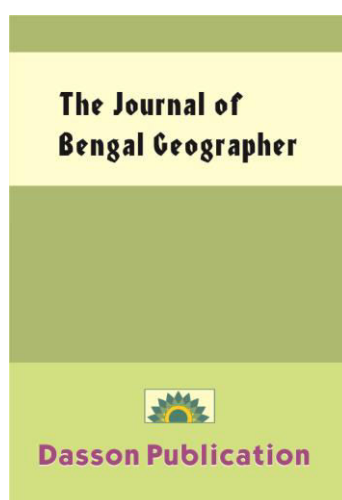


# The Journal of Bengal Geographer



**Dason Publication**  
[www.dasonpublication.com](http://www.dasonpublication.com)

## Population and food security: India's challenge

Savita Ahlawat<sup>1</sup> Dhian Kaur<sup>2</sup>

Research Scholar <sup>1</sup>

Professor<sup>2</sup>

Department of Geography

Panjab University

Chandigarh

India

### **Abstract**

*The status of food security has been a matter of great concern in the era of increasing population. In India, after Green Revolution the growth rate of foodgrains production has however been higher than the population growth rate and it tried to keep pace with the increasing population over the long time in order to sustain the increasing population. The per capita availability of foodgrains which improved after Green Revolution from 395 grams in 1951 to 468 grams in 1971 and 510 grams in 1991 has declined to 462 grams in 2012. The declining trend has serious implications for the country's food security situation. The present study intends to analyse the effects of above highlighted issues viz. increasing population and its effects on the status of food security in India. The results showed that due to population growth agricultural intensification has increased which lead to problems of land degradation, overexploitation of underground water resources, water logging, salinization and alkalization. These problems are more peculiar in Green Revolution areas mainly in north-western states. The study suggests that to have sustainable food security region specific measures should be taken.*

**Keywords :** 1.Environment, 2.Food Availability, 3.Groundwater, 4.Resource Depletion, 5.Sustainable Food security.

### **1. Introduction**

Population is an important source of development, but when it exceeds the threshold limits of the support systems it also becomes a major cause for environmental degradation (Sharma, 2014). The United Nations Conference on Human Environment was also stated that increasing population is a great hurdle in the way of developmental programmes and safe environment (Buss, 2014). As Population growth leads to increase in food demand, which typically results into heavy pressure on land and water resources.

According to Food and Agriculture Organisation (2013) population growth will result in increase in a doubling demand for food globally by 2050 In order to fulfil the demand the production should be increased and the foodgrains production can only be increased by two factors: (i) either increase in area under cultivation i.e. horizontal expansion (ii) or by increasing yield per hectare i.e. vertical expansion. In present scenario, horizontal expansion of land is not possible due population pressure therefore the only way to increase agricultural production is the vertical improvement in agricultural field i.e. use of HYV seeds, Fertilizers, Pesticides. Although agricultural production has increased by following vertical expansion techniques but on the other side these practices have also become a major cause for environmental degradation. Such conditions further effects the agricultural sustainability and food availability of an area. The Asian Development Bank (1997) has also expressed its concern about environmental degradation and future food production.

Thus, the rate of degradation of land and water resources is accelerating due to increasing population pressure which have become a great threat for food security situation in the country.

This paper is divided into four sections; Section I. includes the introductory part of the research problem and shows linkages between population growth and food security. Section II. presents the details of the study area followed by objective, data Sources and methodology. Section III is devoted to the results and discussion and the last Section IV includes the concluding observations.

## **2. Study area**

The present research paper is written in context of India. As India is the second most populous country in the world (after China) having 1.22 billion population (Census, 2011). With the population growth rate at 1.58%, it is predicted that by the end of 2030 India will have more than 1.53 billion people and will surpass China in terms of total population (Mamanshetty, 2012). Therefore, the population pressure on natural resources is very high due to which the country is facing the problem of environmental degradation and resource depletion.

Due to increase in population pressure and environmental degradation the status of food security has undergone a significant change in India. The per capita availability of agricultural land in rural areas has declined from 0.638 hectare in 1950-51 to 0.277 hectare in 2005-06 and per capita availability of forest land has also declined from 0.113 hectare in 1950-51 to 0.064 hectare in 2011. After Green Revolution the growth rate of foodgrains production has however been higher than the population growth rate (in 1980's foodgrains growth rate was 3.5 % and population growth rate was 2.1%) and it tried to keep pace with the increasing population over the long time in order to sustain the increasing population. The growth rate of foodgrains production stagnated during 1990s and it has become almost equal to population growth rate. The per capita availability of foodgrains which improved after Green Revolution from 395 grams in 1951 to 468 grams in 1971 and 510 grams in 1991 has declined to 462 grams in 2012. Even after achieving adequate food supply at the macro level, there is widespread poverty and malnutrition in the country. Out of India's 1.2 billion population an estimated 320 million people go to bed hungry. India has 25 percent of the world's hungry population and an estimated 43 per cent of children under the age of five years are malnourished and this situation is also getting worse due to increase in population pressure. India's rank on the 2012 Global Hunger Index of 63 among 120 countries reflects alarming levels of food insecurity (Grebmer et al., 2013).

