Demographic transformation in South Asia: implications for rice research and development

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Abstract

The demographic structure of South Asian countries are rapidly transforming, which can greatly influence future rice production and consumption in the region. Literature on the impact of demographic transformation on the nature and organization of rice farming are scanty. This paper examines the depth and breadth of demographic transformation and its ramifications on rice farming in South Asia. We use primary long-run panel household data of Bangladesh and secondary time-series data from five major rice growing countries of South Asia. The data were analyzed using simple descriptive statistical methods. Results show that South Asia is observing declining trends in fertility rate, mortality rate, population growth, share of rural and agricultural population, and entry of youth in farming. But, other demographic factors such as rural outmigration of labors, ageing of farming population, and urbanization are on rising trends. These emerging trends are projected to be more rapid in coming decades, with far-reaching impacts on future rice farming mediated through labor markets and rice demand and supply. Declining and ageing agricultural population will lead to labor scarcity, abandoning of farming land, low rate of adoption of improved technologies, higher production cost, and slow growth of rice production. When rice supply growth trail behind the rice demand growth,

it will push rice prices up and will hurt the poor disproportionately more. Policymakers and scientists must anticipate future demographic changes and implement necessary technological and policy interventions to manage or cope with it. The policy and program interventions should focus on farm mechanization, training of youths on improved farming practices, financial and other supports to youth to attract them in farming, and efficient rural-urban marketing system to supply enough rice to urban consumers. Rice research program should aim to develop innovative technologies that are intellectually stimulating and economically rewarding and also develop rice varieties that meet the demands of future rice consumers.

Key words: *demography, transformation, farm population, rice production, and South Asia.*

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1. Introduction

Demography is an important driver of agricultural and economic transformation. The impact of demographic transformation led "demographic dividend" on East Asian economic growth is well documented (Bloom 1998, Mason and Kinugasa 2008). The East Asian baby boom, which started in Japan in the late 1940s, sparked a series of demographic and social changes that helped shape the region's economic growth trajectory (Bloom 2008). It is increasingly recognized that demographic structure of South Asia—population growth, age structure, working to non-working age population ratio, population ageing, migration, and urbanization—is rapidly transforming. Demographic transformation is an important megatrend that will influence future production and consumption of rice in many ways in South Asia. Higher population raises pressure on food, energy, and water. Higher population in urban areas increases competition for inputs used in rice production and importance of rice trade between rural and urban areas. Historically, analysis of population-agriculture nexus mainly focused on the consequences of overall population growth. Other critical dimensions of demography were largely ignored. The issue of demographic transformation and its ramification in agriculture has started receiving attention lately. But, there is paucity of knowledge about the pace and magnitude of demographic transformation and its impact on the rice sector. This paper aims to bridge this knowledge void. The objective of this paper is to discuss the South Asian demographic transformation and its ramifications on rice R&D in Asia. The knowledge about current and future trends on all dimensions of demography is crucial to know potential producers and consumers, to know consumption trends, and to form a basis for market segmentation. This helps scientists and policymakers to allocate resources, craft

appropriate policies, and design interventions that lead to positive outcomes in the rice sector by targeting better technologies and services, social sectors (labor, education, and health) and tailored infrastructures. This paper contributes to the literature on the impact of demographic transformation on the agriculture sector.

The remainder of this article is organized as follows. Section 2 presents data and analytical methods. Section 3 presents results on depth and breadth of demographic transformation in South Asia. Section 4 discusses impacts of demographic transformation on future rice production and suggests some technological and policy interventions. Section 5 concludes the paper.

2. Methodology

This paper mainly is primarily based on the secondary data published by the national government of South Asian countries and by international organizations including Department of Economic and Social Affairs of the United Nations and Food and Agriculture Organization of the United Nations (FAO). In some cases, we also used the primary panel household data of Bangladesh collected over four waves in a discrete manner (1988, 2000, 2004, and 2008) and the latest wave in a continuous manner (2010-2014). Since our focus is on the rice sector, only major rice growing countries in South Asia were considered in our analysis. This comprised of five countries namely Bangladesh, India, Nepal, Pakistan, and Sri Lanka. The data were analyzed using simple descriptive statistical methods and results are presented in tabular and graphical form. The data for South Asia as a whole was computed based on the weighted average of the selected five countries.

3. Results

3.1 Demographic transformation

3.1.1 Population growth

Population growth of a country is a function of several factors including base population size, fertility rate, mortality rate, longevity, population age structure, and migration. Asia is the world's most densely populated region. Three of the world's top ten most populated countries are in South Asia—Bangladesh, India, and Pakistan. The total population of South Asia[1] grew very rapidly from 0.46 billion in 1950 to 1.37 billion in 2000—roughly 3 times in five decades (Figure 1). The population grew at 2.2% p.a. adding 0.91 (0.18) billion new rice consumers in total (annually) to the base population (Table 1). Today South Asia represents 43% of Asia's and 23% of world's population. The population is projected to reach 2.23 billion in 2050. During 2000-2050, it is projected to grow much slowly at 1.0% p.a. adding 0.86 (0.17) billion new rice consumers in total (annually). The population GR has been slowing down but there is no sign of population reaching to the tipping point until 2050. Across countries, population GR ranged between 1.8-2.8% during 1950-2000 and projected to range between 0.4-1.3% during 2000-2050. A combination of high fertility, declining mortality, prolonged life expectancy, and youthful age structure has contributed to population rise in South Asia, which is expected to continue until 2050.

