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Population Growth and Sustainable Land Management in India

Bairagya Ramsundar
Department of Economics, SambhuNath College,
Labpur, Birbhum, West Bengal, India, Pin: 731303,
Fax No.: +913463-266255, Email:ramsundarbairagya@gmail.com

Abstract

Most of the developing countries including India face a dilemma problem of high population growth creating poverty, food crisis and land degradation at the same time the resources like land, water, nutrients and energy are limited in supply. These countries are primarily based upon agriculture and hence a sustainable long-term agricultural growth can only alleviate poverty. Most of the population is engaged in agriculture. Again land which is fixed in supply by nature is the primary input for agricultural production. The poor farmers want to maximize their income earned from this sector in the short-run. But the societal problem is to maintain long-term benefit and biodiversity in flora and fauna and maintain the quality, productivity and stability not only for the present but also for the future generations. Land degradation is a global issue of the 21st century and by the year 2050 it may create a serious threat to food production, adverse impact on agronomic productivity, the environmental pollution, food security and quality of life. Hence a proper planning and management of the available land resource is necessary to ensure maintenance of their production potential, quality and diversity. The health and wealth depends primarily upon the quality of land. Hence the limited scarce land resource must be used in a socially acceptable eco-friendly manner. The Sustainable Land Management (SLM) may solve the crucial problem.

Keywords: Food crisis, GHGs, degradation, green revolution, pollution, sustainable

1. Introduction

Professor W.A. Lewis writes: “The extent of a country’s resources is quite obviously a limit on the amount and type of development which it can undergo. Natural resources determine the course of development and constitute the challenge which may not be accepted by the human mind.” Natural resources include land, water, fisheries, minerals, forests etc. Some of these resources are non-renewable and exhaustible (like minerals) and some are renewable (like land). It should be mind that the total supply of land is fixed and is a free gift of nature i.e. its supply is perfectly in-elastic. Although a piece of land can be used for several purposes in several times the fertility of land must be deteriorated. But it is necessary to maintain the quality of land in the process of economic development. For an individual three basic essential things are required for his survival: food, clothing and shelter. In the primitive community when man lived in jungles he did not have clothing or even shelter (Bairagya R. and Sarkhel J. 2011). But he needed food to survive. Animals can live without clothing or shelter but also need food. Plants also need food. While plants can make their own food man and other animals have to produce or collect food. Thus for all living beings food is the most essential component of life. It is necessary for getting energy which man needs for doing different works. Even when a man is sleeping his major organs like heart or lungs remain active. These are functioning from birth to death at a stretch. To continue these activities energy is required which can be derived from food. For production of food agricultural land is a necessary input. Due to rapid growth of population food crisis arises. To increase agricultural production more cropped area is required. To do this more grazing, forest and wastelands are brought into cultivation and cropping pattern such as single crop to multiple crop use in a single agricultural year is required.

2. Sustainable Development

Sustainable development is a pattern of resource use that aims to meet human needs while preserving

the environment so that these needs can be met not only in the present, but also for future generations. The term was used by the Brundtland Commission which coined what has become the most often-quoted definition of sustainable development as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs". It is usually noted that this requires the reconciliation of environmental, social and economic demands - the "three pillars" of sustainability. This view has been expressed as an illustration using three overlapping ellipses indicating that the three pillars of sustainability are not mutually exclusive and can be mutually reinforcing. Sustainable development ties together concern for the carrying capacity of natural systems with the social challenges facing humanity. As early as the 1970s "sustainability" was employed to describe an economy in equilibrium with basic ecological support systems [Wikipedia]. A primary goal of sustainable development is to achieve a reasonable and equitable distributed level of economic well being that can be perpetuated continually for next generation. Thus the field of sustainable development can be broken into three constituent parts i.e. environmental, economic and social sustainability. It is proved that socio-economic sustainability is depended on environmental sustainability because the socio- economic aspects, like agriculture, transport, settlement, and other demographic factors are born and raised up in the environmental system. All the environmental set up is depended on a piece of land where it exists. Sustainable land management is necessary for the existence of human society.

