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Sustainable agriculture in Ganga Basin

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The watercourse Ganga, coming out from the Himalayas through five states and stream drain into the Bay of Bengal through Sundarbans delta that pass through of more than 2500 km in the northern and eastern plains of India, possesses economic, social and cultural values and as one of the holiest rivers whose cultural and spiritual virtue rise above the boundaries of the basin. The mainstream of Ganga extends from Nepal, India and Bangladesh which accounts for 26 % of the land, 30% of water and 43 % of the population of India (Fig. 1).

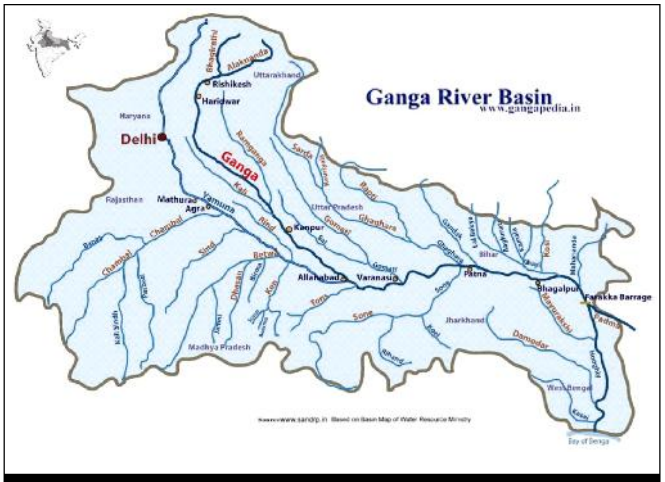

Fig. 1 : Map of Ganga river basin

The environment of the Ganga basin is influenced by both nature and human activities which have been changing and evolving by the time. Despite having its own cultural and spiritual sustenance, the abruptly increase in population and industrialization cause high pollution trends in the Ganga which hampered enormous to the biodiversity as well as the environment of the Ganga with the injurious effects on both quality and quantity of flow. The major cause of pollution in river Ganga are point source e.g., untreated sewage and industrial effluent discharge, and non-point source e.g., sacred activities besides the river, agriculture intensification together with poor solid waste management.

Since last decades, the poor and inadequate infrastructure accompany with weak governance and environmental expertise to supervise the pollution problem in Ganga, has resulted in deterioration of water's quality. Pollutant concentration in river Ganga has been increasing over decades due to rapid urbanization, industrialization and increase in population. Abstraction of water for drinking purposes, irrigation, industrial etc. leading to inadequate flows which are synthesizing the problem. There is a wide gap between the quantity of sewage being discharged into the river and the accessible treatment potential. The Ganga course passes through several towns and cities which generate a large amount of sewage per day and only a fraction of that sewage is treated before discharge into the river. According to The National Ganga River Basin Project (World Bank, 2015), domestic sewage accounts for 70-80 % and industrial effluents add 15 % of wastewater into the Ganga. The ecological stability in the Ganga River has been severely affected, with major indicator species like fishes and dolphins having disappeared since past decades. Demands for water from booming cities, energy and industrial sectors, and agriculture are also reducing the water quantity in the river which results in the increasing concentration of effluents in the water that harm the environment and threaten human health.

Current status of pollution in Ganga : According to the Ganga rejuvenation 15th report (2016-17), the Ganga sink onto the plains, only to be loosed off water by huge diversions through the Upper Ganga at Haridwar, which reduces its discharge to mere 15 billion cubic meters per year. That leaves so little water in the Ganga that the dry-season discharge at Kanpur is merely 90 to 386 cubic meter per second, at Allahabad 279 to 997 cubic meter per second, and at Varanasi 278 to 1160 cubic meter per second. Despite being joined by a number of tributaries, the Ganga is steadily polluted due to heavy discharges at the rate of 3000 million liters per day from towns and cities, despite sewage treatment plants varying from 13.5% in small cities to 27.8 to 50.4% in big cities – 329 million kilolitres. Nearly 50 per cent of untreated wastewaters are discharged into Gangetic Plain. A very large amount of solid waste are daily discharged into ganga as well as liquid waste from agriculture likewise runoff from 9000 ton pesticides and 6 million ton fertilizers and

sewage quantity more than 1.3 billion litre with 260 million litres of industrial waste released into the Ganga stream (Fig. 2 and 3). By these facts of pollution, the Ganga water can no longer be described as life-giving and Holy River. According to WWF International Switzerland, the Ganga has been declared as one of the ten most polluted rivers in the world. Intervention by modern agricultural practices.

