Domestic Product (in million Tk.; constant Price, Base: 1995-96) X₅ = Students in secondary school (in million) X₆ = Sanitation coverage (percent population) X₇ = Annual electricity generation (GWH)</p>
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The above regression equation suggests, the seven variables explain 99.2 per cent ($R^2=0.992\approx 1$) of the determinants of optimum population in Bangladesh. This regression also suggests that increase in regressors will result increase in the number of optimum population. The optimum population would increase only 800 thousand (in any year) if total GDP increases Tk. 100 million (assuming all other variables remain constant) which is 500 thousand for Tk. 100 million increase for total ADP expenditure. The sanitation coverage seems to be highly influential on optimum population as only 1percent increase would result nearly 1.5 million increase in optimum population. Then again, increase in sanitation coverage depends on a lot of other factors those are really tough to manage. The positive impact of increasing sanitation coverage to optimum population suggests increase in improved sanitation coverage over the last decade (2001-2010). The increase in optimum population with per capita annual consumption of grain suggests availability of food grain in Bangladesh.

This estimation applied constant growth rates (estimated for the period between 2001 and 2010) for regressors to calculate optimum population. Such constant growth rate may or may not be achieved in the following years or even higher rate of growth can be achieved. Also projected population has been estimated applying a constant population growth rate; whereas the population growth rate is showing a decreasing trend every following year. Under such circumstances, the projected and optimum population for any year may be different for the same regressor. The estimated regression coefficients for this sustainable development model have been assumed to be constant for calculating optimum population over time (2011-2020).

The hypothesis testing suggests that the residuals appearing from this regression equation are homoscedastic. However, testing for autocorrelation was not found to be fairly conclusive (Durbin-Watson d-statistic lies in zone of indecision). Also, partial and semi-partial correlation coefficients show evidence of multicollinearity in this model, as shown in Table 5.9.

Table 5.9: Results of hypothesis testing for multiple regression model

Test statistic	Estimated value of test statistic	Level of significance
Durbin-Watson	2.766	-
Breusch-Pagan	7.029	0.5335
Koenker	6.407	0.6018

Plugging projected values of independent variables in the above mentioned Multiple Regression Equation, we obtain the following optimum population.

Table 5.10: Projected and optimum population of Bangladesh, 2011-2020

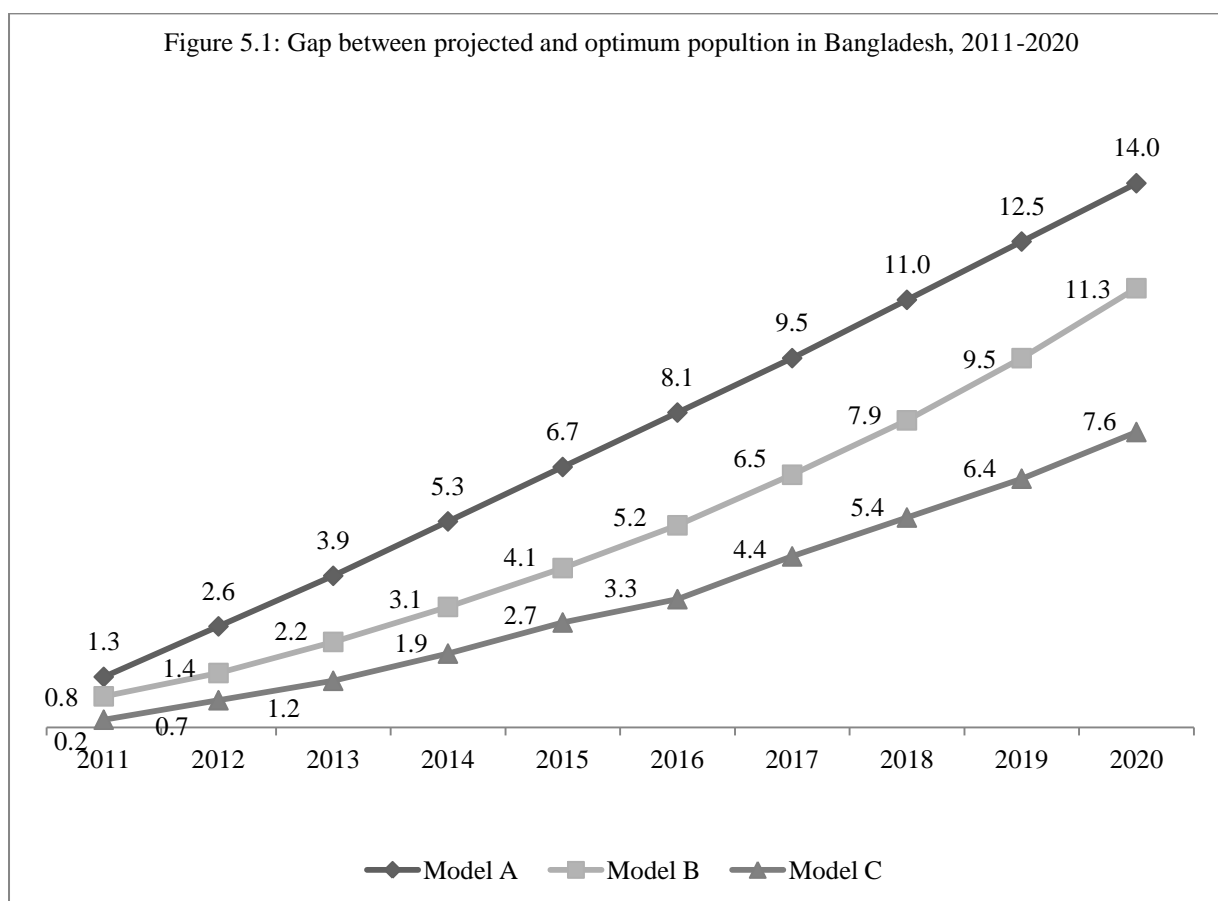
Year	Projected population (in millions)	Optimum population (in millions)	Gap between projected and optimum population (in millions)	Optimum population as percentage of projected population
2011	151.6	151.0	0.6	99.6
2012	153.6	152.5	1.1	99.3
2013	155.6	153.8	1.8	98.8
2014	157.6	155.1	2.5	98.4
2015	159.7	156.3	3.4	97.9
2016	161.7	157.4	4.3	97.3
2017	163.8	158.4	5.4	96.7
2018	166.0	159.3	6.7	96.0
2019	168.1	160.0	8.1	95.2
2020	170.3	160.6	9.7	94.3

