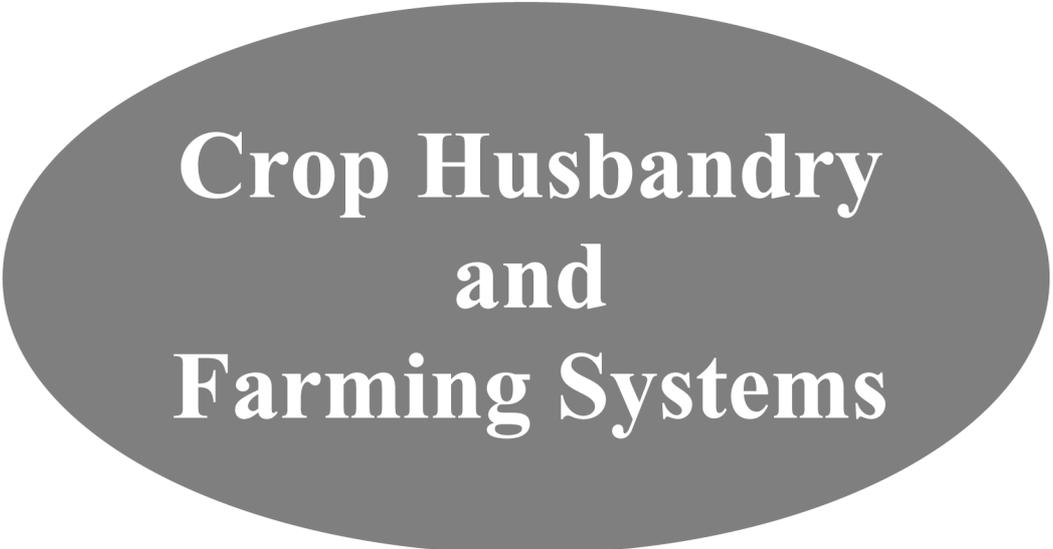




**Part Three**

**Detailed Reports**

## **Chapter I**



# **Crop Husbandry and Farming Systems**

## **Crop Husbandry and Farming Systems**

### **Preamble**

Agriculture all over the world is facing the challenge of i) climate change and ii) high energy intensive agriculture linking intervention of transnational companies dealing with inputs of agriculture on the one hand and controlling through market pressure the purchase of agricultural commodities against a payment that is non-remunerative to the large number of small and marginal farmers around the world. The pathetic conditions of such farmers compelled the UN to constitute – a global multistakeholder body, International Assessment of Agricultural Knowledge, Science and Technology for Development (IAAKSTD) with over 400 international experts. Following critical review by a still larger number of experts and threadbare discussion at a 5-day plenary in Johannesburg by representatives of a host of countries the 2500-page document was finally released globally on 15 April, 2008. With an outstanding in-depth global and regional analysis the report concluded that the challenges of sustaining the expanding population of the world confronted with adverse climate changes could be effectively met by small scale locally adapted agro-ecological farming rather than the mainstream energy and chemical intensive paradigm of industrial agricultural production. Widespread industrial agriculture has actually degraded natural resources contributing heavily to global water and climate crisis and decline of soil fertility. Survival of less-privileged and poorer people is endangered. IAASTD argued against high cost input dependent and environment polluting agriculture and condemned unfair global trade policy and inequitable distribution of costs and benefits accruing to the farming communities of the third world.

India having a 1.1 billion population has mostly people (60%) depending on crop cultivation, animal husbandry, fisheries, forestry and primary agro-processing for their livelihood. Presently, 25% of the farming population of the world live in India and 80% of them are small and marginal farmers having less than 2 hectares of land. These farmers along with large number of farm labour do not have work and income security. The condition is more acute in rain fed farming areas. It is not without reason that 40% of these people, given better alternatives, want to leave farming. Considering SDP as a significant indicator of economic development 8.81% growth of State economy during 2006-07 was reached mainly by the strength of growth of secondary sector and to some extent tertiary sector, while growth of agriculture improved from 2.30 % in 2002 -03 to 4.40% in 2006-07. Over the last decade per capita income of the State having highest population density registered a steady growth of over 5 %. Production of main food crop i.e. rice has increased in 2006-07 to 147.46 lakh tonnes from 145.11 lakh tonnes in 2005-06 in spite of an adverse monsoon (production in 2007-08 estimated at 161.0 lakh tonnes). Productivity also increased to 2593.0 kg/ha from 2509.0 kg/ha. Production of wheat and oilseeds has also increased although that of pulses declined. It, however,

needs to be mentioned in all the three aforesaid materials, West Bengal production falls far short of the domestic level of consumption.

**Historical progress:** Historically, West Bengal now a State of the Indian Union was crafted out of erstwhile undivided Bengal, a province of British-ruled India before 1947. A province having its agro-economy planned and growing in one direction for a long time landed in a totally changed situation with a much lesser land area to carry a much higher population density. The State though not suddenly, became a food deficit state and started its efforts to arrange food for its people. The raw material supply for some of the industries like jute ceased adding further complicity to the agricultural situation. The entire state machinery appeared overburdened to shoulder the total load and could hardly make any headway in spite of some of the development efforts. The decline in different spheres of social development was evident more in the field of agriculture and villages. The State continued depending on others for feeding its population. It actually lost its headquarters for agriculture as also its only institution for agricultural education and research at Dhaka. Having one of the best tracts of fertile alluvial land the State curiously enough continued in a poor state of agricultural production for nearly three decades. There, however, was another very important factor. The land under 'permanent settlement' system instituted by British governance over long neglect of rules has built up two complex problems for agricultural production namely tenancy problem (*barga* system) and land ownership in limited hands so that a very complex production system prevailed. The State was branded as a poor-performing state. The case in point is as much the big land ownership equally so to the scant interest of such class of people for there having investments in other lucrative sectors in urban areas also. Side by side this created a group of parasitic, non-cultivating landlords, and powerful extractors of rent, crafty and dishonest land grabbers. Moreover the process of sub-infeudation through many layers of intermediaries between tillers and landlords created many claimants from the produce of the same land. Hence the first intervention was land reforms.