3.1.2 Fertility rate

Fertility rate determines the population growth and structure. Crude birth rate (CBR) and total fertility rate (TFR) are common methods of measuring birth rate. South Asia' CBR—defined as the number of births per 1000 population per year—fell significantly from 43 in the early 1950s to 22 in the early 2010s—a 49% decline in six decades. It is projected to reach 13 by 2050 (Figure 1). Across countries, current CBR is lowest (17) in Sri Lanka and highest (26) in Pakistan. South Asia's TFR—defined as the number of births per women—fell significantly from 6.0 in the early 1950s to 2.6 in the early 2010s—a 57% decline in six decades. Women now are having fewer children than before. TFR is

[1] In this paper, both South Asia and Asia include only major rice growing countries in the region. These major rice growing countries represent over 97% of the total population in the region.

projected to fall below replacement level (usually defined as 2.1 children per women) by the early 2030s, causing population shrinkage. Across countries, current TFR was lowest (2.2) in Bangladesh and highest (3.2) in Pakistan.

3.1.3 Mortality rate

Mortality rate also determines the population growth and structure. Crude death rate (CDR) and infant mortality rate (IMR) are common methods of measuring death rate. CDR—defined as the number of deaths per 1000 population per year—fell significantly from 25 in the early 1950s to 8 in the early 2010s—a 68% decline in six decades. It is projected to remain stable over the next three decades and marginal increase to 9 by 2050 (Figure 1). Across countries, current CDR is comparable in the range of 6 to 8. IMR—defined as the number of deaths of infants below one year age per 1000 live births per year—fell significantly from 166 in the early 1950s to 49 in the early 2010s—a 70% decline in six decades. It is projected to reach 27 in 2050. Rapid drop in IMR dramatically reduce CDR in the past. Drop in IMR and rise in longevity will reduce death rate and partially offset the effect of fertility decline in the short to medium run.

3.1.4 Longevity

Longevity or life expectancy at birth—defined as the average number of years a newborn baby could expect to live if the current mortality rates were to stay the same throughout its life—affects population growth and structure through ageing. Longevity is one method of measuring mortality. South Asia's longevity increased dramatically from 39 in the early 1950s to 66 in the early 2010s—an increase of 27 years in six decades. It is projected to reach 74 years in 2050. South Asians have been living longer. Across countries, longevity ranges from lowest (66) in India and Pakistan to highest (75) in Sri Lanka. Rise in longevity will reduce death rate and partially offset the effect of fertility decline in the short run.

3.1.5 Population age structure

Population age structure refers to the way in which the population is distributed across different age groups. Population age structures of a country change over time due to changes in fertility and mortality rates. Changes in age structure continue even long after fertility and mortality rates stabilized. The transition in population age structure occurs for two main reasons. First, the initial mortality decline is concentrated among children, which increases population concentration at the lower end of age distribution. Second, the subsequent fertility decline affects age distribution. These two forces together introduce a youth bulge into a population pyramid. With the passage of time, the bulge ages and moves from being concentrated at prime ages for working, saving, and reproduction to eventually being concentrated at the old ages.

Population age structure has several implications. When a country has a high proportion of dependent population—i.e., children or elderly—society's resources are stretched, labor supply is reduced, consumption is higher than saving, economic development is stalled, and rice production is adversely affected. In contrast, a large proportion of working-age population opens up a "window of opportunity" for faster economic growth and human capital development if managed wisely (Birdsall et al. 2001, Ross 2004, Bloom and Canning 2008).

To analyze population age structure, we classify South Asia's population into three age groups: young dependent (0-14 years), working-age (15-64 years) and elderly dependent (65 years and older). As a result of falling fertility and mortality rates and increasing longevity, age structure has been changing rapidly. The ratio of share of children:working-age:elderly population in total population changed from 38%:58%:3% in 1950 to 31%:64%:5% in 2010, respectively (Figure 2). The share of three age groups is projected to be 19%:68%:13%, respectively in 2050. High birth rate in the 1950s and earlier led to a continuous rise of the share of children population until peaking in 1970. The share of children

population fell slowly during 1970-1990, but fell rapidly during 1990-2010; the rapid falling trend is projected to continue in the next four decades. Falling children population will affect future growth of working-age population.

The share of working-age population fell from 58% in 1950 to 55% in 1970; it remained relatively stable during 1970-1990; it has been rapidly increasing now and is projected to peak at 69% in 2040 before start falling. A high and growing working-age population now not only contributes to higher future population growth, but also provides a great window of opportunity for agricultural and economic development through increased supply of labor, productive human capital, and decreased age dependency ratio. The elderly population remained fairly stable at the spectrum of 3% to 5% during 1950-2010. It is projected to rise gradually in the next four decades. Advance economic development is accompanied by falling working-age population and rising elderly population. Japan is a case in point where elderly population increased from 4% in 1950 to 29% in 2010—which is a period of economic boom—and it is projected to peak at 39% in 2040.

3.2 Rural outmigration

Rural outmigration is an important factor affecting rural demographic dynamics in South Asia. It impacts rice production by affecting farmer population and labor supply. Rural outmigration to urban areas and foreign countries in search of non-farm employment opportunities is rapidly increasing in South Asia. In Bangladesh, the panel rural household data show steady increase in rural outmigration in the past two and half decades. The share of households with at least one migrating member increased from 20% in 1988 to 44% in 2012 (Figure 3). The national statistics of Bangladesh show that the proportion of rural population migrating within the country increased from 1.1% in 1990 to 3.6% in 2011. In India, 28% of the rural population currently migrates out from rural areas to other regions within the country or abroad, with rural-to-urban migrating accounting for 20% of the total internal

migrants (NSSO 2010). Besides internal migration, a large number of workers from South Asia migrate abroad for employment and the trend is upswing. Latest data show that 2.6 million workers annually migrate abroad, ranging from 280 thousand in Sri Lanka to 780 thousands in India (Figure 4). The rapidly growing youth population, lack of employment opportunities locally, and expansion of migrant networks are likely to further increase international migration from South Asia in coming decades.