Table 5.11: Projected and optimum population of Bangladesh for the period between 2011 and 2020, results of various models

Year	Projected population (in millions)	Optimum population		
		Model A (2015 Model)	Model B (2015 Model)	Model C: (Barkat et.al, 1996 MOHFW Model)*
2011	151.8	150.5	151.0	151.6
2012	153.9	151.3	152.5	153.2
2013	156.0	152.1	153.8	154.8
2014	158.2	152.9	155.1	156.3
2015	160.4	153.7	156.3	157.7
2016	162.6	154.5	157.4	159.3
2017	164.9	155.4	158.4	160.5
2018	167.2	156.2	159.3	161.8
2019	169.5	157.0	160.0	163.1
2020	171.9	157.9	160.6	164.3

*Out of the different scenarios, the most progressive scenario denoted in the document as “Quality projection or Model C3” is presented here (see Barkat et al, 1996, p. 33)

Figure 5.1: Gap between projected and optimum population in Bangladesh, 2011-2020



CHAPTER 6 CONCLUSION

Two independent models have been developed under the present study to determine the optimum population size for Bangladesh considering assumptions on land size and available resources. In each of the models, we have estimated optimum population from 2011 to 2020, on the basis of different projected population for the same 10 years.

In the First Model, the projected population of Bangladesh ranges between 150.3 million in 2011-12 and reaches 160.5 million in 2020-21. The optimum population sizes for 2020-21 in this Model range between a low at 139.2 million which is most unlikely in real-life situation and a high at 160.5 million which is logically more likely, other values of optimum population sizes are in between these two. However, what is most striking noteworthy here is that the optimum population size of Bangladesh in 2020-21 according to the highest value (most likely situation) estimated using the First Model (160.5 million) and that using the Second Model (160.6 million) were very much close (the difference is only 0.1 million). It is also worth mentioning that the population projection, conducted twenty years ago from now (in 1994-95) for the Ministry of Health and Family Welfare, came up with a projected population size of 164.3 million for the year 2020 under the Family Planning Quality Projection Scenario (Barkat et al, 1996). This means, for the year 2020, we have three different projected population sizes, 160.5 million and 160.6 million under the present 2014 study and 164.3 million under 1994-95 study. The differences are not much significant.

Considering the projected population and optimum population, a renewed thrust over population control program can be suggested from the fascinated anti-natalist policy advocates. But as believer of humane development and peer observer of the country's demographic evolution, the present research team strongly believes that population is not and/or will not be a problem for the country considering its resource base. Growing living standard will impact negatively on the population growth in the long run. In the medium run, distributive justice should be considered to better accommodate the needs of the people. Present or future level of population should not be considered as burden or liability for the country's development rather a human resource approach to population will accelerate the development of the country.