**Lack of right attitude and motivation:** The technical policy of agricultural development in the State was badly in need of diversification and pro-poor orientation for a long period. One reason for lack of growth in agriculture in this state like many other states is continuation of subsistence agriculture and keeping blindfolded toward commercial agriculture for undesirably long period. This possibly was a kind of agro-climatic compulsion for many states but not for West Bengal at least. Lack of initiative on the part of the State proposing major irrigation projects at a time when nation was considering this aspect of agriculture creating dams, etc. had kept large alluvial plains of the State rain fed. Thus the land, which stood all prospects of becoming largely irrigated, could not be converted to irrigated one. In sixties the State earned the 'backward' title in agriculture inspite of having full natural potentials and resources. While for sometime in initial period due to lack of conviction and clear vision, this

State failed to build up institutions for cultivation of agricultural science in the areas of education and research. It is still lingering in organizing agricultural research and its extended senses like KVK, ATMA in proper perspective. The agricultural education also in its turn is yet to make a strong headway taking to the farmland productivity and offering 'ready to implement projects' to enhance employment and income of farmers.

**Collective effort needed:** The issue before West Bengal is to organize all these agencies in collective approach to harvest the benefit of collective wisdom. West Bengal is actually a land of diverse resources. For some years it is working hard to become a land of opportunities. The efforts over six decades had ups and downs. But the silver line is now visible. It is now within the will of human resources and technologists of the State to transform its agriculture further to increase production and to address the interests of poorer and backward groups of rural and urban populace particularly through generation of employment and income for them.

**Vibrant Panchayati system is the key to success:** The other major intervention has been the establishment of elected Panchayat system in rural areas. Taking the responsibility of rural development particularly in agriculture sector by the villagers themselves was so long a dictum in books. The Panchayats were existing in name. Considering that people not having sufficient education did not fail to gather profound experience and wisdom to run the village government. Electing their own representatives was necessary to take charge of village administration with development authority of that is delegated to them. Along with, a gradual change in village power structure was taking place. The creativity in people became bond-free to be expressed. Self-respect and self-confidence got aroused. Rural development no longer remained a leisurely and mechanical or chronological event. Villagers in the State now want to know more about agriculture and technology. The healthiest indication is that they are coming with newer proposals and newer demands. The aspirations changed from demand of food to demand of higher standard of life.

**National Rural Employment Guarantee Act. :** The national project like NREGA i.e. 100-day employment assurance in villages through employment to construct roads, creation of water bodies, and few others are in the right track. Closing down of fertilizer factories in the east, bringing down subsidies from 11% to 3% in the country for a large number of poor villagers however, have not been wise. Again Public Distribution System (PDS) in the country although a necessity, is not getting due attention. Minimum support price for a commodity assures the farmer a market for agricultural produce i.e. food grains. Here also the lack of interest is evident and private players are getting privilege over public sector. This is also affecting livelihood of 2.5 crore BPL (Below Poverty Line) of the country. National Development Council in its 2006 report submitted to the Planning Commission illustrated that only 0.3% of

GDP as investment in agriculture is establishing a steady decline of public investment in agriculture since 1990-91 to 2002-03. Over the years the public expenditure from 29.6% in 1990-91 has declined to 25.6% in 2003-04. This is a picture of public investment for 51% population of the country. Institutional loans to farmers have declined leaving them to the mercy of moneylenders. Hence the pathetic trend among farmers to commit suicide. India is losing international market in agriculture along with industry sector. From Rs. 3.8 thousand crore of export shortfall in 1991-92 it has reached Rs. 2.0 lakh crore in current year inviting sickness in industry, setback in agriculture and increase in unemployment.

**Development with inclusiveness:** India has now 70 crore people dependent on agriculture cultivating 51% of its geographical area. So job and income assurance for their survival through agriculture seems to be a stupendous task for the country in general and agriculture in particular. Moreover development and advancement in agriculture giving more and more production has a trend of becoming less and less human labor dependent. Development now a day is considered by UN to be the key human right as declared in Vienna. Equity and justice based system required removal of disparity among low and high-income group farmers, irrigated area and rainfed area farmers and stress area and fertile land area farmers. Equal facilities of education, health, food, housing, employment and income have to reach all. Development of some people-much more rich and privileged excluding others is not welcome. Development has to be inclusive reaching all classes of people of the society. Agriculture has also to grow keeping the same target as goal. Recent warning from SOFA, 2005 of UN's FAO that 'benefits of trade reforms may not reach the poor without complimentary policies and investments'- has importance in this country. National Commission for Farmers also agreed that farmer's income is more important than food grain production. One National Sample Survey (NSS) survey in 2003 showed that 40% of farmers are keen to quit farming if they have options of alternative healthy living, 27% do not like farming because it is not profitable and 8% consider farming a risky profession. Farmers feel that most Acts in agriculture promulgated by Center are against farmers' interest and are meant for satisfying the traders including multinational and monopolists.

**Agro climatologically diverse, resource rich productive state:** From the point of view of its strength in natural resources like round the year solar radiation, warm temperature and good rainfall (generally not less than 1200-mm annual rainfall in any district) geographically privileged location, and valuable natural bio-resources West Bengal is rich. Six different agro-climatic regions support diversity in biological resources; its deep, fertile, alluvial soil is best for agriculture. Knowledgeable and innovative human resources of the State create the potential of high productivity. Its present strength is evident through increase of production of food-grains from 4,423.8 thousand tonnes in 1950-51 to 16,107 thousand tonnes in 2004-05. Excepting in pulses definite increasing trend is clear in cases of wheat, oilseeds, potato, jute, and sugarcane.

Truly the State has deficit in pulses, oilseeds, wheat and sugarcane. The irrigation potential is 63.23 lakh ha and as it stands today nearly 70% of agricultural area has come under irrigation.

