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Reform Imperatives for Agricultural Sustainability in Ganga Basin

GRBMP: Ganga River Basin Management Plan

by

Indian Institutes of Technology

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1. Preamble

Agriculture is the main source of livelihood of a majority of rural population in the Ganga River Basin. As per the National Sample Survey (NSS) 68th Round (2011-12), 62.37% of total workforce in Bihar, 52.41% in Uttar Pradesh, 48.96% in Uttarakhand and 39.23% in West Bengal directly depend on agriculture. The Ganga river, being a perennial source of water, facilitates both surface and groundwater irrigation in the basin. Since, the scope of bringing more area under cultivation is limited due to rising land demand for non-agricultural uses, such as, urbanization and industrialization, future requirement of agricultural commodities, including food, may be met by intensive use of land, water and other resources which would have some implications in terms of degradation of soil and water resources. Green revolution technology, though has made significant contribution to transform agriculture from the food-deficit economy to food-surplus one and substantially raised farm production, productivity and income, it has no longer remained 'green' and its environmental and ecological consequences have now become quite obvious. The high input-intensive farm practices followed by farmers in the basin have caused depletion in the groundwater table, increase in input cost, deterioration in the quality of soil and water and increased credit requirement and consequently rising indebtedness among farmers. Therefore, basic issue for the GRBMP is how to achieve ever-green and sustainable agricultural development without adversely affecting soil, water, ecology and environment. Keeping these aspects in view, there is strong need to introduce changes in the existing agricultural practices and encourage farmers to adopt sustainable agricultural practices. The proposed sustainable agriculture mission, synergized with other missions, intends to reduce the water resource consumption and pollution and improve rural livelihood by way of promoting sustainable agricultural practices in the basin.

2. Objectives of the Mission

- Develop farming systems that widen livelihood opportunities; conserve soil, water, and other natural resources; protect environment, ecology and biodiversity; reduce farmers' dependence on external inputs; ensure food security; and improve human health and safety.
- Enhance water-use efficiency and reduce non-point sources of water pollution.

3. Emerging Issues

The adverse effects of on-going agricultural practices in the basin on soil fertility and quality of water have already been considerably documented in the literature. For instance, excessive use of chemical fertilizers and pesticides was found to have polluted both surface and groundwater and became the major non-point source of pollution of river water resources, thus adversely affecting the aquatic lives and livelihood of people directly depending upon the river resources. Further, the intensive use of fertilizers, pesticides, and weedicides not only caused degradation of natural resources but also adversely affected human and animal health. Exponential growth of tube-wells in the basin has caused serious depletion in the ground water

table and consequently the quality of water[1]. Groundwater irrigation is preferred on the grounds of equity, efficiency, productivity and private investment. But due to the government policies related to agricultural credit, subsidy, inputs, and energy and absence of effective regulation, its sustainability has become one of the major concerns in the basin. Availability of subsidized electricity and flat rate system of power encouraged farmers to over-exploit the groundwater, as the marginal cost of drawing water from electrified tube-wells is almost zero.

As per the Working Group Report on "Natural Resource Management" (Government of India, 2007a), cost of soil degradation in India during 1980s and 1990s ranged from 11 to 26 percent of gross domestic product (GDP). The land has become addicted to high doses of chemical fertilizers. Absence of the network of reliable advice and soil-testing facilities has also contributed to the indiscriminate, overdose and unsafe use of chemicals. Use of farm yard manure and green manure has declined due to various reasons, such as decline in draught animals and change in the cropping pattern from legume crops to rice, wheat, sugarcane and other commercial crops[2]. The key issues are how to reduce water consumption and water pollution in agriculture and protect livelihood of small and marginal farmers who constitute more than 90% of total farmers in the basin. Can alternative agricultural practices (such as organic farming) generate more income and employment opportunities in agriculture on sustainable basis and improve river health and consequently health of human, animals, and plants in the basin? What kinds of institutional, technological, market and financial support related interventions are required for sustainable agriculture? Can organic farming ensure food security and sustain farmers' livelihood? What are the key factors that would determine the shift of farmers towards sustainable agriculture? What are the demand and supply side constraints to the promotion of organic farming? How to estimate positive externality of organic farming in terms of environment and health and compensate farmers accordingly? What types of changes are needed in the supply chain management for organic products? How to remove the knowledge-deficit in agriculture? And, of course, what could be the action plan to accomplish the desired results? These are some of the important issues that need to be addressed through the mission interventions. The proposed sustainable agriculture mission should address the following issues:

3.1. Reduction in Water Consumption and Increase in Water Use Efficiency in Agriculture

Water is the most precious resource which has competing uses in agriculture, domestic sector, industry and ecological services. Traditionally, agriculture is main consumer of water (more than 80% of total water consumption). How to reduce water consumption per unit of output produced and improve the water use efficiency in agriculture is the key policy concern. Saving in irrigation water implies saving of energy and reduction in the environmental pollution. Due to fast growth of tube-wells, groundwater has become the major source of irrigation. For

[1] See IIT Consortium's GRBMP reports on agriculture for more details.

[2] For example, three crops—sugarcane, wheat and paddy together constituted 68.8% of GCA, and 83% of GIA in Uttar Pradesh in 2007-08.

example, groundwater constituted 80% of total gross area irrigated (GIA) in the Middle Ganga Basin in 2007-08. Figure 1 also highlights that the share of canal irrigation in the total GIA has significantly declined over the period, while share of tube-wells/wells has tremendously increased. Number of pump-sets per 1000 ha of gross cropped area (GCA) in the basin has risen from mere 30 in 1980-81 to 125 by 2007-08 and this fourfold increase has serious medium- and long-term implications for sustainability of groundwater[3].

