Chapter 1

A Broad Overview

1.1 Introduction

Agriculture provides a means of livelihood to a very large proportion of India’s population. Agricultural prosperity is a pre-requisite for industrial growth, overall GDP growth as well as for development. Generally, the years of bad agricultural performance have also been the years of slowdown in the GDP growth rates.

In light of the near-stagnation of the area under cultivation in India and limited possibilities of additions thereto, economists and policy makers have been forced to think of alternative means of raising production. A major post-Green Revolution policy, therefore, was to increase input intensity in agricultural production. While this has paid substantial dividends, it has its limitations in the long run. Therefore, one must seek other measures. The much-required increase in agricultural production can be achieved, at least partly, through an increase in total factor productivity. Although multiple factors lie behind this sought-after increase, investment in health is an important instrument to bring this about.

Health is a fundamental human attribute, and to that extent a critical input into the production process. Each individual must have access to quality health care facilities, safe drinking water and sanitation facilities and a minimum level of food required to maintain good health. The changing concept of development itself has brought health to the forefront of development strategy with the state of health becoming one of the criteria to judge the extent of development that has taken place.

There have been some notable achievements in the health sector in India over the years in terms of an improvement in life expectancy at birth (from 37 years for males and 36 years for females in 1951, to 66 years for males and 68 years for females in
2011) and decline in infant mortality rate (from 146 per thousand in 1951 to 30 per thousand during 2009). However, there has been little improvement in the general health standards of the majority of the population. As a result of inadequate attention, Indian population continues to be exposed to high incidence of communicable but readily preventable diseases. India also performs dismally in the provision of basic facilities such as safe drinking water and sanitation facilities which influence hygiene and health of population.

A healthy workforce contributes to productivity in several ways - the workers can spend more time at work, they can perform more efficiently and faster, they have better educational attainments and skills, and resources do not get diverted from consumption or productive investment to medical care.

The causation also works in the reverse direction. A rise in agricultural productivity leads to enhancement of health status. Higher agricultural output and better agricultural practices are necessary to improve health by increasing supply of food, quality and nutrition of food, medicinal plants etc. The regions / individuals with low-incomes are trapped in the vicious circle of inadequate resources to invest in health care on the one hand, and poor health in turn constraining income-augmenting activities on the other.

Even though good health is an essential pre-requisite for raising agricultural productivity and economic development, it has never got its due place in the spheres of policy-making as well as resource allocation. Spending on health is a productive investment. The fact that there is minimal government spending on health in India, less than 2% of GDP, brings out the lack of importance that has been attached to one of the basic aspects of human life. The low priority attached to health over the years is definitely a matter of concern.

This dissertation attempts to study the relationship between agricultural total factor productivity (TFP) and rural health for fifteen major states of India for the years 1983-84 to 2005-06. The time period is chosen subject to data availability for the labour
input (needed for constructing TFP index that is derived using NSS data) and health manpower (used in construction of multi-metric health index).

The existing literature can be said to be deficient in establishing a definitive relationship between health and TFP in the context of Indian agriculture. Several studies either take health as a separate factor of production or take a restricted view of the impact of health on improving only labour productivity. Although there are several studies that estimate a TFP equation, most of them ignore the health dimension. The studies that do take into account health as one of the regressors of TFP, lack in two major respects. First, health is not captured in its multi-dimensional spirit and few studies use multiple health indicators; and even in the latter, the coverage of the health dimension is far from comprehensive. Second, the relationship between health and TFP in most studies is assumed to be one-way, and the endogeneity issue is completely ignored.

This dissertation seeks to fill these gaps by:
(a) Taking a comprehensive measure of the health status, i.e. a multi-dimensional health index.
(b) Capturing the ‘total’ impact of health on agricultural production process by taking it as a determinant of total factor productivity. This approach also has the additional advantage of providing a quantitative impact of improvement of health on TFP, which cannot be provided by the other approaches.
(c) Recognizing that there exists a two-way relationship between the two variables of interest and hence correcting for endogeneity bias, by instrumenting health variable with its own lagged values, while estimating the TFP equation.

1.2 Estimation of the agricultural TFP index

The construction of the agricultural total factor productivity index for fifteen major states in India is discussed and executed in detail in chapter 2. A rise in production can be attributed either to a growth in inputs or a growth in productivity of various
inputs. Productivity growth takes place due to movement towards the best practice referred to as changes in technical efficiency as well as changes in the best practice reflected by outward shift of production frontier termed as technical change. This chapter estimates changes in agricultural total factor productivity for fifteen states of India for the years 1983-84 to 2005-06 using non-parametric Sequential Malmquist TFP Index.