Therefore, the present study is conducted in context of India as increasing population pressure has serious implications for the country's food security situation.

## **3. Objective**

The main objectives of the present paper are

1. To show the general trend of population growth in India.
2. To analyze the impact of increasing population on the status of food security in India.

## **4. Data sources**

Various governmental departments and their reports has been considered for the present study. Data on demographic characteristics (i.e. total population, population growth, population density) has been collected from Census Department. For environmental statistics related to land degradation, soil erosion, per capita availability of forest and agricultural land various issues of Economic Survey reports has been consulted. Agricultural data of various indicators such as total

foodgrains production, agricultural growth rate, irrigated area, total cropped area has been taken from reports of agricultural census and agriculture department of India.

The collected data has been analyzed by using various statistical techniques and further the results are explained with the help of statistical diagrams and cartographic techniques.

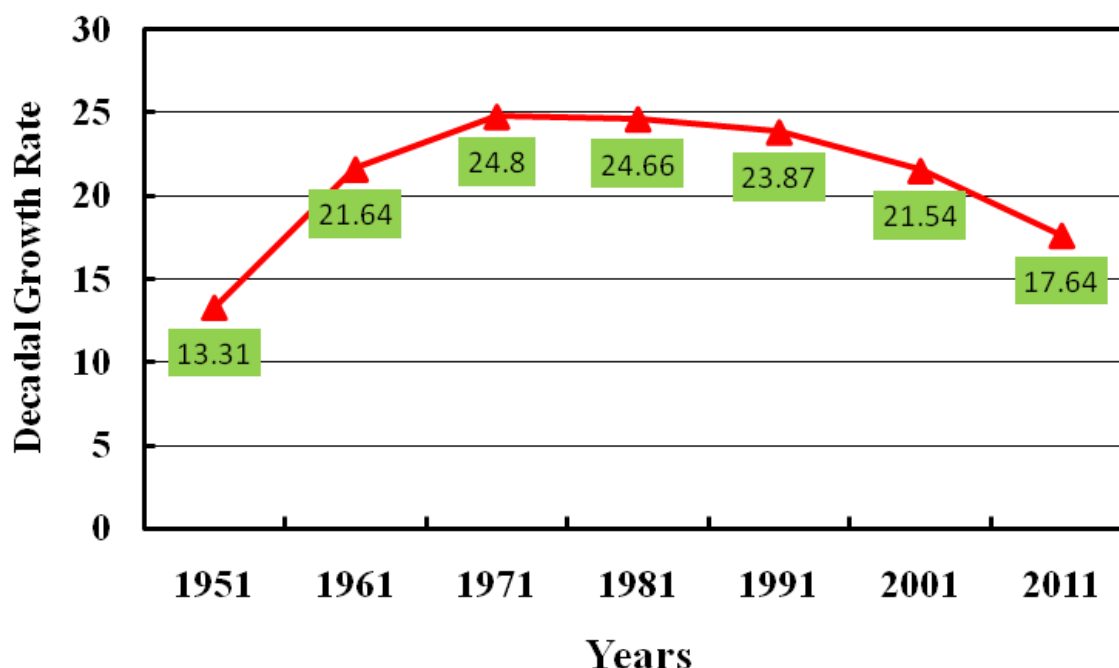
**5. Results and discussion**

This section has two sub-parts: first part explains how increasing population has been responsible for resource degradation which further have serious implications on the level of food security in the country.

**6. Population growth and environmental degradation in india**

India occupies only 2.4% of total geographical area of globe but it is a home to 17.31% of world's population. In contrast, the countries like USA accounts for 7.2 percent of the surface area with only 4.5 percent of the world population. This shows that the pressure on natural and environmental resources is very high in the country. The population growth rate in India is very high as compared to top ten most populous countries of the world and the decadal population growth rate in India has been shown in Fig. 1. The population has grown up from 360 million in 1951 to 1210 million in 2011. The State-wise population distribution shows that twenty states and union territories have a population of over ten million. Uttar Pradesh, Maharashtra, Bihar and Madhya Pradesh share the largest proportion of India's population.

**Fig. 1**  
**Decadal population growth rate of india since 1951**



Source: Census of india (1951-2011)

The exponentially growing human population have negative implications for economic, social and environmental sectors. As the increasing population results into expansion of human activities which further leads towards degradation and depletion of natural resources. The consequent increasing demand for food, water, and housing have considerably altered land-use practices and severely degraded the environment (Pimentel et al., 1997). Many scholars such as Shaw (1989);