**Population density:** Land-man ratio in the State is already narrow and may become narrower in years to come. This has historical reason behind. More than 5 crore out of 8 crore people are in the villages. In spite of having diverse jobs mainly in cottage and home industries in this State the pressure of humans on agriculture is tremendous. This also was acting as one major hindrance in growth of agriculture. Industrialization and urbanization was falling back in this State over last few decades not always due to the State's default. For growth of agriculture also growth of industries and urbanization was necessary. Increase of purchasing power of rural population actually enhanced the rural capacity of the State to absorb more consumables from both industry and agriculture. That is where industry is interested. But with the development of industries and more urban areas farmers start getting better market for their produce. Providing good market is the best process of removal of their despair. This acts as the highest incentive that a farmer expects.

**Input constraints:** Besides modern agriculture, mechanized and precision agriculture requires support of diverse industries. Farmers get a steady supply of inputs, agricultural equipment, machinery etc at reasonable price when they are manufactured nearby. Because of not a grain of fertilizer is being manufactured or not much of seeds being produced in the State farmers are compelled to suffer from irregular and scarce supply, price rise, poor quality, etc. to receive such inputs. They have to compromise with weight, genuinity, contamination and time of supply.

**Low input (organic):** Considering that agriculture in West Bengal is mainly in the hands of small and marginal farmers (1-2 ha holdings) their income increase requires reduction of cost of cultivation on inputs and further increase in productivity. Providing them technology and training on generating inputs of their own utilizing natural and local resources ( water and manures) and training on their judicious use has to be given prime importance in extension work. Our bright tradition of 'family wise mixed farming' using organic inputs from household livestock is the necessity of time and needs to be revived. This agricultural transformation, if made agendum of next five years will not only bring down cost of production but also increase productivity, build up soil fertility and improve nutritional quality of the produces with minimum capital investment.

## **A. Agro-climatic context**

### **1. Agroclimatic variation**

Land area in West Bengal has been divided by different experts on different bases like ecology, agro-ecology, agro-climate and soil. They largely send a message that helps one to understand the differences among the regions from the point of view of agriculture. There has been a steady increase in gross cropped area due to increase in irrigation facilities. It was 95.32 lakh ha in 2005-2006 giving a 180% cropping intensity. Food grain production has also increased from 82.81 lakh tonnes in 1980-81 to 159.74 lakh tonnes in 2006-2007 including 158.20 lakh tonnes of cereals and 1.54 lakh tonnes of pulses. Production of pulses however, is far below the State's requirement. So also is the situation of oilseeds (6.54 lakh tonnes). This demands special attention. Productivity of vegetables, fruits and flowers are also not satisfactory. For meeting our requirements of sugar, alcohol and milk, increase in area of sugar crops and improvement of our cattle are also important.

**The hill region** in the north of the State with high slopes carries mainly forests, plantations, orchards and terraced land under cultivation. The soil is with shallow depth, poor water retention capacity and high erosion proneness. Soils in foothills and valleys are, however, deep with good drainage and moderate erosion. About 30% land is under cultivation with poor crop yields due to soil acidity, high run off and erosion and poor soil depth. Cooler temperature round the year has made an altogether different cropping prospect. High rainfall is another characteristic. Darjeeling district except Siliguri subdivision comes under this region. Maize, soybean, ginger, mandarin orange, large cardamom, peach, plum, ornamentals like orchids, cacti, summer vegetables along with cattle, poultry, 'jhora' fishes are good for this area.

**Terai and Teesta alluvial region** is warm humid alluvial plain of Jalpaiguri and Coochbehar districts, Siliguri subdivision of Darjeeling and Islampur subdivision of Uttar Dinajpur. Soil is medium-deep to deep but poorly drained (20% prone to inundation). Often flooding takes sand on cultivable land turning them temporarily barren for months to years. Soil is moderate to strongly acidic and light with generally low productivity. High rainfall causes heavy leaching resulting in soil acidity. This rainfall makes the region especially suitable for some crops like ground nut, quality rice, black pepper, areca-nut, capsularis jute, cane, bamboo, vegetables, ornamentals, medicinal plants, fisheries, cattle, goat, poultry, silk, bees, etc.

**The lateritic and red soil region** spreads over western districts of Purulia, Bankura, Birbhum, Paschim Medinipur and small pockets in Burdwan, Malda and Dakshin Dinajpur. The land is often undulating with rolling topography and gravels. Lateritic uplands ('tnar') are acidic with poor soil depth, organic matter,

water retention capacity and high erosion proneness. Lower lands ('baid' to 'Kanali') are fertile with good water holding capacity. A good rainfall with moderate to high temperature creates a sub-humid condition that encourages fruits, vegetables, aromatics, medicinal and flowers in addition to maize, sugarcane and groundnut. Seed production could be good in this area. Cattle, poultry, goat, pig, etc. comprise the livestock sector along with fisheries.

**Coastal saline alluvial region**, comprising South 24-Parganas, part of North 24-Parganas and portions of Howrah and Medinipur, is essentially alluvial with high rainfall, warm, humid climate. The soil is saline due to encroaching seawater and intensive drainage problem. Due to magnesium predominance soil is hard when dry, and non-porous when wet. The situation is not good for different crops other than rice and sometimes a few other crops. With sporadic landshaping enabling diverse crops and livestock and fish rearing, the prospects following large scale landshaping are indeed bright.

**Vindhya alluvial region** is spread over Paschim Medinipur and Hooghly, east of Birbhum and Bankura, north Howrah and some part of Burdwan and Purba Medinipur. Soil is acidic to neutral and responds to fertilizer. Only about 10% is flood prone during rains. The area is with advantage of river valley irrigation as also ground water potential. With good rainfall and moderate temperature diverse crop growing is possible.

**Ganga alluvial region** spread over Nadia, Murshidabad and part of Hooghly, Burdwan, Malda, and Dakshin Dinajpur has generally neutral soil that is light in uplands and loam in rest area. Good rainfall and ground water has increased cropping intensity to include field crops, vegetables, flowers etc. Fruit orchards are common and cultivation of diverse fruits and vegetables is a taking place.