3. Concept of Sustainable Land Management

Land degradation is a global challenge for sustainable development. The main problem of the world is the sustainability of natural land resources due to soil degradation, the availability of water and the loss of bio-diversity. About one third of the world's agricultural land has been damaged mostly by soil loss caused by water erosion. Natural resources can potentially be used in a sustainable way if appropriate land management technology, regional planning and the policy framework complement one another in a purposeful way, in accordance with the principles and concepts of sustainable land management (SLM) means the use of renewable land resources (i.e. soil, water, plants and animals) for production and services while protecting the long-term productive potential of these resources (Michael Stocking 2008). For the coexistence with nature so that the productive, physiological, cultural and ecological functions of natural resources are maintained for the benefits of the society. Our challenge is to harmonize the complementary but often conflicting goals production and environmental protection. UNCED estimated that 5to7 million hectares of productive land is degraded every year and affecting more than 2.6 billion people in the world. According to H. Hurni (1997) SLM has been defined as "a system of technologies and/or planning that aims to integrate ecological with socio-economic and political principles in the management of land for agriculture and other purposes to achieve intra-and intergenerational equity." SLM thus composed of three development components technology, policy and land use planning. Management is simply defined as an activity on the ground, using appropriate technologies in the respective land use systems. A sustainable technology has the following 5 pillars: ecologically protective, socially acceptable, economically productive and viable and reduce risk. According to Dumanski J. (1997) the objective of sustainable land management is to harmonize the complementary goals of providing environmental, economic and social opportunities for the benefit of present and future generations, while maintaining and enhancing the quality of the land resource. Land provides an environment for agricultural production, but it is also an essential condition for improved environmental management i.e. source for GHGs, recycling nutrients, ameliorating and filtering pollutants, transmitting and purifying water. The SLM can be shown as: Sustainable soil management- Sustainable agriculture- Sustainable land management- Sustainable resource management- Sustainable development. Expanding human population and economic activities are placing ever-increasing pressure on finite life supporting resource land.

The SLM Module defined many functions of land resources are to produce food, fodder, fuel, construction material, industrial goods, etc to ensure human health by minimizing toxic substances in water, soils and plants, or hazards such as landslides, flash floods, etc. to preserve creation and the integrity of the landscape: the role(s) of water, land, forests and animals as an essential part of the cultural heritage, and to maintain the historical and aesthetic value of the landscape, to ensure maintenance of ecosystem functions and global life support functions, including source/sink capacity for GHGs, filtering of water and pollutants, and maintenance of global geochemical (nutrient) cycles, etc. SLM can be approached by looking for

symptoms of unsustainability, such as soil degradation, water quality decline, loss of biodiversity, increased incidents of plant diseases, etc. Such symptoms are a result of inappropriate land management and exploitation of resources, the causes of which are often societal and political rather than technical or agronomic. SLM can also be approached through analyzing the options to manage the land sustainably.

4. Population growth in India

According to 2011 Census, India's population increases 181 million people from 1.03 billion in 2001 to 1.21 billion in 2011(Visaria L. 2011). The decadal growth rate of population is 17.6% compared to 21.2% during 1991-2001 suggesting a slowdown of growth. The sex ratio of population has began to improve from 927 in 1991to 933 in 2001to 940 in 2011. The overall literacy rate is in 2001 is 745 with 82.1% male and 65.55 female literacy rate. The child sex ratio has fallen from 945 in 2001 to 927 in 2001 to 914in 2011. At the end of October 2011, the world population crossed over 700 crores, China 135 crores and India 124 crores. Though India possesses only 2.4% of world geographical area it covers 17.71 % of total world population. It is expected that India will become the most populous country in the world by 2030 overtaking China. India's population size is expected to stabilize at 1.8 billion at 2041.The state Uttar Pradesh is the most populous state in India with 199.6 million people covering 16.5% of country's population. This high growth of population is main retarding factor of environmental degradation.