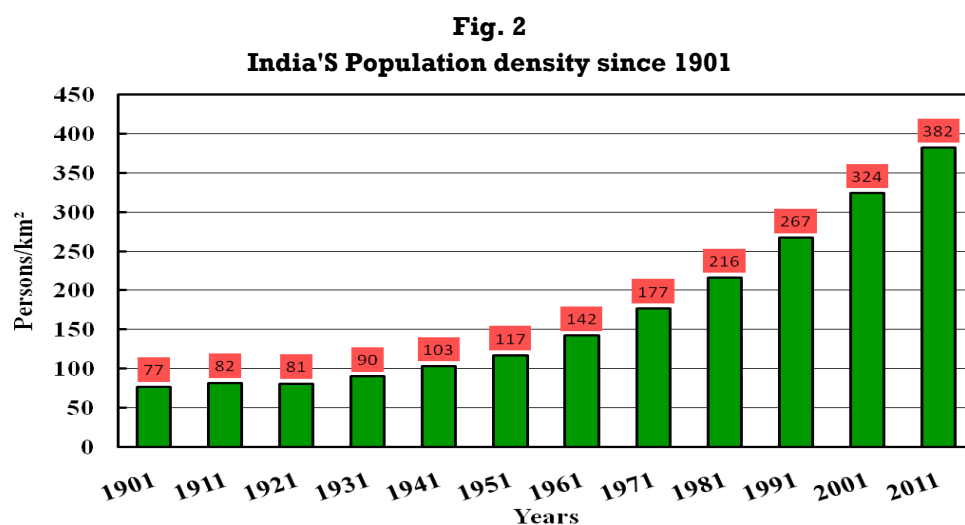
Scott et al. (1997), Dewaram (2007); Harte (2007); Lakshmana (2013) have also analyzed the effects of increasing population on environmental degradation and resource depletion.

Effects of increasing population on environmental resources especially on land and water has discussed as follows:

## 7. Land

Land is the basic natural resource and is backbone of all economic activities. More than 99% of the world's food supply comes from the land, while less than 1% is from oceans and other aquatic habitats (FAO, 1991).

In India, the population density has increased from 77 person in 1901 to 382 in 2011 (Fig. 2). Population density is very high in northern part of India as compared to southern and eastern parts.

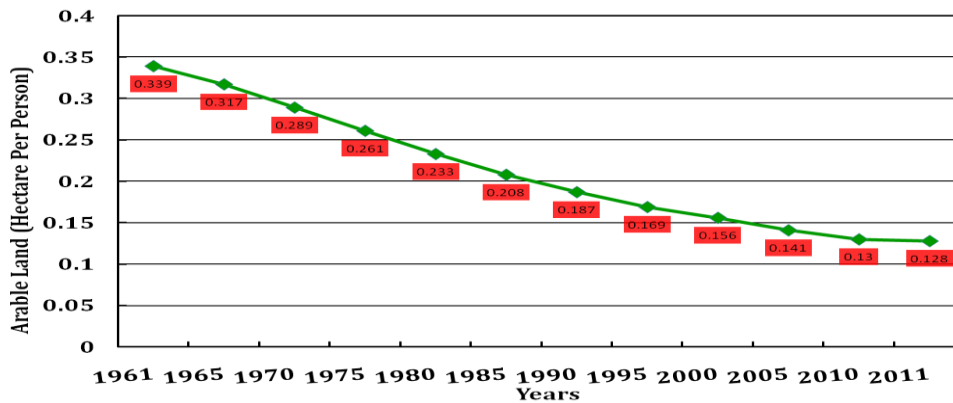


Source: Census of india

Population pressure has resulted into decline in per capita availability of arable land. The arable land in world has declined from 0.37 per hectare per person in 1961 to 0.2 per hectare in 2011. The per capita availability of arable land in India at present is 0.128 per hectare per person (Fig. 3) which is slightly higher in comparison to some South Asian countries such as Indonesia (0.10), Malaysia (0.06), Sri Lanka (0.06) (World Bank, 2011). The projected estimates show that with increasing population pressure the availability of arable land will decline to 0.12 per hectare per person in 2025 and 0.09 per hectare per person in 2050 (Alexandratos and Bruinsma, 2012).

The per capita availability of agricultural land in rural areas has declined from 0.638 hectare in 1950-51 to 0.277 hectare in 2005-06 which is low as compared to 11 hectares in the developed world. In India, agriculturally developed states such as Punjab, Haryana, Uttar Pradesh are showing the declining trend in per capita availability of arable land. This decline in arable land will have serious impacts on people's livelihoods mainly in rural areas. As in the country, almost 69 percent population are living in rural areas which dependent on agriculture and allied sectors for their livelihoods.