It is absolutely necessary to note here three broad perspectives pertaining to the growing population as such and the optimum population. First, the countries which will be the most fast growing in the next 2-3 decades are those having relatively higher population size (not the opposite). But that will not be an automatic process, rather be an outcome of conscious efforts towards new way of managing resources, namely human (implying transforming human numbers into human resources or human capital), physical (roads, highways, bridges, power and all other infrastructure), and natural (land, river, sea, gas, coal, and all other mineral resources). Second, containing population to a reduced size or optimum size requires people's informed choice in terms of reproductive health including family planning (where coercion will be counterproductive). And, third, containing optimum population will require simultaneously addressing issues pertaining to the three broad reasons for incremental population between now and 2020, which are (1) the issue of Population Momentum, (2) the issue of Unwanted or Unintended Fertility, and (3) the issue of High Desired Family Size (or in essence, the issue of son preference). Most scientific way of addressing these issues related to the incremental population should be to vigorously pursue well designed and coordinated programmatic (implying health, family welfare, family planning interventions) and non-

programmatic (implying education especially female education, employment – both male and female, women empowerment, changes in the legal inheritance laws in favour of women, and overall development) interventions, nationwide. These joint concurrent interventions of programmatic and non programmatic nature are necessary, because in terms of family planning programme performance Bangladesh has most likely achieved the soft target in the contraceptive prevalence rate (CPR).

Annex

Primary Variable List

SL	Variable Name	Variable Label
1	CBR	Crude Birth Rate (per 1,000)
2	TFR	Total Fertility Rate (per woman)
3	GRR	Gross Reproduction Rate
4	NRR	Net Reproduction Rate
5	CDR	Crude Death Rate
6	LEB	Life Expectancy at Birth
7	EAP	Economically Active Persons (000)
8	CLF	Civilian Labor Force (in millions)
9	BiA	Bangladeshis in Abroad (000)
10	Rmt	Remittance (in million US\$)
11	Forest	Total forest area (000 acres)
12	NAfC	Land Not available for cultivation (000 acres)
13	CW	Cultivable Waste Land (000 acres)
14	CF	Current fallows land (000 acres)
15	NCA	Net Cropped Area (000 acres)
16	ASMT0	Area shown more than once (000 acres)
17	TCA	Total Cropped Area (000 acres)
18	Aus_Pro	Aus Production (in '000' tons)
19	Aus_Ar	Aus Cultivation Area (in '000' acres)
20	Aman_Pro	Aman Production (in '000' tons)
21	Aman_Ar	Aman Cultivation Area (in '000' acres)
22	Boro_Pro	Boro Production (in '000' tons)
23	Boro_Ar	Boro Cultivation Area (in '000' acres)
24	Wheat_Pro	Wheat Production (in '000' tons)
25	Wheat_Ar	Wheat Cultivation Area (in '000' acres)
26	Sugar_Pro	Sugarcane Production (in '000' tons)
27	Sugar_Ar	Sugarcane Cultivation Area (in '000' acres)
28	RapeMus_Pro	Rape & Mustard Production (in '000' tons)
29	RapeMus_Ar	Rape & Mustard Cultivation Area (in '000' acres)
30	Moong_Pro	Moong Production (in '000' tons)
31	Moong_Ar	Moong Cultivation Area (in '000' acres)
32	Masur_Pro	Masur Production (in '000' tons)
33	Masur_Ar	Masur Cultivation Area (in '000' acres)
34	Tobacco_Pro	Tobacco Production (in '000' tons)
35	Tobacco_Ar	Tobacco Cultivation Area (in '000' acres)
36	Tea_Pro	Tea Production (in '000' tons)
37	Tea_Ar	Tea Cultivation Area (in '000' acres)
38	Jute_Pro	Jute Production (in '000' tons)
39	Jute_Ar	Jurt Cultivation Area (in '000' acres)
40	Cotton_Pro	Cotton Production (in '000' tons)
41	Cotton_Ar	Cotton Cultivation Area (in '000' acres)
42	Spice_Pro	Spice Production (in '000' tons)
43	Spice_Ar	Spice Cultivation Area (in '000' acres)
44	Potato_Pro	Potato Production (in '000' tons)
45	Potato_Ar	Potato Cultivation Area (in '000' acres)
46	S_Potato_Pro	Sweet potato Production (in '000' tons)
47	S_Potato_Ar	Sweet potato Cultivation Area (in '000' acres)
48	Maize_Pro	Maize Production (in '000' tons)
49	Maize_Ar	Maize Cultivation Area (in '000' acres)
50	Pulsetot_Pro	Pulse (total) Production (in '000' tons)