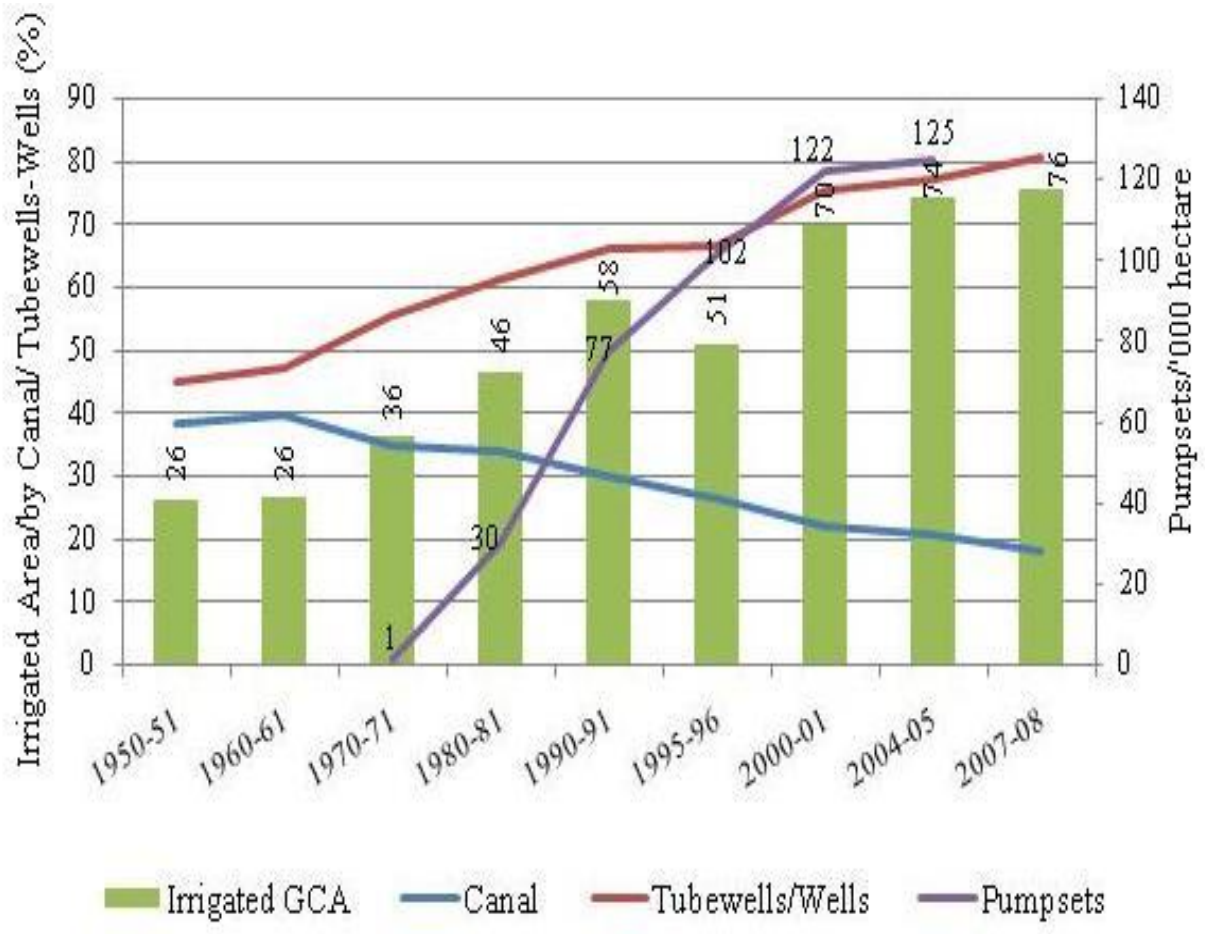

Figure 1: Trends in Gross Irrigated Area by Sources of Irrigation and Number of Pump Sets in Operation in Uttar Pradesh

As is evident from Figure 2, since 1950-51 till 2007-08, cropping pattern has shifted towards water intensive crops viz. paddy, sugarcane and wheat which jointly shared 83 percent of GIA, implying that vast quantity of water could be saved through diversification of cropping pattern towards less water intensive crops.

[3] Data given for the Middle Ganga Basin is only for the purpose of illustration. For more details, state-wise reports on agriculture may be consulted.

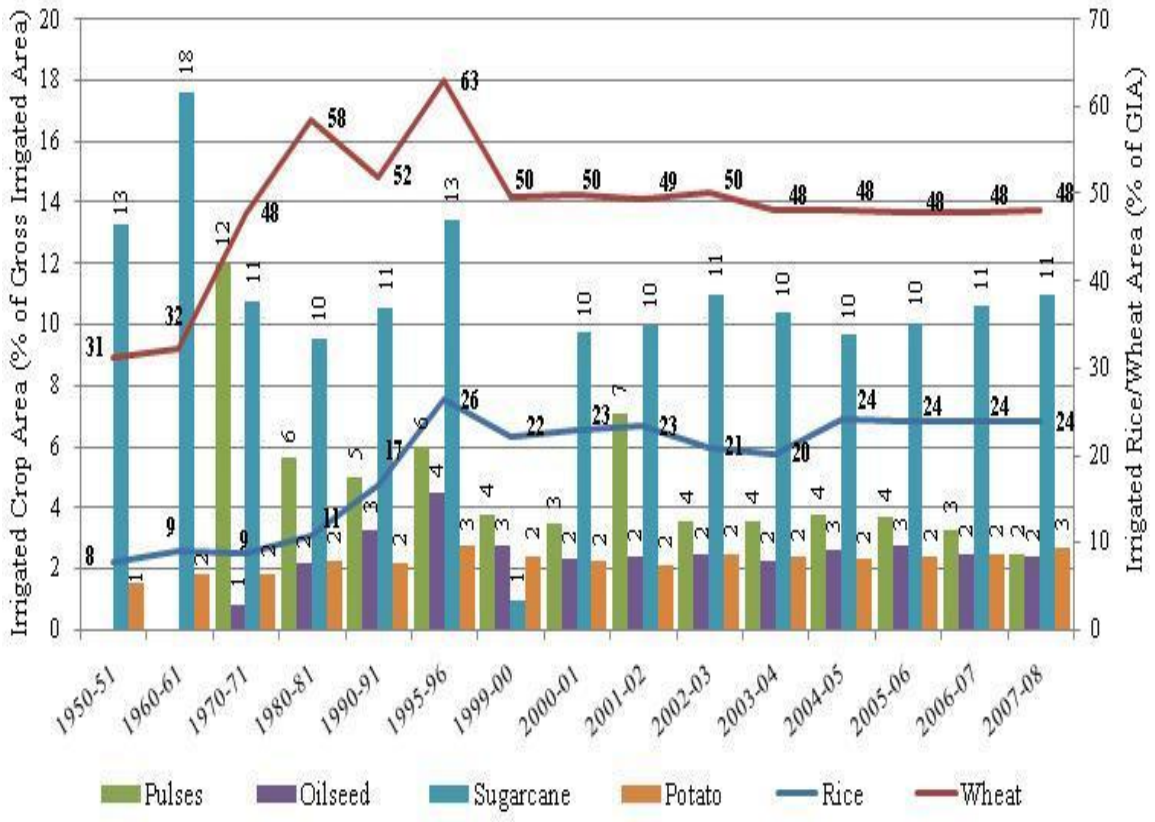

Figure 2: Percentage Share of major crops in the total GIA in Uttar Pradesh

3. 2. Chemicalization of Agriculture and Non-point Source of Water Pollution

Green revolution which essentially rode on the package of chemical fertilizers, high yielding variety seeds, pesticides and weedicides, along with the improved irrigation facilities, has transformed agriculture to the extent that India moved away from a food deficient to food surplus country. However, as indicated earlier, it has also led to the overuse of the ground and surface water, along with avoidable gross wastage of energy through the installation of an ever increasing number of power inefficient agricultural pump-sets[4]. The increasing doses of chemical fertilizers and other inputs have also become non-point sources of water pollution. Consumption of chemical fertilizer has increased over time. Figure 3 displays trends in chemical fertilizer consumption in the Middle Ganga Basin wherefrom it is evident that there has been tremendous increase in its use during the post-green revolution period with Nitrogen constituting more than 75% of the total fertilizer use.