**Fig. 3**  
**Per person availability of arable land in india since 1961**



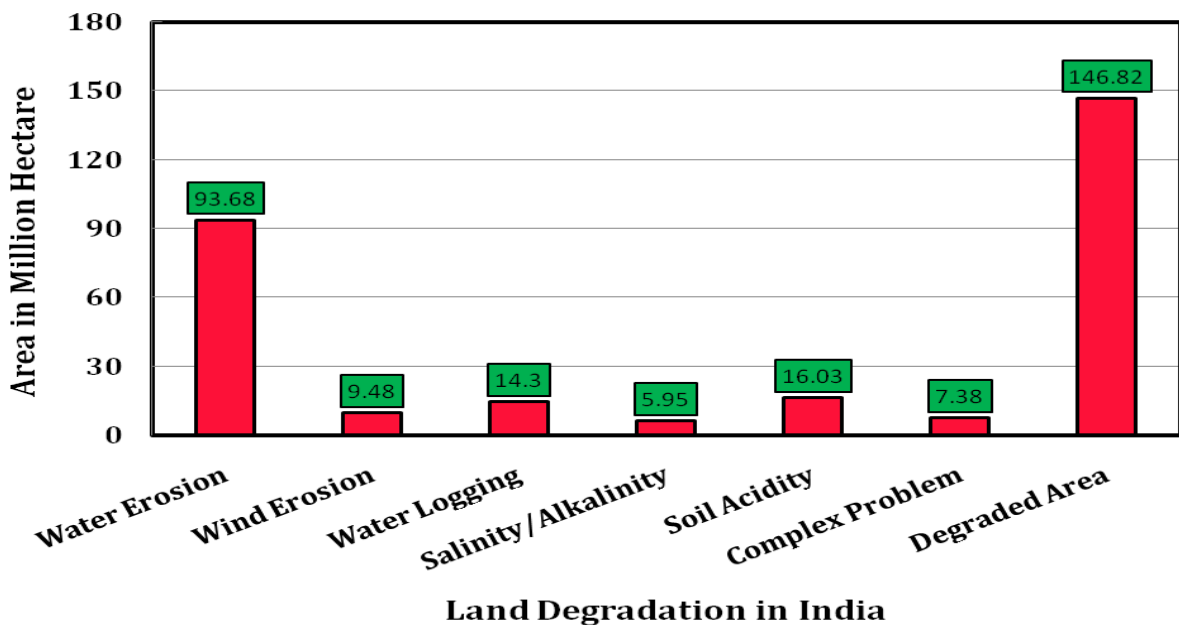
Source: Agricultural and Rural development database, World bank

### 8. Land degradation

It is a major threat to food security. It refers to the significant reduction in the productive capacity of the Land. Increase in size of population result into heavy pressure on agricultural land and also contribute to land degradation, decline in soil quality and overexploitation of underground water resources .

Out of India's total geographical area 146.82 million hectare land is degraded. Extent of Land degradation in India has been shown in Fig 4. The ratio of degraded land is higher in north western parts where agricultural intensification took place after the introduction of Green Revolution during 1960s. In agriculturally developed Punjab state, about 39% soil is completely degraded while 50% of the soil is acutely low in nitrogen and 25% low in phosphorous content (Times of India, 2013).

**Fig. 4**  
**Extent of land degradation in india**



Source: India state of environment report

Land degradation results into decline in soil fertility which effects the country's foodgrains production. Scherr (1999) stated that land degradation is not only a great threat for developing country's food availability, but also have negative impacts on the agricultural income and food consumption of the rural poor.

## 9. Water

Water is very important aspect of life and it is needed to ensure food security, feed livestock, maintain organic life, and to conserve the biodiversity and environment. That's why the availability of water on earth makes it a habitable planet. In present scenario, this essential resource is under threat and both the quantity and quality of water is declining at global as well as national level.

## 10. Availability

According to the international norms, a country having water availability less than 1700 m<sup>3</sup> per capita per year is categorized as 'water stressed' and categorized as 'water scarce' if it is less than 1000 m<sup>3</sup> per capita per year. Population growth has increased the demand for water resources to the extent that more than 40 percent of the world's rural population is living in water-scarce regions and water scarcity will affect 1.8 billion people by 2025. Situation of fresh water availability is very bad in Asian continent in comparison to Africa. As the former has 60% of world's population and has only access to 36% of the fresh water reserves; on the other side 13% of African population has access to 11% of the fresh water reserves (FAO, 2013).

In India where 17.3 per cent of the world's population resides has only 4 per cent of its water resources. It shows the huge stress on water resources in the country. The demand for domestic and agricultural usage of water has been increasing due to population growth and agricultural intensification. In the country, along with forest and agricultural land, the per capita availability of water has shown a declining trend in recent years. The per capita water availability has declined from 5177 m<sup>3</sup> in 1951 to 2309 m<sup>3</sup> in 1991, 1816 m<sup>3</sup> in 2001 and 1545 m<sup>3</sup> in 2011 and the projected estimates of Government shows that this water availability is likely to be reduced to 1401 m<sup>3</sup> and 1191 m<sup>3</sup> by the years 2025 and 2050, respectively (Govt. of India, 2009). Therefore, India will face severe scarcity of water in the near future. At present, Cauvery, Pennar, Sabarmati and East Flowing rivers and West Flowing Rivers of Kutch and Saurashtra including Luni are facing more acute water scarcity having per capita availability of water less than or around 500 cubic metre (Central Water Commission). According to World Bank, only seven Indian states have full drinking water access in rural areas and 30% of rural population are lacking in drinking water accessibility in the country.

Along with surface water ground water also plays a very important role for drinking and irrigation purposes. 92 per cent of utilizable groundwater is devoted to agricultural sector in the country. This highly dependency on groundwater by the farmers for irrigation purposes have led to a serious depletion of the resource. Groundwater is depleted when pumping rates surpass the rate of natural recharge.