The present study uses Malmquist TFP index constructed using Distance Function/DEA approach for the purposes of estimation of total factor productivity in Indian agriculture at state-level. The reasons for choosing this approach are as follows. First, this method does not require any price data. This is a distinct advantage, because in general, agricultural input price data are seldom available and such prices could be distorted due to government intervention in most developing countries. Second, the DEA seems to be a much more powerful tool for measurement of productivity since it does not require restrictive assumptions such as no functional form of production function / distribution form of inefficiency required. Third, the approach permits decomposition of TFP change into its components - changes resulting from a movement towards the production frontier (referred to as technical efficiency) and shifts in the frontier (referred to as technical change) - that would help in gaining insights into the sources of growth of TFP. Fourth, it permits the use of an alternate definition of technology, that is, sequential technology as against contemporaneous technology that is referred in the literature as Sequential Malmquist TFP index.

A literature review related to measurement of agricultural TFP is followed by methodology that includes discussion on the concept of distance function, the approach of Data Envelopment Analysis and the Malmquist TFP index along with its decomposition into two components - technical efficiency change and technical change. Malmquist TFP index, when estimated using the notion of contemporaneous technology, gives rise to two biases, namely under-estimation of technical change for the frontier states and over-estimation of efficiency change for non-frontier states, when contemporaneous technology is used under Hicks-biased technical change.
These biases can be rectified by using the modified Malmquist TFP index, that is, Sequential Malmquist TFP index. The central idea behind it being that input reduction can take place without requiring the frontier to recede. If usage of some inputs gets reduced in a frontier state, either because of non-neutral technical change or some natural calamity, it should not get reported as technical regress for that state and that its effect should not get passed on to non-frontier states. If the frontier shifts inside, the non-frontier states will find themselves closer to the frontier and report greater efficiency. The correct impact of such input reduction on productivity, efficiency and technical change of a frontier state can be measured only if the frontier is not allowed to recede.

The data sources are described next, followed by a discussion on results. The chapter ends by comparing the TFP change obtained under sequential Malmquist TFP Index with contemporaneous Malmquist TFP Index.

1.3 Constructing a multi-dimensional Health Index
Chapter 3 proceeds to present a detailed discussion of the issues involved in the construction of the health index. An epidemiological health production function indicates health status to be function of nutrition, access to health-related facilities such as water, sanitation, clean cooking fuel, literacy, medical care infrastructure, use of health care services, ethnicity, occupational hazards and health endowments. An important problem in the empirical analysis is the unobservability of health status. There are several indicators or health outcomes available such as mortality indices (life expectancy and infant mortality rate); life years adjusted for health and morbidity; and anthropometric measures. The choice of state-level health outcomes available on an annual basis is very limited. The measures for disability-adjusted life years (DALY) are not available at state-level. The anthropometric measures are available only for three time-periods corresponding to the three National Family Health Surveys.

The concept of health is complex, which makes it difficult to indicate it by a single outcome measure. Moreover, defined as a single outcome measure, the state of health
would differ with the indicator chosen. An alternative is to construct the Health Index by using a set of health inputs. If various dimensions of health are in good shape, that is, if people have adequate nutrition, access to safe drinking water, clean air, access to sanitation, immunization and literacy, and access to good medical care facilities, then they are likely to have a ‘good’ state of health. The health index (HI) constructed in the present study is based on the determinants-approach and is a weighted index of several aspects of health, making it a much more comprehensive and broad-based indicator of the health status than those available in the literature.