3.3 Urbanization

Urbanization—defined as the increase in the share of people living in towns and cities—is a part of population dynamics. It affects rice production through labor markets, land markets, competition for water, changes in consumption patterns and demand for foods, development of modern food value chains, and accelerating commercial production. South Asia is rapidly urbanizing. The region's urban population increased from 23 million (16% of total population) in 1950 to 490 million (31% of total population) in 2010—a 21 times increase in six decades (Figure 5). This trend is set to continue and the urban population is projected to reach 1.16 billion (52% of total population) in 2050. The urbanization has been rapid after the 1980s and urban population will surpass rural population for the first time in history in 2050. The absolute number of rural population will start falling after 2030. Across countries, current urbanization is lowest (15%) in Sri Lanka and highest (36%) in Pakistan.

4. Discussions

South Asia's both fertility rate and mortality rate have fell significantly in the past six decades. The falling fertility rate in the past has resulted in the falling share of children population in recent years but at the same time the falling children mortality rate has partially offset the falling share of children population. The high population growth led baby boom few decades back has caused the increasing share of working-age population and marginally increasing share of elderly population in recent years.

The combined effect of these demographic factors is the slow growth of the region's population. South Asia's population growth has been falling but it is still high, causing a large increase in the population (19 million per year during 1950-2000). Approximately 90% of this increase in the population was working-age population. This large working-age population is contributing to agricultural and economic development of South Asia through labor supply, large population of rice producers, human capital, and low age dependency ratio. This human capital is one of major factors contributing to fast economic growth of South Asia now.

Roughly 70% of South Asia's population lives in rural areas. Of which, 61% is working-age population. The large rural population—with a high proportion of working-age—supplies abundant rural labors and farmers for rice production. This led to a large number of rice producers and a small number of net consumers. Large number of farmers supplied large quantities of rice in the country, made the country rice self-sufficient, and kept rice prices at the lowest possible level. Likewise, large supply of labors in the rural labor markets avoided labor scarcity and kept agricultural wages at the lowest possible level. The fast urbanization in South Asia (2.6% per year in the last one decade) will reduce rural population and also pull rural labor out of agriculture, which will induce negative effects on rice production.

A large number of rural labors from South Asia are migrating out to urban areas and foreign countries in search of better employment and other economic opportunities. The rapid rural outmigration and urbanization is causing slow growth of rural and agricultural population. For example, the agricultural population grew at 8.0 million per year during 1980-89, but it grew only at 3.8 million per year during 2001-10; it is projected to grow at 1.1 million during 2011-20. The annual growth rate of the agricultural population fell substantially from 1.72% in 1980 to 0.37% in 2010; it is projected to negative after 2020 (Figure 6). Fast urbanization and fast declining agricultural population mean less number of rice producers and more number of net rice consumers, most of whom living in urban areas.

This will have serious consequences on overall rice production and supply of rice to urban consumers. The decreasing number of net rice producers and increasing number of net rice consumers in urban areas will require efficient rice marketing system from rural to urban areas. The reduced number of producers increases burden on consumers by increasing rice prices and increases burden on the government by increasing country's dependence on rice imports. The growing affluent urban population can afford higher quality expensive rice and also they have different diet patterns. This will require reorientation of future rice research activities.

One important consequence of urbanization and rural outmigration is ageing of farming population. The rural youth are migrating out from rural areas for several reasons including low profit and income from farming, community perception that agriculture is a menial occupation, lack of jobs in rural areas, low wages, rural poverty and hunger, and lack of social services. This is leading to ageing of farming population in South Asia. The Bangladesh panel rural household data show that the average age of farming population increased from 38 years in 1988 to 46 years in 2010 (Figure 7). The ageing of farming population signals low entry of youth in farming. The anecdotal evidences in other South Asian countries also reflect this phenomenon. Latest farm household studies in different South Asian countries show that the average age of principal farm operator is 48 years, with the range being 42 years in Pakistan to 52 years in Bangladesh and Sri Lanka. This implies that a large number of South Asian farmers will retire in the next two decades. The low entry of youth in farming and gradual ageing of farming population pose a serious threat to future rice production and food security.

Another important consequence of urbanization and rural outmigration is escalating agricultural wages. The large outmigration led rural labor scarcity is leading to higher agricultural wages in all South Asian countries. For example, the average nominal wage rate of casual agricultural male laborers in Bangladesh increase from 1.2 US$/day in 2000 to 3.6 US$/day in 2013—an increase of 200% in just a decade or so. Labor is a major input accounting for nearly half of the total production cost of rice in

South Asia. Thus, rising labor wage rate has direct impact on production cost of rice, which in turn will be reflected in terms of higher rice prices.

The wider availability of the green revolution technologies complemented by a favorable demographic condition resulted in a high rice yield growth during the 1980s and 1990s in South Asia (Figure 9). During that period, rice yield growth rate surpassed the population growth rate. This has had a great positive impact on increased national self-sufficiency on rice, food security, and poverty reduction. The region is still passing through a favorable demographic transition phase, such as a reasonably high fertility rate, large share of working-age population, low rate of population ageing, high number of rural population, and mid-age farming population. This indicates still a large potential for rice production and meeting national rice requirements through domestic production in the short- to medium-run future. However, the emerging demographic trends, such as steady falling fertility rate, gradual rising share of elderly population, gradual ageing of farming population, low entry of youth in farming, increasing rural outmigration, and agricultural labor scarcity pose challenge to rice production and food security in the long-run future.