[4] See GRBMP reports on agriculture for more details.

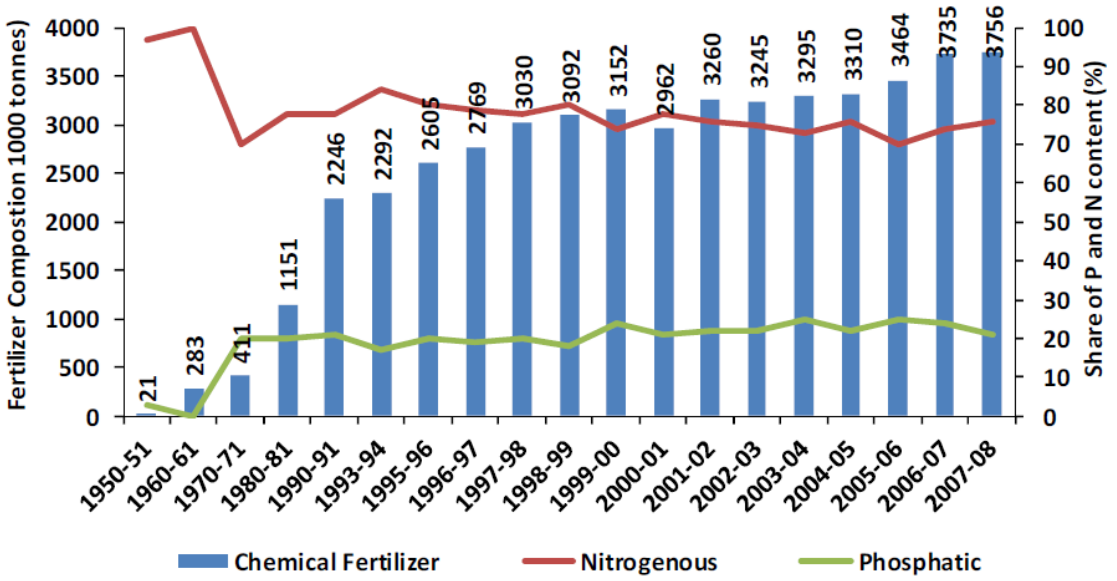

Figure 3: Trends in Chemical Fertilizer Consumption in the Middle Ganga Basin (Uttar Pradesh)

Within the Middle Ganga Basin, the North Upper Ganga Plains region has demonstrated highest intensity of fertilizer consumption, followed by South Upper Ganga Plains and the Eastern Region (Figure 4). This implies that chemicalization of agriculture varies significantly across regions of the Gang Basin.

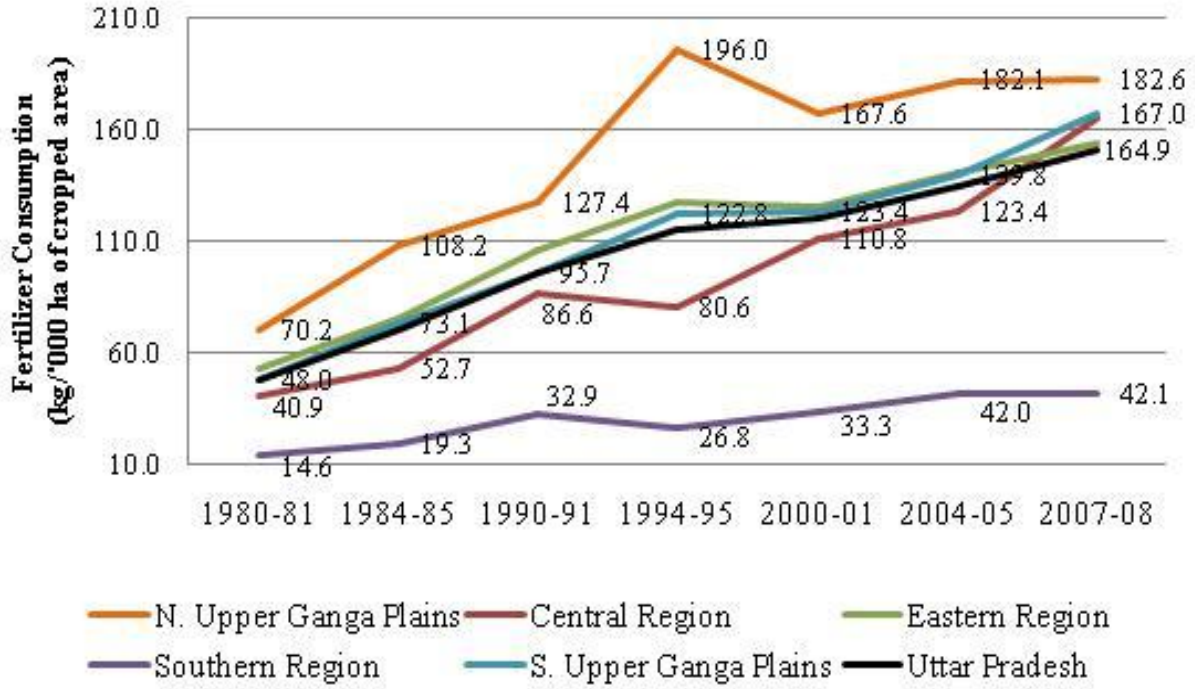

Figure 4: Region-wise Trends in per hectare use of Chemical Fertilizer

Three important crops of the Middle Ganga Basin, namely wheat, paddy and sugarcane consume more than 75% of total chemical fertilizer used in agriculture in the basin. Pesticide use in agriculture varies across years recorded highest at 362 g/ha in 1994 and lowest at 163 g/ha in 1983.