In India, total annual replenishable ground water potential has been estimated as 431 BCM and among the States, Uttar Pradesh ranks first (17.5%) in terms of share of replenishable ground water resources followed by Maharashtra (8.3%), Madhya Pradesh (7.9%), Andhra Pradesh (7.8%), West Bengal (7.1%) and Assam (7.0%). In India, groundwater table is dipping every year by 0.4 m and the country has also been categorized into safe, semi-critical and over exploited groundwater resources (CGWB, 2012). The areas of over exploited groundwater resources correspondence with the areas of green revolution and concentrated in arid, semi-arid areas of western and peninsular India, particularly in Punjab, Haryana, Rajasthan, Maharashtra, Karnataka, Gujarat, Andhra Pradesh, and Tamil Nadu (Shaw, 1989). In north-western states average decline

of 12-16m in groundwater table has been recorded from 1980 to 2010. In the coastal areas of Gujarat, central Rajasthan, Madhya Pradesh, Uttar Pradesh, West Bengal, Karnataka and Tamil Nadu states also a decline of 4-8m in groundwater table has occurred during this time period. Due to depletion of groundwater 25 percent of India's harvest may be at risk in the coming years (Gleick 2000).

PD Chenoy stated that with increase in population and development level India's water needs are getting from bad to worse and the next big fight is clearly about water. Therefore, water availability is very important not only for consumption but also for agricultural activities and for ensuring food security in the country (Hindustan Times, 2011).

### **11. Quality**

Along with quantity, the quality of water is also important. In India, the declining water quality has become a serious issue as impure water has serious implications for health status of people. The water quality is mainly affected by changing land use pattern, climatic conditions and anthropogenic activities i.e. excessive use of fertilizers, disposal of domestic sewage and extent of exploitation of ground water resources.

In India, out of 639 districts in pockets of 158 the groundwater has gone saline and it contains excessive fluoride, nitrates and iron content in 237, 385 and 270 districts respectively (Times of India, 2012). In Andhra Pradesh, Tamil Nadu, Uttar Pradesh, Gujarat, and Rajasthan states 50-100% of the districts have excess level of fluoride content in drinking water sources and this consumption of high concentrations of fluoride lead to serious health issues. Western and North Western states particularly Rajasthan, Gujarat, Haryana, Punjab are facing the problem of salinity and the high concentrations of sodium ions contribute to certain heart disease and high blood pressure.

Therefore, the protection and enhancement of groundwater quality has become a high-priority environmental concern because of its direct impacts on health status of people (Alley, 1993).

### **12. Implications for food security**

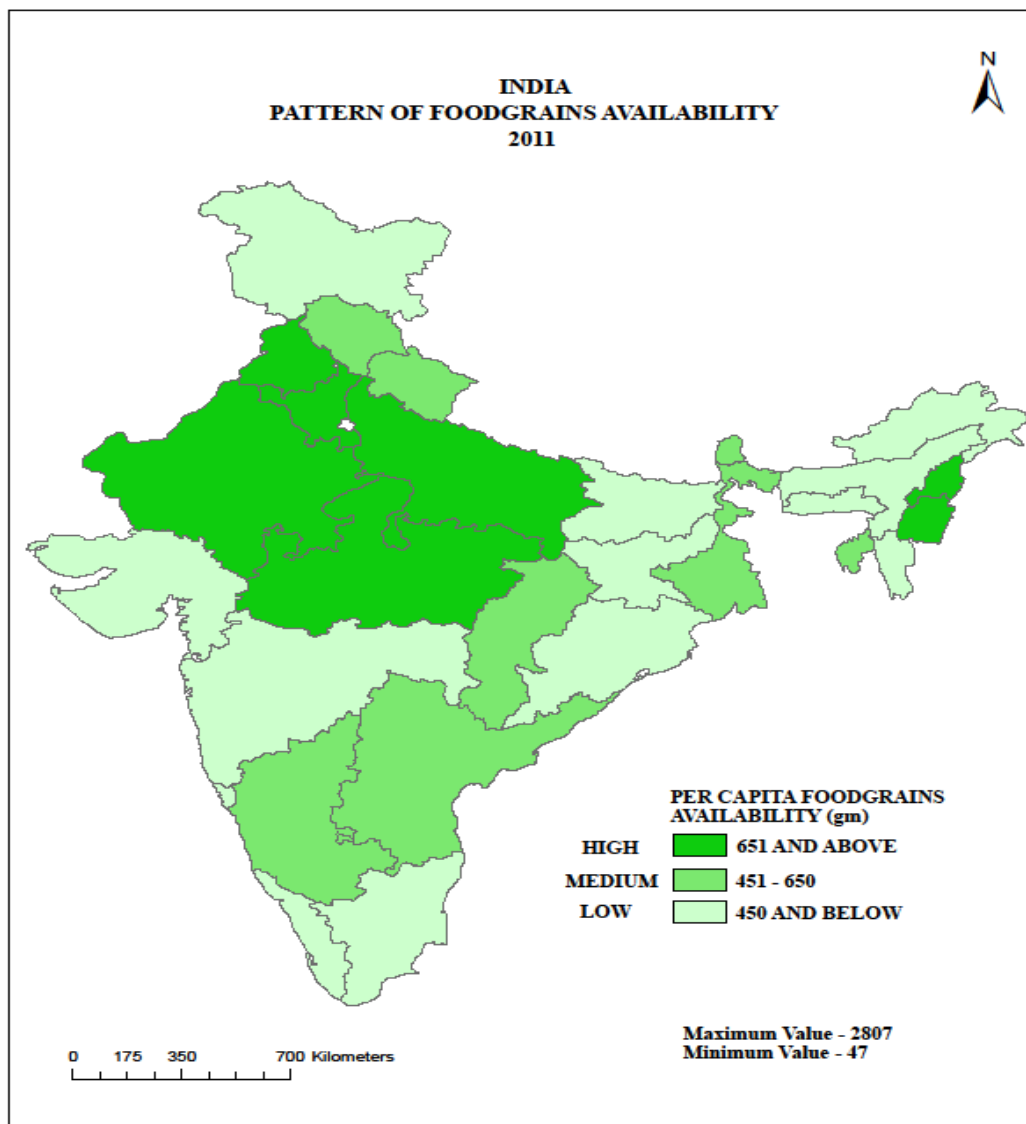
“Food security [is] a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO, 2001). This definition includes the three dimension of food security i.e. food availability, food accessibility and food utilization. The interactions and combinations of these dimensions represent the status of food security and change in any one dimension will lead towards change in status of food security. In any area, the status of food security is directly related to the population growth, environment conditions and natural resources. The growing population have both direct and indirect negative impacts on food security dimensions. In context of India, these are discussed as below:

### **13. Food availability**

Food availability is the major dimension and it remains the key concept of food security till 1980's when Amartya Sen (1982) raised the concept of food accessibility as an another dimension of food security. It refers to the availability of sufficient quantities of food of appropriate qualities, supplied for all people at all times through domestic production. Therefore, sustained growth in agricultural activities is very important for the food security in the country. On one side, growth in agricultural sector increases food availability/ food supplies and on the other side, it also improve the purchasing power of many people, who earn their livelihoods through agricultural production (USAID, 1999).

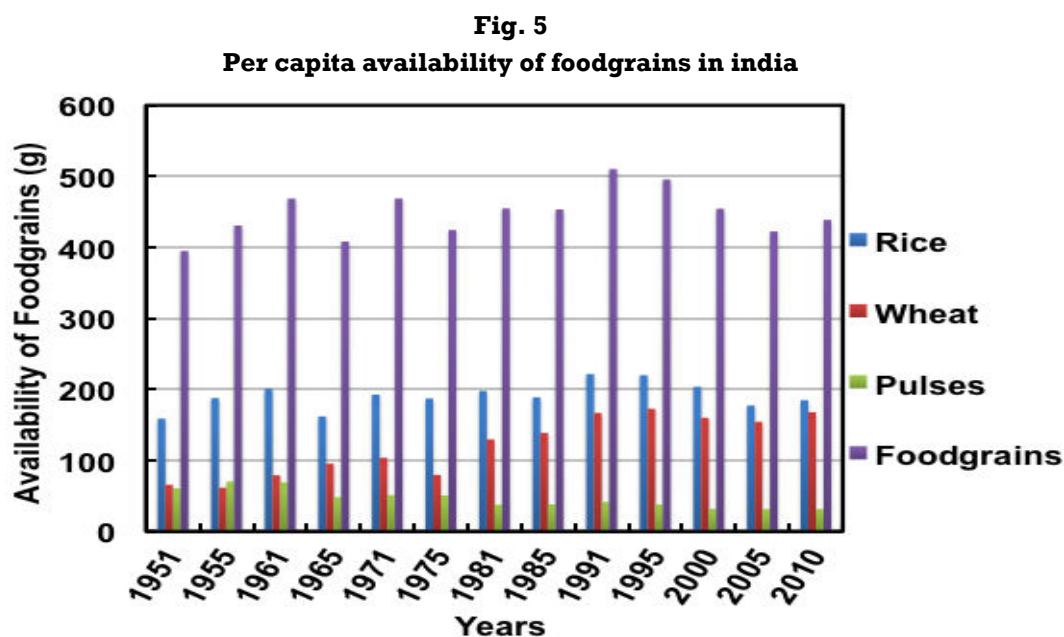


**Map. 1**  
**India: Patterns of foodgrains availability**  
**2011**



Source: Agricultural statistics at a glance, 2011

In India the total foodgrains production is 257.44 million tonnes in 2011-12 which was only 50.82 million tonnes in 1950-51. Only after green revolution the country has become self sufficient in foodgrains production with annual growth rate of 3.5 percent which is higher than population growth rate. But during 1990s the growth rate of foodgrains production could not maintain its pace and annual growth rate has fallen to 1.7 percent just equal to annual population growth rate. Due to problems as discussed in above section (the land degradation, soil salinity/alkalinity, decline in ground water level) total foodgrains production and per hectare yield of foodgrains has been declining and this leads towards decline in per capita availability (which is highly dependent on average size of land-holdings, percentage area under foodgrains and irrigation facilities) of foodgrains in India (Fig. 5).