It is critical for policymakers and scientists to fully appreciate emerging demographic trends and their implications, with particular reference to social and economic development, natural resource, rice production, and food security. Then design and implement appropriate technological, institutional, and policy interventions that effectively address these issues. Rice research and development programs should be developed within the framework of demographic transformation. Some desired changes in policies and programs are discussed below.

Population growth has been a major driver for steady growth in rice demand. South Asia's will add 630 million new rice consumers in the next four decades. Producing enough rice to feed these extra mouths in the face of declining land base, increasing non-agricultural demand for water, and increasing production cost is a big challenge. More investment in rice research and development is needed to

increase rice yield. Rice varieties with higher yield, better nutritional contents, and compatible with local preferences have great potential to address future food security and undernourishment in South Asia.

The region has a large youth population. This is a great asset if productively utilized. Policies and programs are needed to improve the knowledge and skills of this human and create employment opportunities to use them productively. Besides, food preferences and eating habits of youth are different than that of elderly. Youth have busier lifestyle and they are time-starved. Their consumption behaviors are oriented towards convenience, quality, and variety. Future youth consumers are likely to demand rice products that are healthy, nutrient-dense, low-calorie that help maintain weight, shorter cooking time, longer keeping quality after cooking, suitable for sale in convenient stores, and good for takeaway from home. This brings new opportunities for rice production, processing, delivery, marketing and branding to meet the demand of youth consumers.

Ageing of farming population can bring several challenges to future rice production and consumption through multiple ways. First, it will reduce both the quantity and quality of agricultural labors. Labor scarcity increases production cost and reduces profitability of rice farming. Besides, it causes obstacles expanding or even maintaining existing rice production activities, particularly if these depend on manual labor as is the case in most parts of South Asia. Second, older farmers are risk-averse and less receptive to new technologies (Stloukal 2004). This can hinder the adoption of new technologies and reduce rice yield growth. Third, in the long-run ageing of farmers can lead to the abandon of rice lands in the absence of heirs. Four, ageing can increase rice prices by slowing down production growth and by increasing production cost. Five, when traditional rice production sources decline, urban areas will need to find new sources of supply leading to import from longer distances or increase of imports from foreign countries. Six, elderly people are likely to demand rice products that are low in calories, cook soft, easy to digest, longer keeping quality, contain complex carbohydrates, and high in fibers.

As the rice faming population gets older and youth remain skeptical about rice farming as a career, South Asia's future food security will be threaten. The problem will be exacerbated by the growing rural labor scarcity arising from increased outmigration of rural youth. It should be taken as a wake-up call and must adapt to changing demographic structures. Policymakers and researchers must take proactive approach to minimize or cope with the irreversible consequences of population aging on agriculture. The solution lies on attracting youth in rice farming. While youths are leaving rural areas, there are still lots of energetic, smart, and dedicated young men and women who have been farming and want to farm. This requires making farming intellectually stimulating and economically rewarding through financial and other supports. This warrants policies and programs that favors commercial production, mechanization of farming, and better transportation and communication linkages to markets. Efforts are also needed to develop and promote innovative rice-based technologies that attract youth and raise profitability. Access to credit will be crucial to adopt improved technologies and shift towards commercial-type farming. The urbanization and ageing of farming population bring new dimensions to rice demand and supply. The future demand for rice varieties that meet the needs of elderly population is expected to rise and hence research program should be tailored to develop such varieties.

5. Conclusions

The demographic structures of South Asian countries are rapidly transformation. Fertility rate, mortality rate, population growth, share of farming and agricultural population, and entry of youth in farming are declining. Rural outmigration of youth, urbanization, and ageing of farming population are increasing. These changes are occurring at different pace across countries in South Asia. And these changes are projected to be more rapid in coming decades. These emerging trends will have far-reaching impacts on the nature and organization of rice farming mediated through labor markets as well

as rice demand and supply. Declining agricultural population and ageing of farming population will lead to labor scarcity, abandoning of farming land, low rate of adoption of improved technologies, higher production cost, and slow grow rate of rice production. Despite falling population growth rate, South Asia's population is still growing at 17 million per year, creating a large additional rice demand. When rice supply growth trail behind the rice demand growth, it will push rice prices up as it happen in recent past years. This will disproportionately hurt the poor more and threaten national efforts to reduce poverty and hunger. Policymakers, scientists and donor communities must anticipate future demographic changes and craft necessary technological, institutional, and policy solutions to manage or cope with the emerging tides of demographic transformation so that enough rice is produced to ensure food security of future rice consumers in South Asia and beyond. The policy and program interventions should focus on farm mechanization to address farm-labor scarcity, technical trainings for youth to improve their knowledge and skills on improved farming practices, financial and other supports to attract youth in farming, research to develop innovative technologies that are intellectually attractive and economically rewarding, research to develop rice varieties that meet the needs of future youth and old consumers, and efficient marketing system between rural and urban areas. Efforts are also needed to improve the entire rice value chain system as there will be more consumers in the urban areas, whose consumption habits and affordable capacity are different than traditional Asian consumers.