Now an overview of the land situation in the State suggests that alluvial land in West Bengal is the largest area (35 lakh ha) of this kind in the country. About 16 lakh ha of this is Ganga alluvium and 6 lakh ha is Vindhya alluvium. The western part is a vast upland area of Chotonagpur and Rajmahal plateau with extensive laterite formation. About 6 lakh ha situated in the upper side of this area is lateritic and rest 5 lakh ha is red soil. Loose soil with very low water holding capacity becomes acidic due to leaching. The red soil area is relatively better for soil texture and crops are grown with fertilizer application. This area is largely forest covered. Coastal area commands about 11 lakh ha that is prone to salinity attributable to encroachment of seawater to different degrees. About 2.8 lakh ha in Jalpaiguri Darjeeling are terai soil with loose soil but rich in nutrition for having lot of organic matter. This is foothill. Some forest soil in Darjeeling is brown soil. This acidic but loose soil area is 2 lakh ha and is under extensive tea plantations and forests.

## **Recommendations**

1. Production program under an agro-climatic zone should have zone-priority e.g. orchard development, maize cultivation or seed production in uplands of red and lateritic zone.
2. Seed production program should be drawn according to zones identified for different kinds of seeds by experts and published report. A meeting in this respect may be convened to finalize the zones for crops.
3. For increasing crop diversity as well as remunerative crop, experts be consulted and program launched. Prospect of the State to become self-sufficient in commodities like wheat, sugar, alcohol, milk, eggs, meat, major carps, small fishes, *Macrobrachium* (Galda), etc. production of pulses, oilseeds, etc. in large areas should be considered.

## **B. Social context of West Bengal agriculture**

Agriculture in West Bengal is based on land and water. These are the resources to be utilized in the best possible way to the benefit of larger number of people. For historical reasons population density of our State is the highest in the country. Villages also have its reflection. At the beginning this required maximum attention. Ceiling surplus land was targeted naturally. Absentee landlordism, landowners' secondary attention to agriculture, multi-ownership of water bodies are stumbling blocks to productivity increase. Greatest problem remains to be the increasing fragmentation of holdings, all of which need collective and wise attention.

### **1. Land reforms**

**Land to landless:** One aspect of land use is its ownership-relation with villagers. In West Bengal after passing through land reforms, around 30 lakh landless families have earned the right to till and grow crops on their own or barga land. Thus small and marginal farmers own 84% of agricultural land whereas this is only 43% in India. While ceiling surplus land distribution has benefited people of SC and ST community, most of it along with inheritance of property by next generation has given rise to a large number of small holdings. Fragmentation of holdings is a process prevalent in India as a whole out of its inheritance law and increasing population. The ultimate problem is the high pressure of people on agriculture for their subsistence. Development needs a lower percentage of population to depend on agriculture, industry and service carrying the largest number because land use by agriculture cannot support so much people as the secondary and tertiary sectors can do.

**Patta and bargadar:** Key point in the agricultural policy of this State since 1977 is land reforms distributing ceiling surplus land to landless, providing homestead land to homeless and ensuring security of tenure to 'bargadar' (erstwhile share-

cropper) to remove the problem of identity and existence of a large section of village poor. Till November 2007 11.22 lakh acres of ceiling surplus land has been distributed. People numbering 50.39 lakh have benefited including 10.84 lakh SC and 5.38 lakh ST. More than 5.57 lakh homeless have received a total of 18,979.88 acres, 60% of the beneficiaries being SC and ST. Bargadars registered in the 'Record of Rights' on 4.54 lakh hectare land are 15.33 lakh in number. The general tendency of fragmentation of holdings is increasing since middle of nineties. Nevertheless, the process has given the landless people a foothold in the village by helping such people to stand erect and participate in the production system of the nation.

**Homestead land:** Equally heartening is the effort to purchase land in districts for distribution among left-out landless and homeless rural people in eight districts to allocate 16 kottha homestead land – 5 for house erection and rest for vegetable growing that makes their stay in the village relatively secured. Providing non-land inputs to such farmers also boosted them in their effort to earn livelihood security. The NSS 59<sup>th</sup> Round (2003) reports 90.43 % of landholders to have below 1-hectare land.

**Migration:** Another change is recorded in NSS 61<sup>st</sup> round (2004-05) that reveals that 45.8% of the total work force in the State is dependent on agriculture. This change as the next step through urbanization, industrialization and growth of service sector is to reduce the human load on agricultural land. The State average of migration of work force from agriculture to non-agricultural jobs that are more lucrative is 12% per year, highest being above 70% from Darjeeling district or above 60% from Howrah district for example. Growth of service and industry sectors and urbanization in adjoining areas are behind this trend – a process reducing human load on agriculture.

### **Recommendations**

1. Land reforms should be continued bringing out of litigation more ceiling surplus land and such vested land should be distributed among landless.
2. Effort to purchase land in identified 8 districts by the Government and distribute the same at the rate of 16 kottah per landless family as homestead land for building a house with toilet, etc. on 5 kottah and vegetable growing on the rest is unique and valuable and should be continued as planned. All such farmers should be extended support for their easy access to inputs.

### **C. Natural resources: land and soil**

West Bengal is richly endowed by nature in having fertile deep alluvium soil, satisfactory rainfall in all the districts and 6 to 7 hours sunshine almost round the year

encouraging enormous vegetative growth and existence of diverse agro-climates allowing cultivation of a wide range of crops. Weaknesses include decline in soil fertility in the recent years, extensive annual destruction of resources through flooding, excessive silting of riverbeds and collapse of river banks, etc.