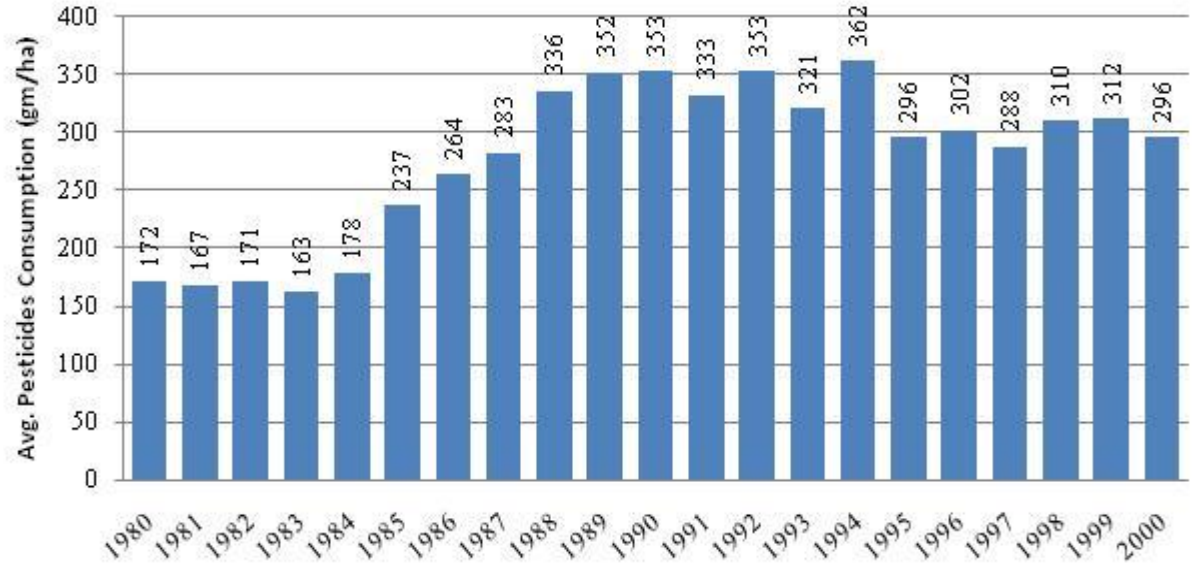

Figure 5: Trends in Consumption of Pesticides in Uttar Pradesh

Increasing use of chemicals for raising production and productivity has not only started backfiring in terms of increasing salinity and degradation of land, it may further necessitate more use of chemicals in order to maintain production and productivity of the land. This may seriously jeopardize health and safety of human beings and other living creatures directly or indirectly dependent on agriculture and may further vitiate quality of the ground and surface water as a consequence of run-off. Indiscriminate use of these chemical nutrients has adverse effects on the physical, biological and chemical properties of the soil and water resources (Greenpeace, 2011).

3.3. Slow Pace of Diversification

Slow pace of crop diversification is a critical issue as far as sustainability of agriculture is concerned. For instance, area under wheat, paddy and sugarcane has significantly increased, jointly accounting about 69% of GCA. Wheat alone constitutes about 37% of the GCA (Figure 6). There is need to diversify the agriculture in favour of other remunerative and water saving crops as the rice-wheat system of farming prevalent in the basin would not be economically and environmentally sustainable for a longer period. Further given the low possibility of horizontal expansion of area under cultivation, the most plausible options to augment farm income and employment are diversification of agriculture and intensive use of scarce land and

water resources. Towards this end, price signals and market conditions could be influenced through some interventions viz., agricultural price policy.

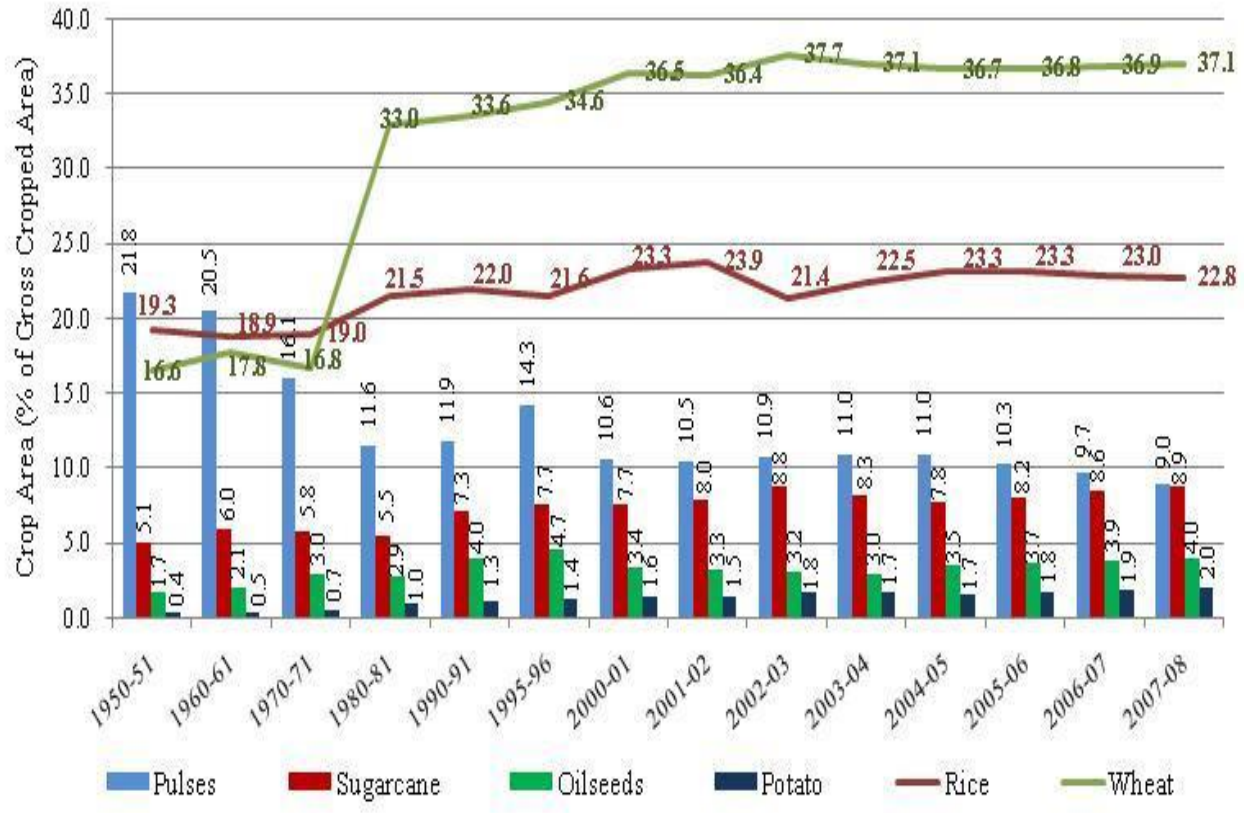

Figure 6: Trends in Area Under Major Crops in Uttar Pradesh

Horticulture and livestock are two emerging sectors within agriculture which have enormous potential for raising farm income and employment, especially for small and marginal farmers. Vegetable cultivation and livestock rearing may be suitable activities for marginal landholders as they have relatively higher availability of family labour per unit of land.