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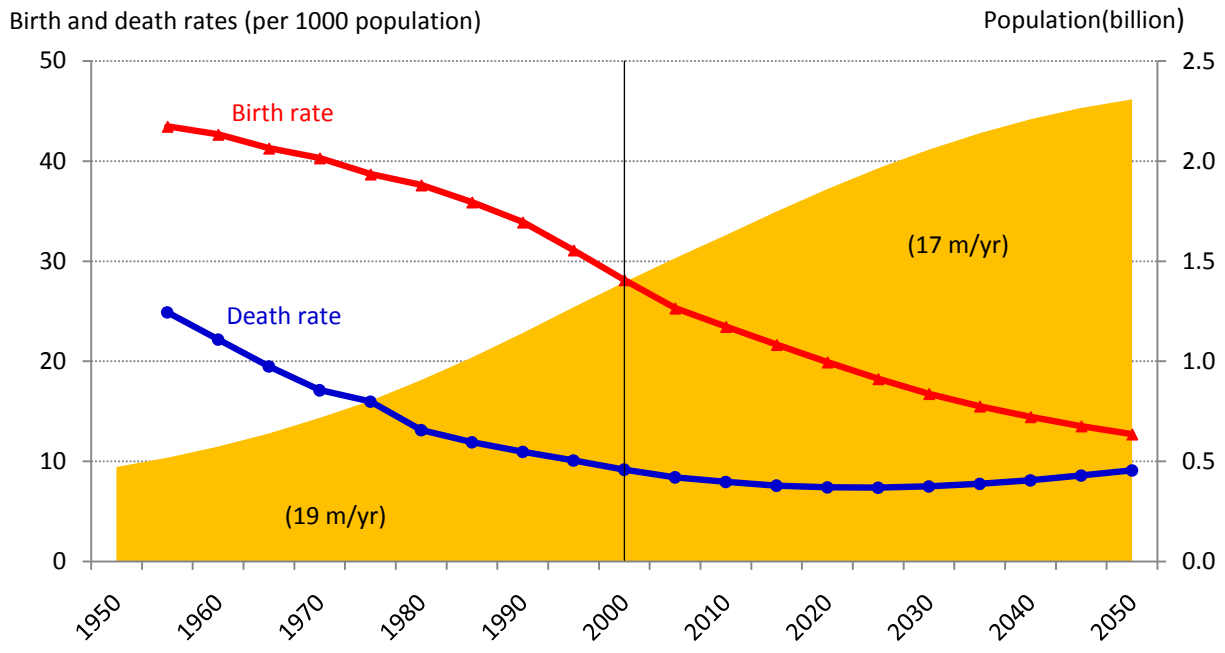

Figure 1. Total population, birth rate, and death rate in South Asia, 1950-2050
Data source: UNDESA, 2013.

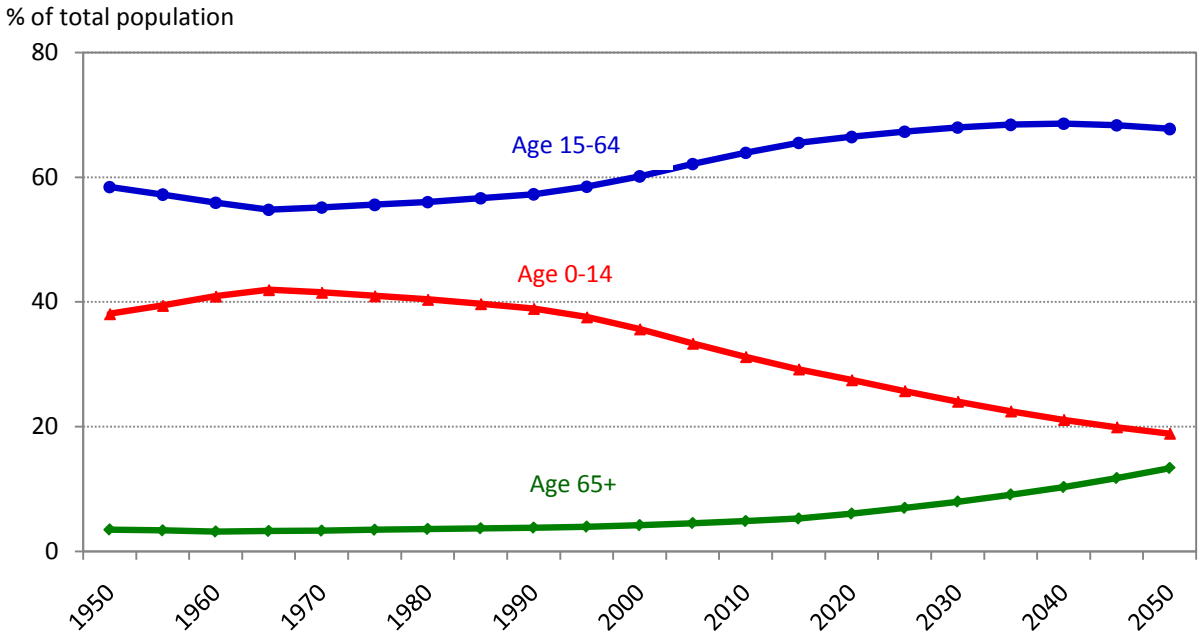

Figure 2. Change in the percentage share of child-age, working-age, and old-age population in total population, South Asia, 1950-2050.
Data source: UNDESA, 2013.