The health index so constructed comprises eleven dimensions that are used to construct three sub-indices – the Material Access Index (MAI), the Health Infrastructure Index (HINFI) and the Health Care Utilization Index (HCUI). The Material Access Index indicates the command of people over the set of five facilities that strongly impact health - level of nutrition, access to safe drinking water, use of clean cooking fuel, access to sanitation and literacy levels. These are the basic requisites that enable people to stay in good health; inadequacy or lack of these would imply greater susceptibility and exposure to disease thereby increasing health risks. This index may alternately be called as Risks to Health Index or Income index. The Health Infrastructure Index takes into account three components related to availability of physical as well as human aspects of medical facilities, namely number of primary health centres, hospital beds and health manpower (includes medical as well as para-medical personnel) per thousand population. The Health care utilization index should ideally include the parameter of utilization of medical care facilities for rural population as a whole. However, data is available for utilization of medical care only for two population groups – children (in the form of immunization data) and women (in the form of immunization data for expectant mother and skilled attendance at the time of delivery of child). Even this data does not cover the entire child and woman population. The three components - immunization of expectant mother, immunization of children and percentage of births attended by skilled personnel – are best available proxies for rural utilization of health care facilities.
Instead of assigning equal weights to all the parameters or assigning weights based on judgement, the present study combines multiple dimensions by weights derived statistically by the method of Principal Components Analysis.

The chapter also provides a brief discussion on health policy in India since independence and literature review related to determinants of health, indicators of health and India-specific health literature review.

The results for the three sub-indices and the Health Index are presented for selected years - 1983-84, 1994-95 and 2005-6. The chapter ends by providing a comparison of constructed Health Index with other health indicators.

### 1.4 Health and agricultural TFP

Chapter 4 brings together these two important elements of the agricultural production process, and explores the relationship that obtains between them. The impact of health on agricultural productivity can be divided into two routes, namely direct and indirect. The direct effects of health relate to the labour-augmenting or quantum impact, and quality of labour supply such as greater time devoted to production activity, greater physical strength, and reduced absenteeism from work. Apart from improved labour productivity, health also has several indirect effects on TFP that include impact on investible resources, impact on education, demographic impact, and impact on productivity of other factors.

The causation also works in the reverse direction. A rise in agricultural productivity, when accompanied by a rise in income, leads to enhancement of health status of rural community. Also, higher agricultural output and better agricultural practices are necessary to improve health by increasing supply of food, quality and nutrition of food, medicinal plants etc. The regions/individuals with low-income are trapped in the vicious circle of inadequate resources to invest in health care facilities, and poor health itself constraining income-augmenting activities.
There are three approaches by which the impact of health has been studied by existing literature – taking health as an additional factor of production, taking health to affect labour productivity by augmenting the labour input and taking health entering the production process through its impact on productivity.

The present study seeks to capture the total impact of health on agricultural production process by following the approach of treating it as a determinant of total factor productivity. Health being intangible cannot be considered as a separate factor of production. The use of effective labour tends to under-estimate the impact of health since it is not restricted to augmenting labour productivity only. Health has a much bigger role to play in production process. As indicated by the indirect effects of health, an improvement in health is very likely to bring about gains in overall productivity, and the third approach is, therefore, likely to capture the impact of health on the production process in the most comprehensive manner. This approach also has the additional advantage of providing a quantitative impact of improvement of health on TFP, which cannot be provided by the other two approaches.

The relationship between health and TFP is studied using two alternate approaches. First, the impact of growth rate of health on growth rate of TFP is analyzed using Arellano-Bover/Blundell-Bond dynamic panel system Generalized Method of Moments (GMM) estimator. The GMM estimator is an instrument variable (IV) estimator that uses all past values of endogenous regressors as well as current values of strictly exogenous regressors as instruments. In other words, it constructs instruments from within the data set. The approach uses a system of two equations, namely the original equation as well as the transformed (differenced) one. The use of additional moment conditions, in which lagged differences of the dependent variable are orthogonal to levels of the disturbances, allows additional instruments that improve the efficiency of the estimator.

The growth rates of TFP used in the above approach represent changes occurring in the two consecutive time periods that reflect improvements / deterioration only with respect to the previous time period. As an alternative, the changes occurring in TFP
can be accumulated so that the growth rate is not sensitive to any shocks occurring in any previous time period and indicates TFP changes in a more robust manner. For this, TFP-modified index is constructed by taking first year TFP index as initial value and then cumulating changes in TFP index to it. The relationship between health and TFP-modified index is analyzed using Pooled Mean Group estimator as suggested by Pesaran, Shin and Smith (1999). The approach can be used to test for panel cointegration when the regressors have different orders of integration, that is, are a mixture of I(0) and I(1). While short-run coefficients and error variances are allowed to vary across cross-sections, long-run coefficients are constrained to be the same for all.

I end with some discussion about the implications of the entire exercise that, hopefully, will be of use in further empirical research on this issue, and to policy makers.