3.4. Marginalization of Agricultural Holdings

Marginalization of agricultural holdings is one of the key concerns for sustaining the livelihood of farmers. Table 1 shows that number of small and marginal holdings (below two hectares) has increased from 42.23 thousand in 2005-06 to 44.92 thousand in 2010-11, thus recording a net increase of 6.37 percent. Highest increase in number of small and marginal holdings is observed in Bihar (11.16%), followed by Uttar Pradesh (4.64%) and West Bengal (2.28%). In 2010-11, about 96.92% of operational holdings in Bihar, 95.93% in West Bengal, 92.46% in Uttar Pradesh

and 90.80% in Uttarakhand were small and marginal. Making agriculture as a profitable activity for these 94.47% small and marginal farmers of the Ganga River Basin is also one of the key challenges.

Table 1: Number and Area of Operational Holdings in the Ganga River Basin

States	Size	2010-11		2005-06		% Variation	
		Number ('000)	Area ('000 ha)	Number ('000)	Area ('000 ha)	Number	Area
Bihar	All Sizes	16191	6388	14657	6251	10.47	2.19
	Small & Marginal	15692 (96.92)	4855 (76.00)	14117 (96.32)	4537 (72.58)	11.16	7.00
UP	All Sizes	23325	17622	22458	17906	3.86	-1.59
	Small & Marginal	21567 (92.46)	11414 (64.77)	20610 (91.77)	11313 (63.18)	4.64	0.89
UK	All Sizes	913	816	922	847	-0.97	-3.70
	Small & Marginal	829 (90.80)	521 (63.85)	821 (89.04)	486 (57.38)	0.97	7.20
WB	All Sizes	7123	5510	6992	5526	1.88	-0.29
	Small & Marginal	6833 (95.93)	4448 (80.73)	6681 (95.55)	4394 (79.52)	2.28	1.23
Basin	All Sizes	47552	30336	45029	30530	5.60	-0.63
	Small & Marginal	44921 (94.47)	21238 (70.00)	42229 (93.78)	20730 (67.90)	6.37	2.45

Note: Figures in parentheses are percentages to the total operation holdings and operated areas.
Source: Agricultural Census 2010-11, Ministry of Agriculture, Government of India

For economic growth to be at all inclusive and sustainable, livelihood needs of small and marginal farmers are required to be met. While some of them may exit farming due to non-viability, a majority of them would remain in agriculture and the objective of inclusiveness requires that their concerns are properly addressed (GOI, 2012). Although, most of the new farm technologies are scale-neutral and can be used by any category of farmers, but these technologies are not resource-neutral and therefore, their access to the marginal and small farmers is extremely limited.

3. 5. Knowledge-Deficit in Agriculture

One of the major problems is the knowledge-deficit in agriculture. As per the NSS survey, about 60 percent farmers did not have access to any source of information for advanced agricultural technologies. Due to lack of education, skills, and timely availability of resources, technology transferred to farmers' fields fails to provide the desired yield (GOI, 2005). Educated young farmers are better able to respond to new technology, market opportunities, and risks, while uneducated ones usually copy their agricultural practices with a time lag that too with their

own modifications which make replication a redundant exercise. Foster and Rosenzweig (1995) observe that technical change in agriculture is likely to have a greater effect on profits in an educated population than an uneducated one; and policies resulting in greater technical change are complementary to those increasing investment in schooling. Farmers requires not only the skills to grow cost-effective products but also the strategic skills that help them to select the farming system that gives the highest possible returns while maintaining sustainability of soil and water and also skills to deal effectively with agri-business companies, input dealers and extension workers.

4. Mission Interventions

Sustainability has three intertwined dimensions: ecological, economic and social. National Mission for Sustainable Agriculture (GOI, 2010) emphasizes that sustainable agricultural practices have to balance environmental health and economic profitability in order to promote social and economic equity. While there is no denying the fact that agricultural growth must rise to feed the increasing population, the former brings in numerous challenges towards environmental sustainability including the sustainability of surface and ground water. Any unsustainable agricultural practice may create serious harm to surface and ground water, both in terms of quantity and quality. It is, thus, pertinent to carry out agricultural practices that would be sustainable through time. Therefore, the mission should focus on optimization of water use in agriculture, reduction in soil and water degradation, improve the livelihood of farmers, and ensure food security. In this respect a set of policy related interventions are recommended which are discussed in the paragraphs that follow.

4.1. Promotion of Organic Farming

Promotion of organic farming is desirable for maintaining soil fertility, preventing groundwater degradation and depletion through reduction in water requirement of crops, protecting human health, and finally diminishing non-point sources of water pollution. Organic farming is more labour and knowledge intensive; depends more on locally available resources; has potential to improve rural livelihood, reduces distress migration; and facilitates involvement of Self Help Groups (SHGs) in preparing bio-fertilizer and bio-pesticides and develop local markets for these products. This also reduces input costs, making agriculture far more profitable in the long run. The documented literature and established practices have shown that the period of convergence of conventional farming to organic farming is about three years. During this period, per hectare yield remains lower than what is achieved under chemically accelerated farming. Low yields and no premium prices during transition period, lack of technical knowhow, inadequate access to genuine organic inputs, and operational difficulties in its adoption are some of the major constraints blocking its effective use towards sustainable agriculture practices. A Greenpeace study in 2011 reveals that out of 1000 farmers surveyed, 98% may use organic fertilizers if they are subsidized and made easily available.

The policy framework to support organic farming is very important to push its spread. In order to encourage farmers to adopt this alternative system of farming, their net income should be

insured at least for three years either through subsidized inputs or through direct transfer of subsidies. This transfer could be much lower than the environmental and health costs that the society bears due to existing practice of chemicalization of agriculture and consequent pollution of water systems. Organic farming could be a viable option if the government supports farmers by protecting their farm income, developing marketing infrastructure, putting in place functional institutions of certification, quality check, branding, and training of farmers.

The following policy supports are required to promote organic farming:

- Building strong marketing networks linking farms, processing and distribution and the organization of production with the support of local non-governmental organizations (NGOs) with stringent certification programmes.