4.1 *Land Resources in India*

According to Central Statistical Organization (2002) the total geographical area is 306 million hectares (Datt and Sundharam 2010). Out of this 42 million hectares (i.e.14%) is barren land such as mountains, deserts, lands occupied by buildings, roads and railways, rivers, canals and others which cannot be brought under cultivation. 69 million hectares of land (i.e. 23%) area is under forests includes all land whether state-owned or private and whether wooded or maintained as potential forest land. Pastures, meadows and village common grazing land occupied 11 million hectares (i.e. 4%) only. The cultivable waste land means land available for cultivation but not cultivated during the last 5 or more years and these lands may either be fallow or covered with shrubs and jungles which are not put to any use. This area covered for 18 million hectares (i.e. 6%). Fallow lands are cultivable but remain uncultivated during some period of time due to unremunerative nature of farming, poverty of the cultivators, inadequate supply of water, silting of canals and rivers etc. This land accounts for 25 million hectares (i.e. 85). Now the total agricultural land is 193 hectares (i.e. 66%), out of which 140 hectares is net area which is used once in a year and 53 hectares are cultivated more than once in an agricultural year.

5. Population Growth and Land Degradation

5.1 *Malthusian Theory*

Rapid growth of population over the world is the main cause of food crisis. According to Malthus population increase at G.P. rate (e.g. 2,4,6,8,10,……..) while the supply of food increase at A.P. rate (e.g. 2,4,8,16,32,……) i.e. population grow at a higher rate than he food supply and create food scarcity. This shortage of food gives rise to famines, epidemics, food riots etc. Due to these calamities a part of population is eliminated and a natural balance between population and food supply is established only in the short-run because again population begins to grow at a faster rate than food supply and the economy again moves to food crisis. In this way food crisis arises in an economy at a regular interval. Malthusian theory is based on the agrarian economy. Since the supply of land cannot be increased beyond a certain limit intensive cultivation would have to be adopted for increasing the volume of production. Intensive cultivation means application of more labor and capital on a fixed amount of land which follows the law of diminishing return with no technological progress. By introducing new improved technology it is possible to postpone the operation of the law of diminishing return. By means of this introduction of new innovative techniques in agricultural production the western countries of the world are able to escape from this. Even if the Malthusian theory has been discarded, the shadow of Malthus is still haunting us. Moreover by means of intensive cultivation using new techniques and chemical fertilizers the fertility of land is deteriorated day by day. The SLM is the main objective here to feed the rapidly rising population at the same time maintains the bio-diversity of the environment. A balanced land management can achieve both economic and environmental Sustainability.

5.2 *Water Scarcity*

Scarcity of water is a global problem today (Bairagya R. and Chakraborty K. 2011). For agricultural production huge amount of water is required. In most of the developing countries, population is primarily engaged in agriculture which is the primary source of income to maintain their livelihood. Again agricultural production is the gambling of rainfall. To raise agricultural productivity various dams have been made in an unplanned way which have adversely affected to the commons and the environment. To control flood and supply irrigation water the construction of big dams have rarely helped. In villages for irrigation many tube-wells and submersibles have been installed in an unplanned way (it should not be bored less than 1000 feet) which use the ground- water in a massive scale and consume a huge amount of electricity. As population raises the scarcity of food grains rises. Food scarcity is highly positively-correlated with water scarcity. According to Lester Brown, "Water shortage may soon become food shortage". Rice, wheat and sugar-cane together constitute 90% of total water consuming crops. From the economic point of view, return of water in industrial sector is many times more attractive than in agriculture. Approximately 1000 tons of water is required to produce only one ton of wheat. This monetary return is much lower than if this water is invested in industrial sector. In this case the non-food grains like fruits, vegetables and animal products for daily food intake should be raised as substitutes to rice and wheat. To meet the heavy demand for food the pressure on land must be increased.

5.3 *Environment pollution*

Environmental pollution is indirectly responsible for land degradation. In the last few decades several measures have been adopted for increasing agricultural production which has adverse effects on natural environment. Fertility of land has been reduced due to over exploitation, excessive use of chemical fertilizers, insecticides and pesticides. Due to indiscriminate deforestation the amount of rainfall reduces and land erosion takes place. Natural calamities like droughts, floods, cyclones, global warming, melting glaciers, raising sea level etc. are increasing and environment is degraded. As a result the production of food grains decreased and made food crisis at a global level. Naturally a question arises: Is environmental degradation not acceptable for meeting the food crisis and maintaining food security? In answer to this question it can be said that additional food grains can be produced in the short-run by degrading the environment but this food security will not be sustainable. This is so because food security for the present generation can be maintained by the degradation of the environment but then food security for the future generation cannot be maintained. For permanent cure SLM is necessary here.