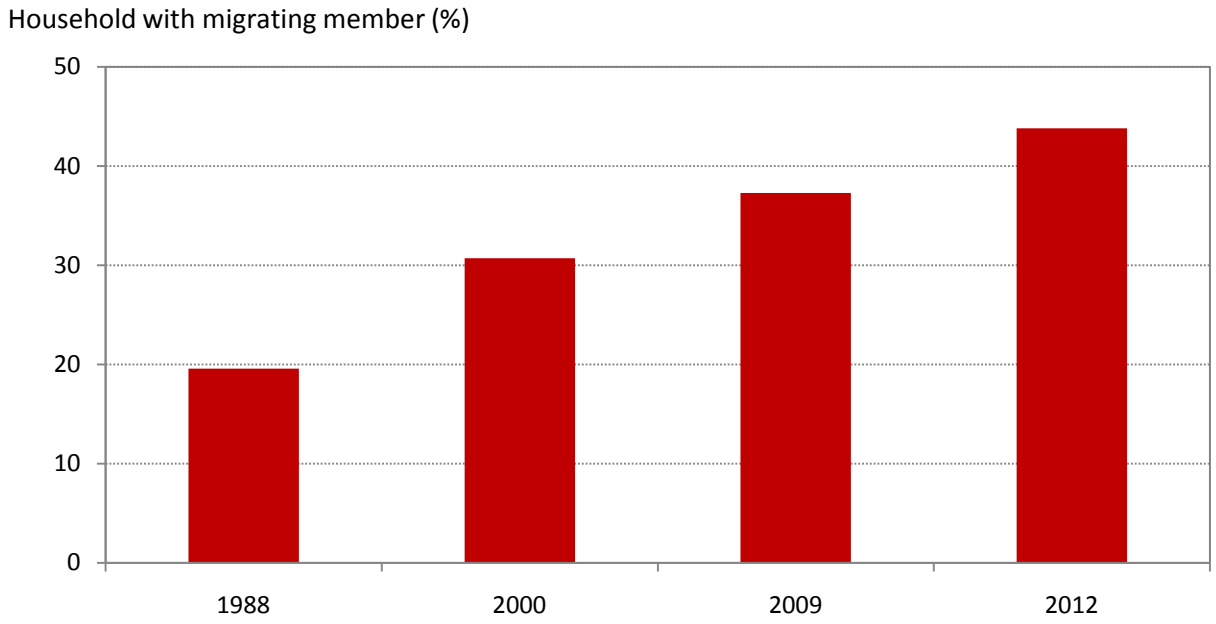

Figure 3. Percentage of sample rural households with at least one member migrating, Bangladesh, 1988-2012.
Data source: VDSA Project Panel Database, 2014.

Figure 4. Annual outflow of migrant workers to foreign countries from South Asia, 2006-08.
Data source: VDSA Project Panel Database, 2014.

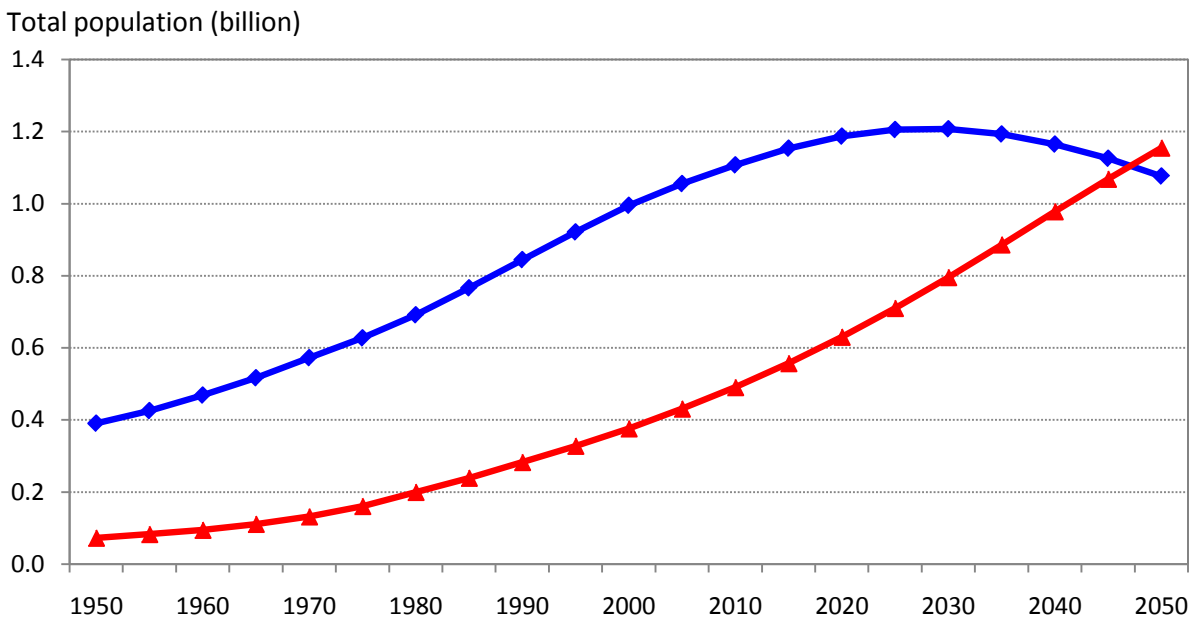

Figure 5. Distribution of rural and urban population in South Asia, 1950-2050.
Data source: UNDESA, 2013.