- Training and capacity building infrastructure at the block level should be created to enhance knowledge and skills of farmers through effective training programmes related to organic farming, composting techniques, bio-pesticides and bio-fertilizer, value addition techniques, group-forming and organizational skills.

- Animal dung is the main source of cooking energy in rural households. In order to save animal dung for preparing manure for organic farming, rural households should be provided subsidized LPG connections for meeting out their cooking energy needs.

- Encourage social entrepreneurship in bio-gas energy production. There is immense potential for bio-energy generation from cattle dung. It would not only help to solve the rural energy problem but also provide compost for organic farming. Technological upgradation is required so that bio-gas be filled in cylinders and supplied to households as cooking fuel. To make the bio–energy–organic input production a commercially viable and sustainable stand-alone initiative, the new policy may encourage rural youth, primary organic producers, community based organizations (CBOs), civil society organizations (CSOs), private/ corporate sector to develop bio-energy producer companies, suitable mechanisms may be developed to support incorporation, handholding and technology backstopping to nurture these budding institutions.

- Assured markets for organic products through contract farming, risk coverage through insurance, consumers' awareness on organic products, identification of markets for organic products, development of infrastructure facilities for post-harvest management, processing and marketing, financial support, and certification are required for promotion of organic agriculture.

- Professional diploma/degree courses in organic agriculture should be introduced to produce qualified specialists in the area.

- Special Organic Zones (SOZ) should be set up in the areas and crops which have natural advantages for organic farming, such as hill areas of Uttarakhand and Bundelkhand Region of Uttar Pradesh, where chemical fertilizer use is quite low.

- Educated rural youths should be supported for establishing agri-clinics and agri-business centres for organic farming. At least one-third of total agricultural subsidy should be earmarked for promotion of organic farming.

4. 2. Water Use Efficiency

Agriculture is the largest consumer of water. Water-use efficiency is quite low ranging between 30 to 40%. Since water is becoming a scarce input and its demand is ever increasing for both agriculture and non-agricultural purposes, its efficient management and utilization becomes quite essential. Sincere efforts are required to improve water use efficiency through various interventions, including improvement in technologies, agronomic practices and cropping pattern.
It has been assessed that even a 10 per cent increase in the present level of water-use efficiency in irrigation projects may help to provide life-saving irrigation to crops in large areas. Water-use efficiency can be enhanced by generating synergy with seed varieties, nutrients and farm implements (Government of India, 2007b).

4.2.1 Technological Interventions

The following technological interventions should be made to improve water-use efficiency in agriculture.

4.2.1.1 Promotion of Laser Leveling

Use of laser-land-leveling technology is estimated to curtail irrigation application losses up to 30 to 40 per cent. Other major benefits of using this technology may be stated as follows.

- Reduction in the cost of production because of near optimum use of inputs such as fertilizers, irrigation, seed, pesticides etc., and minimization of labour required for irrigation.
- Increase in crop yield approximately by 20 per cent (observation based upon interaction with farmers using this technology), leading to better farm returns.
- Control of water-logging and salinity,
- Uniform germination of seeds also facilitate other agricultural practices such as hoeing, weeding, spraying and harvesting because in such cases crop plants are of equal heights.
- Minimization of pre and post-harvest losses as crop is likely to mature uniformly.

4.2.1.2 Adoption of Zero Tillage Technology

Zero tillage technology is most suitable for paddy-wheat cropping system. Its use would not only reduce cost of cultivation but also save irrigation water. It has shown tremendous potential in the Indo-Gangetic Plans of India for improving soil quality and sustaining its fertility. Punjab and Haryana are using this technology but it is not widely used in the Ganga Basin, mainly due to high cost of machine and small size of holdings. Market for custom hiring of this technology should be developed with government intervention. Use of this technology can save 20-35% water, 6-9 tractor hours and 5-8 man days per hectare in wheat crop.

4.2.1.3 Micro Irrigation Systems

Available estimates indicate that water use efficiency under flood irrigation is only about 35 to 40 percent because of high distribution losses. Micro irrigation system can substantially increase water use efficiency. Government of India launched a centrally sponsored scheme (CSS) on micro-irrigation during the financial year 2005-06. This was up-scaled as National Mission on Micro Irrigation (NMMI) in 2010. Evidence shows that up to 40-80 per cent of water can be saved and water use efficiency can be enhanced up to 100 per cent in a properly designed and managed MI system (Palanisami, *et al*. 2011). However, the rate of adoption of MI has been slow as compared to the potential of the technology. The system is being adopted mostly in water-scarce states such as Rajasthan (723,810 ha), Maharashtra (697,020 ha), Andhra Pradesh (564,020 ha), Karnataka (405,950 ha), Haryana (525,500 ha) and Gujarat (305,950 ha). Its coverage in the Ganga Basin is quite low. Among the Ganga Basin states, West Bengal has the highest area (150,180 ha) covered under the scheme, followed by Uttar Pradesh (21,260 ha) while Bihar has a very small start (370 ha)[5]. Under the provisions of NMMI, government provides 50% subsidy to set up micro irrigation system (40% by the centre and 10% by the state). In case of small and marginal farmers, additional assistance of 10% of total cost of MI system is provided by the Centre (Government of India, 2010b). The scheme covers sugarcane, banana, coconut and maize in Bihar; vegetables, mango and sugarcane in Uttar Pradesh; orchard crops, potato and groundnut in Uttarakhand; and banana, maize and mango in West Bengal. The area is mostly under sprinkler irrigation system. Since sprinkler and drip irrigation systems are very costly, it cannot be adopted for all the crops in all areas. It can initially be applied to horticultural crops such as fruits and vegetables. Cost of MI systems may be reduced through tax rebates on raw materials and excise duties. Subsidized credit may also be provided to groups of small and marginal farmers who want to do group farming.

4.3 Development of Custom Hiring Market for Farm Equipment

Productivity of farms depends considerably on the use of farm power derived from efficient farm implements and their judicious utilization. Mechanisation of various farming operations

[5] For more details, see (Palanisami, et al. 2011).

increases production and productivity of land, reduces drudgery associated with farm operations and helps in reducing socio-economic disparity among farmers. Contract farming companies should also provide latest farm equipment and machines to contracted farmers at nominal rent so that small and marginal farmers may adopt contract farming in high value crops.

4.4 Reforms in the Agricultural Practices

Organic farming is the most preferred farm practice for achieving sustainable agriculture in the Gang River Basin. However, due to various constraints, it cannot be adopted by all the farmers of the basin at least in short and medium term. Therefore, in addition to promoting organic farming as a strategy for sustainable agriculture, reforms in other existing agricultural practices are also required.