5.4 *Industrialization*

As population rises Production use of land (which is fixed in supply by nature) for non-agricultural purposes increases due to rapid urbanization in building roads, houses, factories etc even the fertile land is used for non-agricultural purposes. Norman Borlaug rightly told, "When people fail to recognize farmers' role in feeding the country, be sure there is something terribly wrong happening." Most of the developing countries believe that industrialization is the only key indicator for economic development and increase in national income. Hence even if they have comparative advantage in agriculture they are bent on industrialization at any cost. Even fertile agricultural lands are being used for setting up industries. Not only had that to make buildings and factories huge amount of bricks required. To produce this volume of land soil is definitely decreased and land is degraded.

5.5 *Soil Erosion and deforestation*

Direct impacts of agricultural development on the environment arise from farming activities, which contribute to soil erosion, land salination and loss of nutrients (Ray S. and Ray I. 2011). The main causes of soil errosion are runways of waterbodies, floods, deforrestations etc. Due to rapid growth of population a huge amount of wood, wooden furnitures, for making new buildings many forest areas are vanished beyond limit. The forest areas has dual roles to maintain environmental balance by directly reducing air pollution on the one hand and check for soil errosion on the other. But the tragedy is that this common property bis misused by many ways Thus for SLM new plantation and afforestation must be required.

5.6 *Global warming*

The main cause of global warming is the increase in GHGs in the atmosphere. Due to increase in temperature the amount of ice in the glaciers has drastically fallen raising the sea level and some countries will be immersed under water and on the other hand the rivers, lakes and springs which are filled up by melting ice supplying water throughout the year will be dried up during summer and finally create water scarcity for irrigation and drinking purposes. It is expected that some countries in the world will immersed into water due rise in sea level and finally decrease the available land for utilization purposes. Thus pollution control may be an alternative way to SLM.

5.7 *Use of fertilizers and pesticides*

To solve food crisis a major change in Indian agriculture occurred in the form of Green Revolution using Chemical fertilizers to agricultural land to increase land productivity. The excessive use of pesticides, fertilizers and HYV is an important factor for land degradation particularly salination, alkalization and finally the quality of land must be deteriorated. It is evident that Indian economy is based primarily on agriculture. But most of the land in the country is degrading and affecting the productive land resource of the economy. Besides the loss of nutrients from top soil, there is also degradation through the creation of gullies and ravines, which make the land unsuitable for agricultural production. This is the major evil effects of Green Revolution. SLM is one of the iportant few options for land users to generate income without destroying the quality of the land on the production process.

5.8 *Poverty*

Rapid growth of population is the main cause of poverty and unemployment. As they have no alternative occupations the unemployed people are forced to engage in agriculture and create disguished unemplyment whose marginal productivity tends to zero. Most of India's poor live in rural areas and are engaged in agriculture. The rapid population growth and poverty are found to coexist and thus seems to reinforcing each other in a cyclical manner. The poor people, who rely on natural resources more than the rich, deplete natural resources faster as they have no real prospects of gaining access to other types of resources. Poorer people, who cannot meet their subsistence needs through purchase, are forced to use common property resources such as forests for food and fuel, pastures for fodder, and ponds and rivers for water (Ray S. and Ray I. 2011). Moreover degraded environment can accelerate the process of impoverishment, again because the poor depend directly on natural assets. It also contributes to environmental degradation through over exploitation of natural land resource.