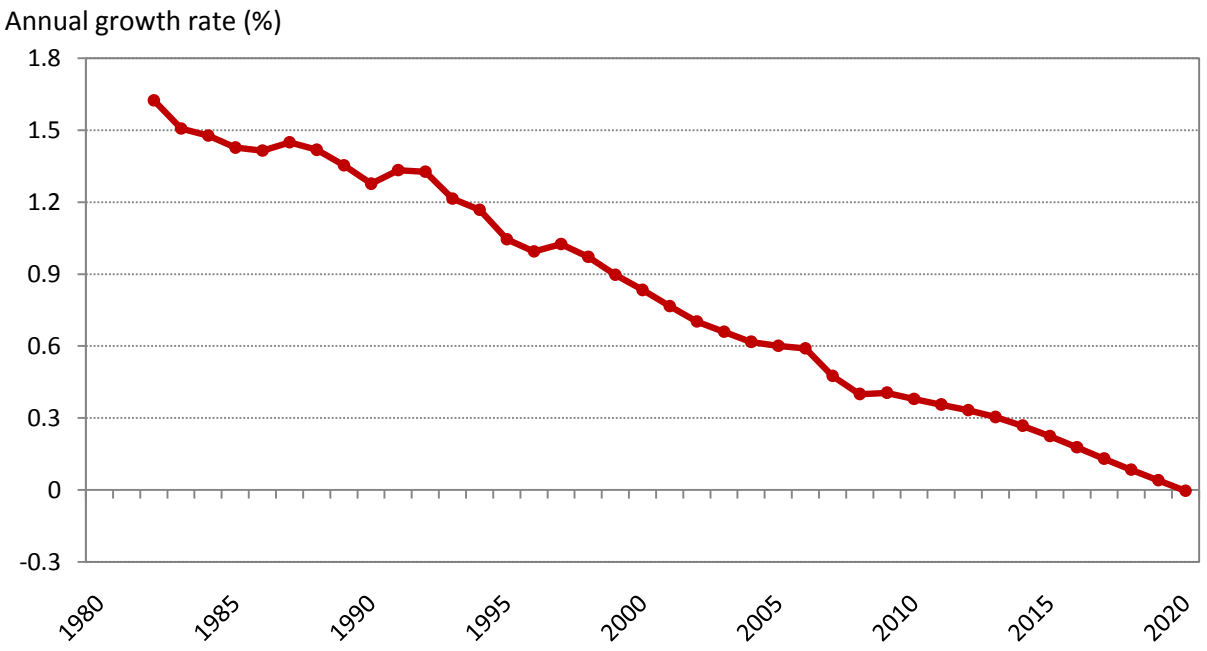

Figure 6. Three-year moving average annual growth rate of agricultural population in South Asia, 1980-2020.
Data source: VDSA Project Panel Database, 2014.

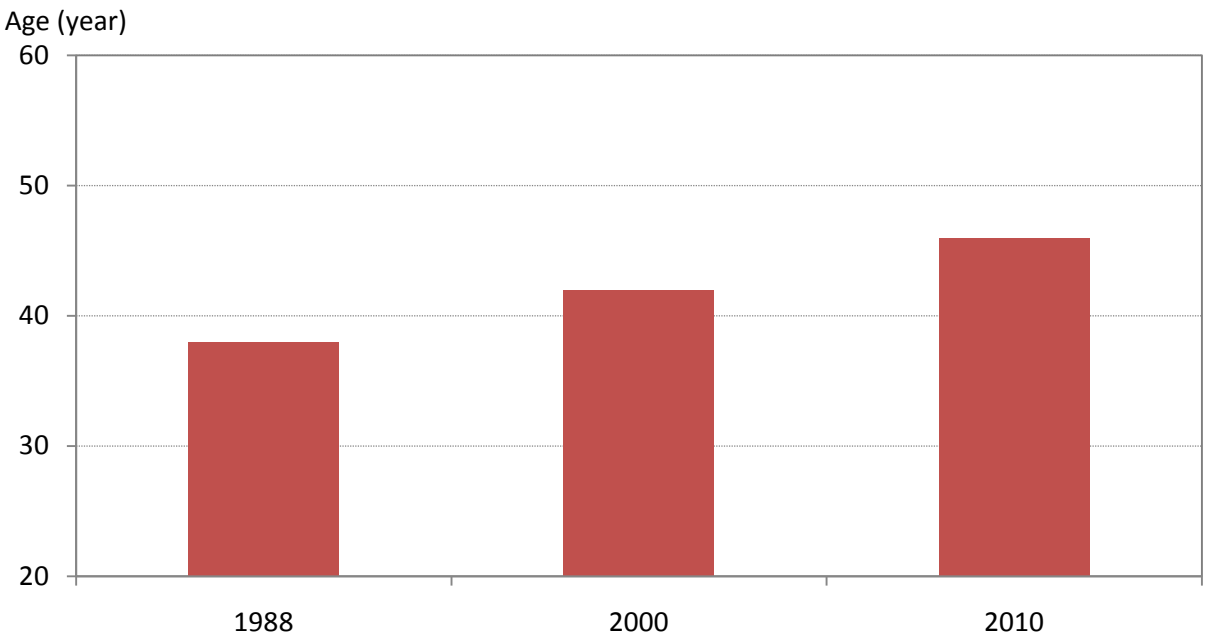

Figure 7. Age of farming population among sample households, Bangladesh, 1988-2010.
Data source: VDSA Project Panel Database, 2014.