Modern agricultural system have been extensive root of soil deterioration and fertility loss, water pollution and depletion of the natural resource. Though the agricultural based cultivable land is a limited specify constraint in Ganga basin, the agricultural growth approximately increased four times in 40 years since the 1960s by adopting high-yield varieties (HYV) crops which necessarily require high fertilizer and water inputs. Soil erosion and degradation have been accelerated by the extensive use of pesticides and fertilizers and high water inputs, blindly tillage of soil, and mono-cropping, depleted nutrients and biodiversity of soil, and polluted its ecosystems.

The main agricultural practices to adopt in Ganga basin: (i) Conservation Agriculture (no-tillage or zero tillage, crop diversification, and permanent organic soil cover by mulching) adaptation to increase soil fertility and agricultural productivity in long-term, (ii) Adoption of Organic Farming, (iii) Improved water and nutrient management techniques, (iv) Major use of soil testing for balanced nutrients and soil amendments management.

Generally, the physical or natural resources of a river basin are soil and water, on other hand a collection of minerals and compounds bent in it way. Water as nature wise, is a mobile resource. Deviation from time to time, generally the water in any river basin follows through precipitation and from groundwater inflows and through river and groundwater outflows, evaporation-transpiration, and *vice-versa*. Soil is formed by the process of weathering of naturally parent rocks, for decomposition and transformation that may take thousands of years. Therefore, the soil and water both are influenced by each other through many biotic and abiotic operation.

One of the objectives of National River Ganga Basin Management is Sustainable Agriculture, to ensure both natural and human resources is of prime importance and the agriculture practice remains environmentally sustainable, *i.e.* the productivity increases sufficiently and surviving without degrading the physical resources of the river Ganga . Agricultural productivity mainly depends on quality and availability of physical resources *i.e.*, water and soil. Agricultural growth can be sustained by conservation and sustainable use of constrained natural resources over location-specific processes.

Agriculture remains usually rainfed, covering about 60 per cent of the net sown area and accounts for 40 per cent of the total food production in India. Thus, conservation of natural resources in association with the development of agriculture holds the basic need to meet demand for food in the country.

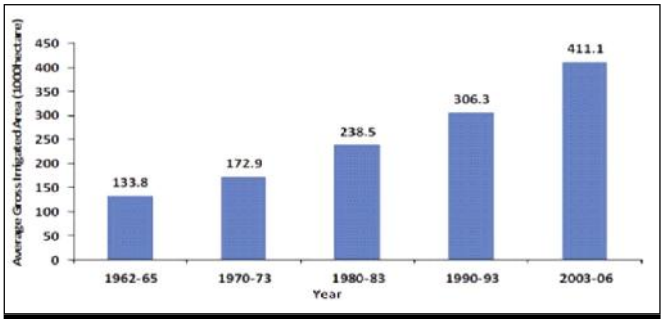

Fig. 2 : Average irrigated area in Ganga basin (IITC, 2011)

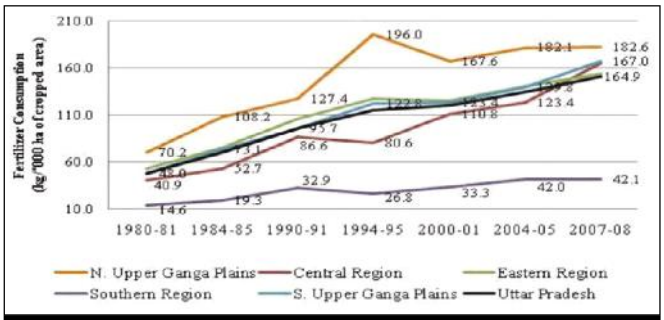

Fig. 3 : Fertilizer consumption in Ganga basin per hectare (IITC, 2014)

Why is Sustainable Agriculture Important for Ganga River Basin Management?: India is among such most intensive farming regions within the world. India accounts for only about 2.4 per cent of the world's geographical area and 4 percent of the world's water resources, but support about 17 per cent of world's human population (MOA, MoWR, 2008). Sustainable agriculture incorporate environmental growth, economic benefit and social integrity (IITC, 2014). The land and water, constraints of agriculture have speeded up the deterioration of lands, with eroded soil and nutrients flowing into the river Ganga and actively affecting the water and other ecological systems. The modern agricultural has negative effect on soils in many ways, with accelerating soil erosion and degradation of land in many parts of the world. Globally, the soil erosion rate from traditional agricultural lands is estimated to average 1.54 mm/year whereas the soil formation rate is only about 0.075 mm/year (Parikh, 2011). In India, a large

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