SL	Variable Name	Variable Label
51	Pulsetot_Ar	Pulse (total) Cultivation Area (in '000' acres)
52	Ricetot_Pro	Rice (total) Production (in '000' tons)
53	Ricetot_Ar	Rice (total) Cultivation Area (in '000' acres)
54	GDP_const	GDP at constant market price (in crore taka)
55	GNI	Gross National Income (in crore taka)
56	BoT	Balance of Trade (in crore taka)
57	PE	Proportion of Public Expenditure
58	GDP_current	GDP at current market price (in crore taka)
59	GNP	Gross National Product (in crore taka)
60	Agriculture and forestry	Sectoral Share (%) of GDP at constant price (1995-96 base year)
61	Fishing	Sectoral Share (%) of GDP at constant price (1995-96 base year)
62	Mining and quarrying	Sectoral Share (%) of GDP at constant price (1995-96 base year)
63	Industry	Sectoral Share (%) of GDP at constant price (1995-96 base year)
64	Electricity ,Gas, and water supply	Sectoral Share (%) of GDP at constant price (1995-96 base year)
65	Construction	Sectoral Share (%) of GDP at constant price (1995-96 base year)
66	Whole sale and retail trade	Sectoral Share (%) of GDP at constant price (1995-96 base year)
67	Hotel and restaurant	Sectoral Share (%) of GDP at constant price (1995-96 base year)
68	Transport, storage and communication	Sectoral Share (%) of GDP at constant price (1995-96 base year)
69	Financial intermediation	Sectoral Share (%) of GDP at constant price (1995-96 base year)
70	Real estate, rentind and business ser.	Sectoral Share (%) of GDP at constant price (1995-96 base year)
71	Public Administration and defense	Sectoral Share (%) of GDP at constant price (1995-96 base year)
72	Education	Sectoral Share (%) of GDP at constant price (1995-96 base year)
73	Health and social services	Sectoral Share (%) of GDP at constant price (1995-96 base year)
74	Community social and personal ser.	Sectoral Share (%) of GDP at constant price (1995-96 base year)
75	CPR	Contraceptive Prevalence Rate
76	U5M	Under 5 mortality (per 1000 live birth)
77	MMR	Maternal Mortality Ratio ((per 1000 live births)
78	POP	Population (in millions)
79	NAC_foodgrain	Net Availability of food grains excluding minor cereals for consumption ('000' tons)
80	NAC_pulse	Net Availability of pulse for consumption ('000' tons)
81	NAC_edibleoil	Net Availability of edible oil for consumption ('000' tons)
82	Electricity_IC	Electricity -Total Installed Capacity (MW)
83	Electricity_maxdemand	Electricity -Maximum demand (MW)
84	Electricity_TG	Electricity -Total Generation (GWH)
85	GAS_TP	Total production of Gas (BCF)
86	GAS_cons.	Total consumption of Gas (BCF)
87	UPL	Poverty head count ratio below upper poverty line
88	LPL	Poverty head count ratio below lower poverty line
89	Culti_land	Cultivable land (000 acres)
90	GDP_per.cap	GDP per capita at constant price (in Tk)
91	UPL_est.	Estimated poverty below UPL
92	LPL_est.	Estimated poverty below LPL

SL	Variable Name	Variable Label
93	Poverty Gap (UPL)	Poverty Gap from UPL (%)
94	Squared Poverty Gap (UPL)	Squared Poverty Gap from UPL (%)
95	Poverty Gap (LPL)	Poverty Gap from LPL (%)
96	Squared Poverty Gap (LPL)	Squared Poverty Gap from LPL (%)
97	ADP	Annual Development Programme Expenditure (In crore Taka)
98	FER	Foreign Exchange Reserve (Million US\$)
99	GDP_PPP	GDP in PPP dollar (Billions)
100	Expatriates	Number of Expatriates (in thousands)
101	Remittance	Remittance (crore taka)
102	Doctors	Number of registered doctors
103	Students	Student enrolled in secondary school
106	Savings (%GDP)	Total Savings as % of GDP at constant price
107	Investment (%GDP)	Total Investment as % of GDP at constant price
108	Adult mortality rate (female)	Mortality rate, adult, female (per 1,000 female adults)
109	Adult mortality rate (male)	Mortality rate, adult, male (per 1,000 female adults)
110	IMR	Mortality rate, infant (per 1,000 live births)
111	NNMR	Mortality rate, neonatal (per 1,000 live births)
112	U5M_WB	Mortality rate, under-5 (per 1,000 live births)
113	Education_GoB_dev_exp	GoB Development Expenditure in Education (Million Taka)
114	Health_GoB_dev_exp	GoB Development Expenditure in Health (Million Taka)
115	Improved_Sanitation_coverage	Percentage of improved sanitation coverage
116	Improved_water_coverage	Percentage of improved water source coverage
117	Percapita_elec_cons	Per capita electricity consumption (kWh)
118	GDP_atlas	GNI per capita, Atlas method

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