Source: Agricultural statistics at a glance

The spatial pattern of foodgrains availability (Map. 1) depicts that the per capita availability of foodgrains is very high in Green Revolution states i.e. in Punjab, Haryana, Uttar Pradesh, Rajasthan, Madhya Pradesh and it is low in eastern and north-eastern states (except Nagaland and Manipur).

Results also reveal that the areas of high foodgrains availability are corresponding with areas facing more environmental degradation problems and due to which at present the growth rate of foodgrains production is almost stagnant in these areas. Therefore, if this scenario of population growth will be continue than the status of food security in the country will be under question.

#### 14. Food accessibility

It refers to economic access by individuals to adequate resources (entitlements) to acquire appropriate foods for a nutritious diet at all times. It depends on the purchasing power of people. FAO stated that the prevalence of widespread hunger is not due to the non-availability of food in the market but due to lack of adequate purchasing power among the rural and urban poor. Inadequate purchasing power, in turn, is due to insufficient opportunities for gainful employment. The famines of jobs and of purchasing power are becoming the primary causes for the famines of food in the households of the poor.

In India, approximate 69 percent population lives in rural areas and two - third of working population depends on agriculture for their livelihoods. As discussed in last section, increase in population size creates huge pressure on natural resources; this results into decline in per hectare arable land, forest land, size of land holdings and increase in problems of environmental degradation and resource depletion. Unemployment ratio has also increased which further results into lack of purchasing power of people. Due to increase in population size urban population has also grown-up and urban areas start expanding towards the periphery rural agricultural land. This results into transformation of agricultural land into non-agricultural uses and further leads towards increase in ratio of unemployed rural people. Most of agriculturally developed states in north India are facing this problem. This affects the livelihoods of people living in rural areas and makes them more vulnerable to food insecurity. Thus, agriculture is not only important for food availability but income level of rural people is also associated with it.

Therefore, in India, despite having marketable surpluses of food grains some areas are facing problem of food insecurity due to lack of economic access. As Increasing population results into increase in food consumption, decline in natural resources, environmental degradation which further effects the status of food security in the country.

### 15. Food utilization

It is related to utilization of food through adequate diet, clean water, sanitation, and health care, to reach a state of nutritional well-being for which all physiological needs are met. But due to huge population pressure access to basic services safe drinking water and sanitation is also limited. For poor countries with rapid population growth and depletion of groundwater, water-deficit induced food insecurity is a rising problem (Yang et al., 2003).

As discussed in earlier section, the per capita water availability is declining in the country and this situation is very critical in rural areas of Rajasthan, Uttar Pradesh, Bihar, Maharashtra, Madhya Pradesh and Chhattisgarh (MSSRF, 2003). This lack of water availability has also led towards poor sanitation facilities.

Along with water availability, the quality of water matters a lot for food utilization. Declining water quality have serious implications on health status of people. Worldwide, about 4 billion cases of disease are contracted from impure water and approximately 6 million deaths are caused by water-borne disease each year (Pimentel et al. 1996). Approximately 4 billion cases of diarrhoea each year cause 2.2 million deaths. These problems are very severe in developing countries where about 90 per cent of the diseases can be traced due to a lack of pure water (WHO and UNICEF, 2000). Water having high content of fluoride causes fluorosis disease which hits teeth and bones. Presence of nitrates in drinking water cause blue baby disease which hits infants and can lead to respiratory and digestive system problems. These situation are very worse in rural India where facilities to even detect chronic health problems arising out of water contamination do not exist.

### 16. Conclusion

As discussed above if India's population will continue with the same growth rate the availability of natural resources will decline to low levels and in this scenario it will be very difficult to maintain sustainable food security in the country. More people means less forest, water, soil, and other natural resources, but more waste, pollution, and greenhouse gases and this also leads toward climate change. It would not be exaggerated if stated that the major international wars in the future will mainly focus on natural resources (Kumar, 2003).

A study conducted by MS Swaminathan Foundation shows that the most agriculturally developed states are facing problems of environmental degradation and resource depletion in India and these states will have less food sustainability in future (MSSRF, 2004). Therefore, the growth of population should be checked and resource conservation techniques should be adopted for sustainable food security in the country. Region specific measures should be taken in this regard.

### 17. References

1. Alexandratos, A. and Jelle Bruinsma (2012), *World Agriculture Towards 2030/2050*, ESA Working Paper No. 12-03, Agricultural Development Economics Division of FAO.
2. Alley, W. M. (1993), *Regional Ground-Water Quality*, Van Nostrand Reinhold, New York.
3. Amartya Sen (1982), *Poverty and Famines: An Essay on Entitlement and Deprivation*, Oxford University Press.
4. Asian Development Bank (1997), *Emerging Asia, changes and challenges*, ADB, Manila, Philippines.