### **1. Land and land use**

West Bengal largely presents alluvial lands of great depth whether Vindhya or Ganga alluvium. To add to its diversity it has in its west an extended plateau and in north a hilly terrain of Himalayas. Coastal lands are alluviums with salinity dispersed in different degrees. Being mainly in the delta of river Ganga the land is bisected by large number of rivers and their tributaries that flow north-south or northwest to south taking the pool of water to the Bay of Bengal in the south. Since ancient times the land on the riverbanks is under cultivation by humans. Much earlier, natural forests started growing all around because of fertility of the land and plenty of rainfall in the area for its geographical location. With increase of habitation development and population growth, crop cultivation centering round rice spread. Evidently as it stands today 61% of the area are net sown in 2005-06 from 59.5% in 1985-86. . Forest area remains steady on 13.5% area since 2003-04. District-wise land use situation reveals that except the districts of Howrah and North 24-Parganas 16 other districts have forest areas from 530 ha (Hooghly) to 4,26,507 ha (South 24-Parganas) while four others having 1.2 lakh ha. This requires to be noted in the context of 'zero forest' area in some of the agriculturally prosperous states of the country.

**Land use change:** Land and water are the primary natural inputs for agriculture. In other words these are also the productive surfaces or substrates on which cultivation is possible. Land as one vital input carries on its surface forests. Mineral and water harvest is done from its depth. It supports various ecosystems, habitats, and biodiversity on it. Naturally the pattern of its use excepting what has been natural is very important. Similarly water on the surface or in ground is no less important both from quality, quantity and availability points of view. Actually land and water are closely linked inputs, change pattern of use of one depending on circumstances would influence the other. Of the total 8,875 thousand hectares of land area large part of it (61%) is under agriculture for a large population depending on this land. Forests occupy 13.5% and the rest is mainly under urban areas, industries, mining and infrastructure. Over last few years significant decline in land under miscellaneous tree groves and heavy increase of area under current fallows are on record. Changes in cropping pattern, cropping intensity and bringing degraded land under cultivation may be the reasons behind.

**Culturable waste and animal resources:** Attention needs be paid to the culturable wasteland situation totalling 42,587 ha in the State mainly in the districts of

Burdwan, Birbhum, Bankura, Purulia and Paschim Medinipur. There are considerable upland areas with relatively greater elevation in the lateritic to red category of soils. In South 24-Parganas, Nadia and Murshidabad they are with drainage problems thereby demanding two distinctly different approaches for their reclamation. Improvement and scientific management of 5,544 ha of pastures and grazing land also deserve attention. For obtaining best output from animal resources in our State this deserves early attention to get an important support for ARD. Agricultural land in this State is claimed generally to be under intensive use. This is a very important issue particularly in the context of the slow decline of net-cropped area that normally has a negative correlation with development through urbanization and industrialization. The compensating answer to this problem is to increase gross cropped area. It depends much on the spread of irrigation that has already made cropping intensity 180 percent and stands for further improvement. It is necessary to emphasize here that simply irrigation by itself specifically groundwater use would be undesirable and counterproductive and option lies in rainwater harvesting.

### **Recommendations**

1. Utilization plan for the forest floors in the fringe areas as also the orchard floors for growing shade tolerant fodders, medicinal plants, etc. for income generation and to check soil erosion, making the land more productive involving concerned departments.
2. 'Paira' cultivation of 'khesari' and others on rain fed aman lands using either of Ratan, Prateek or 'Nirmal' variety should be reintroduced to increase pulse production in the State. They are high yielding besides being low in beta-n-oxalyl amino alanine (BOAA) content considered to be a causative factor of lathyrism.
3. Road side land and 'nayanjuli' farming has to be planned and taken up through SHG formation by local poor with technical advice from SAUs, Government Departments and relevant Institutions. These offer good opportunities for fodder crops and particularly semiaquatic fodder crops.
4. Proper organizations of local poor should take up suitable farming on mine-waste land, fly-ash ponds, 'baliyari', 'diara' land, swamps, marshes, mud flats, etc.
5. City farming in pots, modern green boxes, and hydroponics using manures produced from city garbage as also nutrient solution needs attention of the corporations and municipalities to make city environment soothing, and to provide citizens a valuable respite and freshening. For this purpose surplus land space in urban houses, their roofs and verandas, verandas in flats and all other space should be used centering round this; 'services' supplying seedlings, saplings, manure packets, ornamental fishes, small aquaria, fish feed, potted ornamentals or even poultry cages for roof-top may grow. Urban and periurban

farming are now making significant contributions to the food needs of city people. East Kolkata wetland is considered to be biggest of the later kind in the whole of Asia.

## 2. Degradation of land

**Degradation type and quantification:** Having a long history of agriculture, this area not without reasons includes a total of 2,081 thousand ha of degraded land of different kinds. About 29% of geographical area of the State is under soil degradation. This data from Department of Agriculture, Government of West Bengal includes 820 thousand ha of saline-alkaline land, 666 number of ravenous gullies rill and 594 thousand ha of waterlogged area.

**Problem of drainage, options for crops and cropping intensity:** The area having drainage problems would amount to 4,439 thousand hectares. This breaks up to 173.4 thousand ha very poorly drained in Medinipur, Hooghly and South 24 Parganas, 2453.3 th ha poorly drained in 24 Parganas, Nadia, Murshidabad, Jalpaiguri, Coochbehar, Medinipur, Howrah and Hooghly, 1747.6 th ha imperfectly drained in Burdwan, Birbhum, Howrah, Malda, West Dinajpur, Medinipur and Purulia and 64.7 th ha of excessively drained area in Darjeeling, Jalpaiguri, Bankura and Purulia. This problem of drainage brings in profound negative influence on agriculture by limiting crop cultivation, diminishing cropping intensity and inflicting standing crop loss. It adversely affects productivity as also soil condition. Two other kinds of land degradation are also causing decline in productivity, cropping intensity and options for crops. When considered as percentage degradation of total non-forest land it is 69.2 % in 24 Parganas, 65.86% in Purba Medinipur, 63.16% in Howrah and 35.26% in Darjeeling. It is within 20% in the two Dinajpurs, Malda, Nadia, Hooghly, Murshidabad, Coochbehar, Jalpaiguri, Burdwan and Bankura leaving Paschim Medinipur at 20.45, Birbhum at 23.67 and Purulia at 27.16%. The degradation average of the State is 28.8%.