4.4.1 Integrated Nutrient Management

In conventional farming system, attention should be given to balanced use of nutrients. Correcting the distortion in relative prices of chemical fertilizers could help correct the imbalances in the use of primary plant nutrients-nitrogen, phosphorus, and potash and use of bio-fertilizers. Generally, NPK consumption ratio of 4:2:1 is considered desirable based on recommendation of 120:60:30 NPK kg/ha dose (4:2:1) for wheat/rice crop. This ratio is rarely maintained by farmers. During 2011-12, this ratio for Uttar Pradesh, Uttarakhand, Bihar and West Bengal was 18.4: 6.2: 1, 12.0:3.1:1, 8.4:2.6:1, and 2.7:1.5:1 respectively. This indicates that except for West Bengal, in all other states of the basin, NPK consumption ratio was inappropriate[6]. Farmers used more quantity of urea (nitrogen) than other nutrients. Government of India implemented the Nutrient Based Subsidy (NBS) scheme on P and K fertilizers with effect from April 1, 2010. However, urea has not been yet covered under the NBS scheme. Excessive use of chemical fertilizer, especially urea, has made the soil more hungry for fertilizers and thirsty for water. Fertilizer use has to be crop responsive and efficient to increase production while rationalizing input costs and minimizing environmental degradation. Soil testing should be made mandatory for each farmer and based on the testing reports doses of different nutrients in each crop should be recommended.

4.4.2. Changes in Cropping Pattern

As mentioned earlier, the possibility of horizontal expansion of area under cultivation is quite low. Most promising options to augment farm income and employment are diversification of agriculture and intensive use of scarce land and water resources. Currently a big chunk of land in the Middle Ganga Basin is used for cultivation of wheat, paddy and sugarcane which are

[6] For more details, see official website of Department of Agriculture and Coorperation, Ministry of Agriculture, Government of India. http://agricoop.nic.in/documentreport.html

more water and chemical fertilizer intensive.[7] There is need to diversify the agriculture from these crops to other remunerative and water saving crops. Rice-wheat system of farming being adopted in the basin would not be economically and environmentally sustainable for a longer period. Price signals and market conditions are main determinants of diversification which can be influenced through appropriate agricultural price policy.

Horticulture and livestock are two emerging sectors within agriculture which have enormous potential for raising the farm income and employment, especially for small and marginal farmers. Vegetable cultivation and livestock rearing may be desirable activities for marginal landholders as they have relatively more availability of family labour per unit of land. There is a need to converge the scheme of National Horticulture Mission (NHM) with the activities of Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS). Annual action plans and labour budget prepared for the MGNREGS can be prepared by integrating the schemes of district line departments, such as agriculture, irrigation, forest, horticulture, etc. so that livelihood component be effectively integrated in the plan with other components such as development, environment, water and soil conservation, regeneration of natural capital, etc.

Apart from horticulture and agro-forestry, dairy, poultry and fishing are other alternative livelihood options within the agriculture and allied sector that could be included as components in the overall basin management plan. There is need to construct a network of ponds, even on the private land. These ponds, if planed properly, would help not only in development of fisheries but also serve the purpose of storing rainwater and recharging groundwater. Recently, the Government of India extended the scope of MGNREGS works to the small and marginal farmers land. This provides an ample opportunity to plan and execute works related to horticulture, minor irrigation, land development, construction of ponds, etc. on the private land too.

Transportation of agricultural commodities from the remote hill regions of Upper Ganga Basin to the market places is another major problem. It is therefore, necessary to diversify hill agriculture from traditional crops to high value and low volume products, such as herbal and medicinal plants, aromatic plants, mushroom, spices, soybean and pulses, off-season vegetables and fruits. Primary processing of some of the above mentioned products can be done in the village itself and secondary and tertiary processing may be done in the industrial clusters. This would not only help in reducing the volume but also make value addition to the growers. SHGs could be formed and trained to do the primary processing. Diversification towards these high value and labour intensive commodities can provide fair income and employment to the farmers dependent on small size of farms. Contract farming may be promoted as an institutional arrangement to realize economies of scale, promote technology adoption, and supply of needed quality inputs.

[7] See IIT Consortium's GRBMP reports on agriculture for more details.

4.5. Removal of Knowledge-deficit and Building Human Capital Base

Sustainable agriculture, including organic farming, is more knowledge and technology based and removal of knowledge-deficit and building human capital base is a must for its promotion. Training and capacity building infrastructure at block level should be created to enhance the knowledge and skills of farmers through effective training programmes related to organic farming, composting techniques, bio-pesticides and bio-fertilizer, value addition techniques, group-farming and organizational skills. Training programmes should be organized on a regular basis for adopting modern technologies more effectively. Irrigation literacy of farmers should be improved through electronic and print media to optimize water use in agriculture.

Literate and educated rural youth would be the critical mass to be quickly brought on board to accelerate the pace of policy implementation, generate meaningful livelihood and employment opportunities, developing a cadre of independent trained and professional service providers to the millions of organic producers.

Sustainable agriculture requires continuing investments in human resource development, agricultural R&D, improved information and extension, market, roads and related infrastructure development and efficient small-scale, farmer-controlled irrigation technologies, and custom hiring services.

4.6 Protection of Livelihood of Small and Marginal Farmers

Integrated farming having combination of crops, horticulture, livestock, fisheries, is becoming important. Farm profitability and viability of small and marginal farmers are crucial for achieving inclusive growth. A farm activity may be profitable to a farmer but it may not necessarily be economically viable. For example, a small size of holding may generate profit but amount of profit may not be adequate enough to meet household consumption and investment needs. For economic viability of agriculture, a farm household should generate a total net income that is sufficient to meet its consumption as well as investment needs on sustainable basis. The ongoing price policy driven agricultural growth in India may not be sustainable if it is not properly integrated with technological breakthrough in agriculture to raise productivity per unit of land, labour, water and other resources. The following interventions may be made to improve livelihood of small and marginal farmers.

- Group farming should be promoted among small and marginal farmers for achieving economies of scale.
- Small farmers' cooperatives would, therefore, be encouraged and supported to take up activities such as processing, value addition and marketing of agro products.
- Develop custom hiring market for farm machinery.
- Reform in land lease market.

- Subsidies on modern technology and inputs.
- Training & Capacity building of group members.
- Promotion of contract farming for small holders.

4.7 Other Interventions

- Enhancement in water use efficiency by de-incentivizing the use of flood irrigation.
- Improvement in the efficiencies of existing irrigation water delivery systems by upgrading field channels and regular maintenance.
- System of Rice Intensification (SRI) method should be promoted to increase productivity, save water, reduce production costs and increase farm income.
- Introduce new water rate structures that encourage efficient use of water.
- Tax rebates on efficient irrigation equipment to achieve broader social or environmental benefits.