5. Buss, R. (2014), *United Nations Conference on the Human Environment (UNCHE)*, Stockholm, Sweden. Retrieved on 21<sup>st</sup> June, 2014 from [www.eoearth.org](http://www.eoearth.org).
6. *Census of India (2011), General Population Tables*, retrieved on 15<sup>th</sup> March, 2014 from [censusindia.gov.in](http://censusindia.gov.in).
7. *Central Ground Water Board (CGWB, 2012), Annual Report, Ministry of Water Resources, Government of India*.
8. *Central Water Commission, Water and Related Statistics, Water Resource Information System Directorate*, Retrieved on 10<sup>th</sup> July, 2014 from [www.cwc.nic.in](http://www.cwc.nic.in).
9. Dewaram, A. (2007), *Population growth and environmental degradation in India*, *Asia Pacific Journal on Environment and Development*, 14, 41–63.
10. *FAO (1991), Food Balance Sheets, Food and Agriculture Organization, Rome*.
11. *FAO (2001), The State of Food Insecurity in the World, Food and Agriculture Organisation, Rome*.
12. *FAO (2013), The State of Food Insecurity in the World, Food and Agriculture Organisation, Rome*.
13. Gleick, P.H. (2000), *The Changing Water Paradigm: A look at Twenty-First Century Water Resources Development*, *Water International*, 25 (1), 127–138.
14. *Govt. of India (2009), Background note for consultation meeting with Policy makers on review of National Water Policy, Ministry of Water Resources, New Delhi*.
15. Grebmer, V., D. Headey, L. Haddad, D. Wiesmann, H. Fritschel, S. Yin, C. Foley and B. Iseli, (2013) *Global Hunger Index: The Challenge of Hunger*, Bonn, Washington, DC, *International Food Policy Research Institute, and Concern Worldwide*.
16. *Hindustan Times (2011), India Facing Water Crisis*, Retrieved on 16<sup>th</sup> April, 2014 from [www.hindustantimes.com](http://www.hindustantimes.com)
17. J. Harte, (2007), *Human population as a dynamic factor in environmental degradation*, *Population Environment*, 28, 223–236.
18. Kumar, M.D. (2003), *Food security and sustainable agriculture in India: The water management challenge*, Working Paper 60, Colombo, *International Water Management Institute, Sri Lanka*.
19. Lakshmana, C.M. (2013), *Population, Development and Environment in India*, *Chinese Journal of Population Resources and Environment*, 11 (4), 367-374.
20. Mamanshetty, S.V. (2012), *Growth of population impact on environmental degradation: an over view of India*, *Elixir Agriculture*, 51, 2012, 10877-10880.
21. *MSSRF (2003), Food Insecurity Atlas of Rural India, M.S. Swaminathan Research Foundation and World Food Programme (WFP) , United Nations*.
22. *MSSRF (2004), Atlas of Sustainability of Food Security in India, M.S. Swaminathan Research Foundation and World Food Programme (WFP), United Nations*.
23. Pimentel, D., J. Houser, E. Preiss, O. White, H. Fang, L. Mesnick, T. Barsky, S. Tariche, J. Schreck, and S. Alpert (1996), *Water Resources: Agriculture, the Environment, and Society*, *Bio. Science*, 47 (2), 97-106.
24. Pimentel, D., X. Huang, A. Cardova, and M. Pimentel (1997), *Impact of Population Growth on Food Supplies and Environment*, *Population and Environment*, 19 (1), , 9-14.
25. Scherr, S.J. (1999), *Soil Degradation: A Threat to Developing- Country Food Security by 2020, Food, Agriculture and the Environment Discussion Paper 27, FPRI, Washington*.
26. Scott ,R., J. K. Huang, L.X. Zhang (1997), *Poverty, Population and Environmental Degradation in China*, *Elsevier Science*, 22 , 229–251.
27. Sharma, P.D. (2014), *Population growth and environmental degradation*, retrieved on 10<sup>th</sup> July, 2014 from <http://safeenvironment.wordpress.com>.
28. Shaw, R. (1989), *Rapid Population Growth and Environmental Degradation: Ultimate Versus Proximate Factors*, *Environment Conservation*, 16, 199–208.

29. Shaw, R. P. (1989), *Rapid Population Growth and Environmental Degradation: Ultimate Versus Proximate Factors*, *Environment Conservation*, 16, 199–208.
30. *Times of India* (2012), *Poison in India's groundwater posing national health crisis*, Retrieved on 8<sup>th</sup> July, 2014 from [timesofindia.indiatimes.com](http://timesofindia.indiatimes.com).
31. *Times of India* (2013), *Over 39% soil in Punjab completely degraded*, Retrieved on 15<sup>th</sup> July, 2014 from [timesofindia.indiatimes.com](http://timesofindia.indiatimes.com)
32. USAID (1999), *Food Security Indicators for the Use in the Monitoring and Evaluation of Food security Program*, United State Agency for International Development, Retrieved on 23<sup>rd</sup> September, 2013 from [www.fantaproject.org](http://www.fantaproject.org).
33. WHO and UNICEF (2000), *Global Water supply and sanitation assessment, Report*, World Health Organization and United Nations Children's Fund, Geneva: UN.
34. World Bank (2011), *Agricultural and Rural Development Database*, Retrieved on 24<sup>th</sup> March, 2014 from [data.worldbank.org](http://data.worldbank.org)
35. Yang, H., P. Reichert, K.C. Abbaspour and A.J. Zehnder (2003), *A Water Resources Threshold and Its Implications for Food Security*, *Environmental, Science & Technology*, 37, 3048–54.