**Other causes of degradation:** Possibly drainage appears to be given priority in reclamation drafting a master plan in participatory mode. Others along with this will be discussed later. The State is often ravaged with destructive flood. About 43% of its geographical area is flood prone. There are several other allied problems like river-bank erosion, drainage congestion, cyclonic disaster associated with loss of agricultural crops, livestock, and properties along with spread of diseases. Crop fields are turned barren by depositing thick layer of sand on fertile lands. Possibly continuous damage of agricultural lands by erosion of riverbanks or water logging for long period are destructive problems for the State. Erosion of the left bank of Ganga-Padma-Bhagirathi-Hooghly on the upstream of Farakka barrage has reached an alarming state. The State Government has considered this flood management and

erosion control as its priority and programs have been launched. The situation, however, as at present would need far more improvement.

### **Recommendations**

1. One 'Barrage and River Desilting Authority' should be created by Union Government to take charge of this required regular reclamation work for bunds, barrages, reservoirs and canals in Eastern India particularly in the lower Gangetic plains as a regular job.
2. The State Government should also create such a body authorizing them to reclaim water bodies, rivulets, canals, etc.
3. Large scale tank excavation program under district authorities in concerned districts in Teesta-Mahananda basin and Damodar-Ganga basin may find important position in development.
4. Water bodies that are locked in 'sorikana' or multiple ownership problems should be brought under a functional cooperative or so among the owners to bring them under fish farming or at least under aquatic crops.

### **3. Soil erosion and conservation**

**Erosion and its degree in different classes of land:** Soil erosion is a means of land degradation. A total of 1,360.5 thousand ha of land is affected. Severely eroded soils in this State are in parts of Darjeeling, Purulia, Birbhum, Bankura and Paschim Medinipur indicating that the high slopes result in run off during heavy rains, conservation structures and measures being scanty. However the affected area is only 57.4 th ha compared to a larger (1,303.1 th ha) moderately eroded area. Excepting South and North 24-Parganas, Nadia, Howrah with flat plain erosion is going on continuously at moderate rate on rest of West Bengal. This emphasizes the importance of following cultivation practices that essentially prevents chances of minimum erosion even. Rainwater lands on the field and if excess at a time, gravitational flow or run off occurs in the slope direction. Quantity and degree of slope determine direction and speed. A high speed overflowing is common. A smaller part moves vertically through soil column to reach aquifer. A part of this water passing through soil leaches out of soil till summer at lowest ('bohal'/'sole') level. This is sub-surface lateral flow. Some portion evaporates from surface. Land irrigability classes (LIC) are based upon capability of the soil to allow maximum irrigation efficiency that is maximum coverage with minimum water use. Degradation of an average productive land may create waste land of various classes (land classes \*I,II,III, and IV are those with progressively decreasing capacity to produce green biomass; class V is temporarily wasteland). Economically unproductive wasteland due to lack of appropriate water and soil management or due to natural causes would fail to produce green biomass and belong to land

capability classes VI, VII, and VIII <sup>1</sup> (class V\*\* are considered temporarily waste land).

**Conservation programmes:** Serious efforts need be made involving local participation and leadership for reclamation of such land areas. One of the conservation programs is through implementation of NWDPRAs covering micro watersheds spread over 13 districts of the State. Under the program usually construction of water harvesting structure, contour bunding and gully bund etc are followed and in 2005-06 it covered 2,708 ha area. Other soil conservation programs implemented are Flood Prone River Project, projects in Rupnarayan and Ajay catchments and River Valley Project in Kangsabati and Teesta catchments covering 43 watersheds.

**Afforestation by the Forest Department:** Department of Forest besides afforestation is implementing soil conservation work in the areas of erecting earthen dams to harvest rain water, gully plugging and rock-check dam erection in eroded areas, contour trenching in plantation areas for soil-moisture conservation, afforestation in gully beds and land slip areas and palisade and river training works to check erosion of agricultural fields.

### **Recommendations**

1. Soil conservation works under NWDPRAs should be continued aggressively or revived in a massive scale through people's participation taking PRI as leader. People's teams can be constituted in the line of 'Forest Protection Committee' keeping some provision of remuneration especially in the districts of Darjeeling, Purulia, Bankura, Birbhum, West Burdwan and Paschim Medinipur. Soil conservation works should be organized by Department of Agriculture in consultation and preferably jointly with Forest Department experts utilizing NREGA funds.
2. To reduce acidity North Bengal soils need be lime treated in small doses continuously for years and not total in one time application. In the west (red lateritic zone) however liming should be done applying total required in one time.
3. Erosion due to slope can be minimized using barrier crops (*Vetiver*, *babui*, etc.) on 'aills', or by creating conservation canal/bund across the slope.
4. Salinity problem in coastal soil could be overcome by growing tolerant crops (chilli, sunflower, cotton, coconut, sapota, bitter gourd and transplanted rice

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<sup>1</sup> Class – VI, VII, VIII – Fails to produce green biomass for natural cause, poor soil and water management.

\*Class – I, II, III, IV – Green biomass produced.

\*\* Class – V – Temporarily waste land.

depending on market demand). Rain water harvest and storing in tanks by landshaping helps cropping in rabi season when the salinity problem becomes acute. The State Government should take up necessary steps to introduce integrated crop-livestock ecosustainable farming practices in the coastal regions.

#### 4. Soil fertility status

For crop cultivation best soil contains 10-25% clay, 70-90% silt and 20-50% sand. A soil with higher clay can hold higher quantity of crop nutrients but drainage of water from soil is impeded. Such soils crack open when dry and it becomes difficult to till. When the clay and humus go down, the soil loses nutrient holding, property and fertility. Mostly a soil pH around 7.0 is best for soil microbes and the crops. Higher pH invites problem of erosion and loss of fertility. Correctives like sulfur or gypsum are used. Very low pH is also harmful for microbes and crops and the same to be corrected by liming. Such soils are present in Darjeeling, Jalpaiguri, Coochbehar, Birbhum, Bankura, Purulia and Paschim Medinipur.