5. Policy Consideration

The following policies and incentives are needed to be implemented for water-saving technologies and sustainable farm practices.

1. A water credit system should be instituted to encourage farmers to make efficient use of irrigation water and save water for river ecosystem services. The credit may be given to individual farmers or the entire village community. Water saving can be estimated through various ways, such as, shift in cropping pattern from high water to low water intensive crops, recharge of groundwater table and net decline in canal water use. As water management and irrigation is the subject of Panchayati Raj Institutions at the village level, participation of Gram Panchayat and Gram Sabha should be ensured in distribution of credits to individual farmers. Some percent of total credits distributed to a village should be given to Gram Panchayat as an incentive and to generate financial resources of the Gram Panchayat.

2. Soil health index should be prepared and farmers maintaining proper soil health should be provided ‘soil health bonus’.

3. There is need to develop appropriate decision support systems and agriculture advisory services for farmers so that they may get timely advice on various aspects related to sustainable farm practices.

4. So far there is no clarity on who owns the ground water. It is, therefore, necessary to institute secure water rights to users and develop water market and water pricing so that water-saving technologies may be encouraged.

5. The mission should examine various issues, regulatory concerns, water laws and legislations, R&D development and technology dissemination, social mobilization and participatory and community involvement. Cultivation of water intensive cash crops, such as sugarcane should be regulated in overexploited zones. R&D should focus on developing new seeds that require less water per unit of output produced.

6. Both environment and livelihood issues should be kept in view while providing subsidies on agricultural inputs. Environmental considerations should be in-built in the subsidy structure to make efficient use of inputs, including land and water. Subsidies should be rationalized and redirected towards organic and sustainable agriculture initiatives.

7. The minimum support price (MSP) programme may be used as a policy instrument to achieve diversification of agriculture towards high value and low water consuming crops. There is also need to estimate the social cost of chemicalised farming and internalize its negative externalities.

8. While restrictions on the number of private tube-wells in the river basin may improve groundwater table, there is also need to revive and renovate traditional water bodies in the basin area. Efforts are required to be made to create a network of ponds, even on the private land. These ponds, if planed properly, would help not only in the development of fisheries but also serve the purpose of storing rainwater and recharging groundwater. Recently, the Government of India extended the scope of MGNREGS works to the small and marginal farmers land. This provides an ample opportunity to plan and execute works related to horticulture, minor irrigation, land development, construction of ponds, etc. on the private land also.

9. The electricity tariff system in agriculture should be shifted from flat-tariff to meter-tariff, initially in the over-exploited blocks. However, farmers should be appropriately supported for procurement of modern water saving technology, such as, sprinkler and drip irrigation in these blocks (Singh, 2008).

10. Responsibility of billing and collecting water charges may be handed over to Gram Panchayat (GP). For this, GP should have some share in the revenue collection. This would not only be one of the sources of income generation of these local bodies but it would also reduce transaction cost and corruption in billing. The problem of tampering with meter, bribing of linemen and over-billing can largely be solved with their active participation and installation of tamper-resistant electronic meters.

11. In addition, constant monitoring of groundwater tables in the river basin districts is necessary for evaluating its status from time to time. In order to utilize the groundwater resources for agricultural use and other development activities in the Ganga River Basin on a sustainable basis, it is necessary to ensure that extraction of groundwater is less than or equal to the rate of recharge. This will ensure that the groundwater resources are not overexploited.

12. Encouraging better crop planning measures will be a key determinant in regulating water usage. These measures could include regulations on the time of sowing of crops as has been done in Punjab and Haryana through a legislative measure viz., 'Preservation of Sub-soil Water Bill, 2009' which restricts paddy plantation before June 15, and 10 June respectively. About 20% water used in paddy can be saved through these regulations.

13. Information database, comprising data on rainfall, groundwater recharge and utilization, water demand for different purposes, land use pattern, cropping intensity and cropping pattern, customary water rights, irrigation system and practices, etc. should be maintained at the block level and updated annually. It should be linked with national level database through MIS in the same manner as is being done in case of MGNREGS.

6. Summary of Key Actionable Points

- Institutionalization of water credit system in agriculture.
- Effective participation of Gram Panchayats in irrigation water management; rationalization of water pricing and equitable access of water to all categories of farmers.
- Micro-irrigation (sprinkler and drip), being very costly systems, may initially be applied to horticultural crops in the Ganga River Basin.
- Develop custom-hiring market in costly agricultural machines (such as laser land leveler and zero tillage technology) to ensure better access to farmers, especially small and marginal ones.
- Promote organic farming through budgetary support and involvement of contract farming companies.
- In order to encourage farmers to adopt organic farming, insure their net income during the transition period (at least for three years) either though input subsidy or direct cash transfer.
- Set up Special Organic Zones (SOZ) in the areas and crops which have natural advantages for organic farming, such as hill areas of Uttarakhand.
- Rationalize agricultural subsidies and transfer, at least, one-third of subsidies from chemical fertilizers to bio-fertilizers and organic nutrients.

- Reorient agriculture R&D, extension and training system towards development and transfer of technology suited to the sustainable agriculture practices.

- Encourage corporate sector to use a part of its CSR funds towards training, skill formation and capacity building of farmers so that they may adopt water efficient, cost-effective and sustainable farming system.

- Promote group farming among small and marginal farmers for achieving economies of scale in production and marketing. The group may also be encouraged to take up activities, such as, preparing of organic manure, vermi-compost, bio-fertilizers and pesticides.

- Diversify agriculture towards high value and less water intensive crops and livestock through policy support, influencing price signals and market conditions, and contractual arrangements, as rice-wheat-sugarcane system of farming being adopted in the basin would not be economically and environmentally ecologically and economically sustainable for a longer period.

- Make soil testing mandatory for each farmer and recommend doses of different nutrients in each crop based on the testing reports.

- Apart from horticulture and agro-forestry, dairy, poultry and fishing are other alternative livelihood options within the agriculture and allied sector that could also be included as components in the action plan of sustainable agriculture mission.

- Build training and capacity building infrastructure at the block level to enhance the knowledge and skills of farmers through effective training programmes related to organic farming, composting techniques, bio-pesticides and bio-fertilizers, value addition techniques, group-farming and organizational skills.

- Create Information Database at the block level comprising data on rainfall, groundwater recharge and utilization, water demand for difference purposes, land use and cropping pattern, cropping intensity, customary water rights, irrigation system and practices, socio-economic and demographic data, etc. and link it with national level database through management information system (MIS).

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