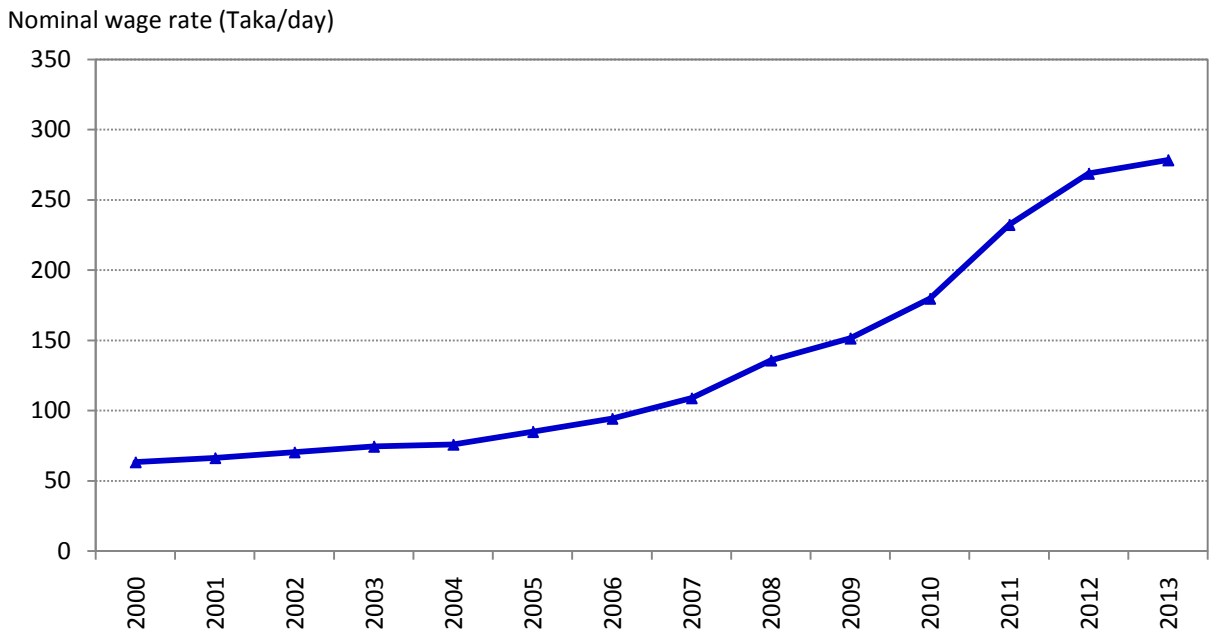

Figure 8. Daily nominal wage rate of casual male agricultural labors, Bangladesh, 1990-2013.
Data source: VDSA Project Panel Database, 2014.

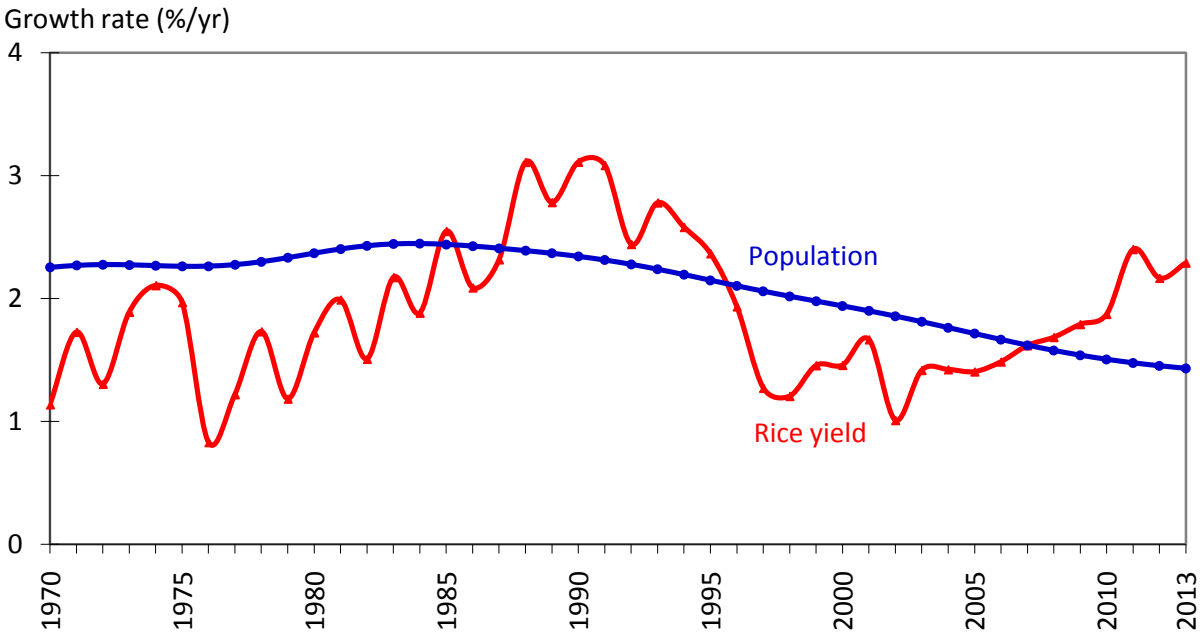

Figure 9. Ten-year moving average annual growth rates of rice yield and population in South Asia, 1970-2013.

Data source: FAOSTAT, 2014.

Table 1. Compound annual growth rates (%) of total population, South Asia, 1950-2050.

Decade	Bangladesh	India	Nepal	Pakistan	Sri Lanka	S Asia
1950-60	2.8	1.9	1.7	2.0	2.0	2.0
1960-70	3.0	2.1	2.0	2.6	2.3	2.2
1970-80	1.8	2.3	2.3	3.0	1.8	2.4
1980-90	2.7	2.2	2.4	3.3	1.4	2.4
1990-00	2.1	1.9	2.5	2.6	0.7	2.0
2000-10	1.4	1.5	2.1	1.8	1.1	1.5
2010-20	1.2	1.2	1.6	1.7	0.7	1.3
2020-30	0.8	0.9	1.3	1.3	0.3	1.0
2030-40	0.5	0.7	0.9	0.9	0.1	0.7
2040-50	0.2	0.4	0.6	0.6	-0.1	0.4
1950-00	2.4	2.2	2.2	2.8	1.8	2.2
2000-50	0.8	0.9	1.3	1.3	0.4	1.0

Data source: UNDESA, 2014.