Soils of most (11) of the districts of West Bengal have more acidic areas than neutral areas. Two districts namely Malda and North 24-Parganas showed good percentage (20-11%) of soil area alkaline. Neutral to acidic soils are more or less in balanced proportion in South 24-Parganas, Howrah and Malda.

**Electrical conductance:** In regard to electrical conductivity of soil 61-99% of soil samples from different districts recorded less than 1 m mhos/cm EC indicating normal salt concentration in soil. In districts of South and North 24 Parganas, Howrah, Hooghly and Purba Medinipur 4-7%, in Coochbehar 2% and in Jalpaiguri 1% of samples recorded high (>3) EC that is injurious to crops. The problem is also present in Jalpaiguri, Purulia, Coochbehar, Uttar Dinajpur at a level that is critical for seed germination.

**Soil NPK:** While examining the fertility status of the State upto the block level the problem of deficiency of plant nutrients was seen on various crops on different types of land. On the basis of this recommendation the Department of Agriculture, Government of West Bengal made separate fertilizer recommendations for each agro-climatic region. Application of N, P and K fertilizers is almost balanced (2:1:1) in the State of West Bengal; however, in some districts like Uttar and Dakshin Dinajpur, Murshidabad, Nadia, Burdwan, Birbhum, Bankura and Paschim Medinipur it is not so. No problem of deficiency of Ca and Mg was detectable. But in red and lateritic and Terai regions, soils with low CEC, crops responded to Ca and Mg fertilization. In Terai and old alluvium region with dolomite and OM application lentil and boro paddy gave higher yields.

**Sulphur deficiency:** Deficiency of sulphur appeared widespread in Burdwan, Birbhum, Murshidabad, Nadia, and North 24 Parganas, Paschim Medinipur, Hooghly, Malda and Jalpaiguri. This has developed due to use of very little OM under high cropping intensity with HYV s and use of NPK fertilizers free from S. Use of SSP was suggested as a good corrective measure. In Terai, hill and lateritic regions although deficiency of molybdenum was not generally recorded, the yield of wheat, rice and pulses responded to Mo application. Zinc and Boron deficiency are widespread in West Bengal. Their application gives economic response. But further studies could clarify the position. Immediate need is the assessment of Zn, B, and S status in soils of the State. Careful monitoring of available micronutrients and secondary nutrients needs to be done so that supply of these nutrients to crops do not become limiting. Since most critical level values are not adequately field-tested such values reported in India are often misleading. In West Bengal a large area is under waterlogged paddy or under alternate wetting and drying that cause pronounced decrease of available Zn content. Application of phosphate fertilizer cause further decrease. The block wise color map available for Zn, B, and S, the only of this kind for the State may be used as base map for understanding fertility till an improved one is available. Sulfur deficiency is prevalent in Purba Medinipur, Howrah, South 24 Parganas, North 24 Parganas, South Dinajpur, Nadia, Malda, Hooghly, Burdwan, Birbhum, Bankura and Paschim Medinipur in alarming extent. Boron deficiency problem is quite prevalent in Jalpaiguri, Coochbehar, Uttar Dinajpur, Dakshin Dinajpur, Birbhum and Purulia while Zn deficiency is prevalent in Bankura, Jalpaiguri, Purulia, Paschim Medinipur and Malda.

**Block wise NPK status:** The NPK status map drawn on the basis State Department of Agriculture data may also be used. Out of 350 odd blocks 188 are nitrogen deficient. Another 171 blocks are likely to turn N-deficient with time. This sounds alarming. In the entire state only two blocks in Burdwan and one in Nadia has sufficient N in soil. Sixty-three blocks are phosphate deficient. Districts like Darjeeling, Murshidabad, Uttar Dinajpur and Hooghly are in a better position. But a large number (228) of blocks is likely to become phosphate deficient in course of time. At least 43 blocks are having sufficient phosphate in soil. Except Darjeeling and districts in red laterite zone, north Bengal districts are in vulnerable position. Potash deficiency is recorded in soils of 57 blocks. But 198 blocks are likely to become deficient in course of time. Interestingly soils of 17 blocks in Purba Medinipur are with sufficient potash. The overall picture is changing with time but the indications are sufficient to recommend to the planners, executors, agricultural technologists and farmers to ponder and take immediate steps.

## 5. Soil testing

**Components that need are to be tested:** For designing management program of the soil, soil testing is very important. To determine the quantity of nutrients to be

applied for a crop soil test and crop response is a necessary prerequisite. Moreover other soil characteristics like pH, EC, organic carbon content besides N, P, K and secondary elements like Ca, Mg and S contents of the soil are the minimum to be checked for a field to obtain best production. In fact soil scientists feel that as nutrient Ca and Mg has received much less attention. Soil test laboratories with these minimum facilities may be created at each block headquarters and may be run by couple of educated youth after being trained at SAUs. Village graduates trained suitably and extended support for laboratory establishment may own and run the ST labs to offer soil test services to farmers against some charges. SAUs may take responsibility of training, consultancy, and advisory services in this regard. At district ST Labs under Department of Agriculture or some NGOs, facilities for micronutrient (Zn, Cu, Fe, Mn, B, and Mo) analysis must be there in addition to others. This is expected to build up strength of agriculture in the State. Soil test service has to improve by way of reaching the test results not only upto ADOs but to farmers and quickly.

### **Recommendations**

1. Soil Test Laboratories for testing pH, and estimating organic carbon, nitrogen, phosphorus, and potash in soil should be established at each block with initial Government support but to be run as an enterprise by local educated youth that are trained by SAUs against nominal fees.
2. District level Soil Test labs should have micronutrient analysis facilities and established and run by private groups with some initial Government support.
3. Block and district labs should be in a network to be looked after by Rural Development Department with State Laboratories and Soil Science Departments of SAUs to develop uniform policy for their operation.