5.9 *Energy crisis*

Crisis of energy is a global problem today. As the price of oil rises bio-fuel is used as an alternative source of fossil fuel. Bio-fuel is produced from agricultural produce like oil seeds, food grains. Apart from this food products are also used for extracting ethanol. The US utilized 20% of its corn in the year 2007 to 32% by the year 2016 to produce ethanol. As the price of crude oil raised the US has set a target for producing 25 billion gallons of bio-fuel in the next 10 years and Europe has set a target of 5.75% of its diesel needs extracting from plants 2011. The China is extracting ethanol not only from corn but even from rice and wheat. These tendencies of the developed countries are the main responsible for food crisis. This change in agricultural pattern from food production to commercial crop production has a negative effect on land degradation. Because to earn more profit more fertile land are used for commercial purposes using modern techniques of production and chemical fertilizers which deteriorated the quality of land, reduced forest area and cultivable land for food production and finally the quality of land must be lost.

6. Policy Implication

To simplify the whole analysis we first consider the following static equation-

$L_t = L_{1t} + L_{2t} - \mu L_t$

Where L_t = total supply of land in period t

L_{1t} = land available for agricultural production (food crops + commercial crops)

L_{2t} = land used for other than agriculture

μ = the fraction of land degraded per year, $\mu < 1$

As population increases more land should be brought under cultivation for the production of food to feed the people and to avoid mal-nutrition, hunger, poverty i.e. food crisis. By means of intensive cultivation, using innovative techniques and using chemical fertilizers and pesticides food production can be raised up to a certain limit. After this the law of diminishing returns to scale on a fixed supply of land operates and also the land lost its quality. We know that the mineral oil is the main source of energy supply. But this is an exhaustible resource and after a long period this resource will not be available. Due to this scarcity the oil price is rising day by day. As an alternative source of energy some lands are used for commercial purposes to produce bio-fuels. As L_t is fixed in supply, if we want to produce more food we must have to surrender other crop. But we want to need both and hence there is a policy dilemma.

Now we consider about L_{2t} which is used mainly for industry, urbanization, roads, buildings, meadows, pastures and grazing lands. Again as population raises the demand for manufacturing products increases and many industries are established even in a fertile land. Due to rapid urbanization land is used for making buildings, roads, educational institutions, hospitals, perks etc. Deforestation is made in a massive scale and the common pasture and grazing lands are in the dilemma of the tragedy of commons and finally the quality of land must be deteriorated.

The final parameter μ is also increasing by means of environmental pollution, emission of GHGs, global warming, climate change, melting glaciers, rising sea level, soil erosion, water-runoff, floods, silting, deforestation, use of chemical fertilizers and pesticides etc. The ultimate result is that land is degraded day by day due to environmental pollution and its control is not in the hands of the commons and the total supply of land is decreasing. But our objective is to minimize it. For example, to avert the tragedy of the common village grazing land should use in a co-operative manner of the co-user.

When we consider sustainability of land use time t is very important. By sustainable land use we mean land use not only for the present but also for the future generations. So for dynamic sustainability we must take into account not only in period t but also in period t+1.

As a social point of view a cost must be counted that land user who is degrading the land. To neutralize the degrading factors of land the value of land may be calculated as: NVL = VL –EC, where NVL =Net Value of Land, VL =Value of Land and EC = Environmental Degradation Cost. But unfortunately, the NVL is decreasing both in quality and quantity due to the mismanagement of land and failure of both stakeholders and government policies.

All these problems are not independent to each other rather they are complementary in nature. So we must control all these factors simultaneously. All the stakeholders must be aware about this fact. Each government of the world should take policy united to solve these problems by means of SLM.

7. Conclusion

From the very beginning of the society land was not a problem at all. But due to the course of time as population grow rapidly all ill hazards like environmet pollution, global warming, food crisis, povety, unemployment, mal-nutrition, deforestation, water scarcity, soil erossion, use of chemical fertilizers and pesticides etc are focus into the picture. Al these facors more or less directly affect the pressure upon land and μ is increasing. All these problems cannot be solved unless the growth of population is checked. The modern society faced the dilemma problem of population growth and for sustainable land use. Land resource is not properly incorporated in national income accounting. When land is degraded natural resource accounting should take place to protect this common property resource. The only way out is the SLM through which the fixed supply of land can be used in different alternatives in a sustainable eco-friendly manner. This would involve improved land use policies, application of environmentally feasible and viable technologies, desertification and proper management of natural resources both at the stakeholders and government level. If we cannot make SLM successfully the human society will not exist so long.

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