### **6. Soil fertility management and improvement and productivity increase**

**Increasing the efficiency of applied nutrients:** It is often claimed that 50% additional food production shall come from nutrient management. Fertilizer consumption in different districts of the State is highly skewed that suggests scope of further growth in fertilizer use particularly with the increase of irrigated area. Scientific fertilizer management practices can increase efficiency of use of applied fertilizer. The entire problem of increasing efficiency of applied nutrients has assumed serious urgency. An expert Standing Committee constituted with representatives of SAUs, Departments of Agriculture and Horticulture and producer Industry should be assigned this duty to monitor and suggest correctives from time to time. ADOs and KPSs are required to be given the knowledge (not information only) through exposures to these experts so that they can moderate recommendations as per need of the agro-ecological situation and farmers economic condition. Technologies shall include all aspects of fertilizer placement, split application, timing, and level of application, foliar application, correct granule size,

slow release fertilizers and their relation with crop sequence, etc. to increase recovery of fertilizers. Knowledge and technology of need-based application of micronutrients in recognized deficient areas should be with them to advice the farmers. The knowledge that the nitrogenous fertilizers of all sources during undergoing nitrification process to produce nitrate, forms hydrogen ion i.e. acidity. It is capable of replacing calcium ion from the exchange complex to be leached out with water resulting in Ca deficiency. This needs to be corrected.

### **Recommendations**

1. Based upon soil test results pH of lands using chemical fertilizers like urea, ammonium sulphate, or DAP should be monitored and necessary liming program be followed.
2. Monitoring organic carbon content of soil application of organic matter to soil should be made a regular practice. Farmer should be constantly chased to inspire producing and applying organic manure and biofertilizer to soil.
3. Farmer should be convinced growing green manure crop and planting organic matter supplying trees on the bank of his pond or on 'ail'.
4. Farmers should be convinced not to waste animal dung or droppings for fuel purpose. Planting of fuel wood plants like 'subabul', 'sonajhuri', glyricidia, etc. should be advised in homestead spaces.

### **7. Organic matter and soil**

To be fertile a soil should have good quantity of organic matter estimated by organic carbon. In fact soil organic matter content is often considered as the direct measure of soil fertility. This is an integrated component of INM. Organic matter content of soil is continuously depleted by its oxidation through solar radiation. This is a problem also for our State. Minimum tillage, cover crops and mulching reduce this oxidation of soil organic matter that is so very important. The plus point in this State is that huge quantity of round the year naturally growing vegetation is constantly supplying organic matter. A massive participation of people in converting regularly part of this vegetation to organic manure can maintain organic matter content, hence fertility of our soil. Every village household needs to have a composting system. Use of chopped greens, cow-dung and earthworms available locally has to be an important essential step. The KPS or ADO or any other technical person visiting the farmer can easily provide necessary training by sparing only half an hour's time. For improvement of soil quality and fertility this is most important a step and the farmer need not spend money but only the resources around (greens, cow dung and earthworm) and to develop the habit. Possibly a massive campaign by farmers' organizations will be the key input. But the benefit is immense. Different kinds of composts using Purulia-phos, etc. are to be taken up. Green manuring with legumes and using succulent foliages by retting in water for 20 days, diluting and spraying gives good home scale liquid manure preparation. Its

use by foliar spraying requires some simple technological advice and zero investment. Using different refuses from crop residues, straws and stubbles, bagasse, coconut pith, kitchen refuses, droppings and dung of domestic animals the entire soil fertility aspect may be taken care of to a good extent. Use of cow-dung for fuel purpose needs to be stopped voluntarily by farming families. The Planning Commission estimated that 8.5% of total energy need of rural poor is met by cow-dung cakes.

### **Recommendations**

1. To save our agriculture and soil and to reach the potential productivity of a crop species farmers should consider switching over slowly and partially to organic farming practices without compromising yield increase. Partial substitution will bring down cost of production and offer a premium price for the produce especially if produced through non pesticidal management (NPM). Under improved fertile soil response of chemical fertilizer will be better.
2. Each farmer family shall compulsorily have a compost pit or heap and produce regularly sufficient quantity of compost/ vermi-compost/ phospho-compost\*/ super-compost\*\*.
3. Each farmer should have liquid manure production system in an earthen pitcher to cause retting in water of easily decomposable leaves and dilute the solution for spraying on crops.
4. Gram panchayats should take initiative to produce enough 'Dhaincha' seeds required for the village identifying growers interested. Price to be fixed has to be remunerative.
5. As a collaborative program with agriculture Forest Department should launch social backyard forestry in rural poor families to provide substitute fuel for cow-dung cake.

### **8. Bio-fertilizers**

**Microbial resource:** The crop production scenario in West Bengal remained very poor for a pretty long period since independence because tillers were not in control of land they till. The landlords, often absentee, had other lucrative areas also to invest. Hence they did not pay much attention to agriculture excepting collecting their share of produce using their power. They developed their agents to manage the affair in the villages. The benefit of high yielding varieties and high fertilizer use

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\* Phospho-compost – Compost in which rock phosphate powder is added to enrich the compost with phosphate.

\*\* Super-compost – Compost in which rock phosphate powder and pyrite ('Dhatumol') powder to enrich the compost with both phosphate, iron and sulphur.

could not be harvested till early eighties when tillers were having the authority to decide the mode of cultivation. With the application of these modern agricultural tools production scenario of the State changed and the State achieved self-sufficiency in food grains and several other agricultural and horticultural commodities.

After reaching a stage of productivity through use of fertilizers and HYVs it appeared difficult to obtain equal increment in productivity by addition of more fertilizer. It was realized that further increase of productivity required improvement of soil fertility. Complete dependence on chemical fertilizers and pesticides brought in many problems of the crop itself besides creating environmental problems. Loss of sustainability in production due to degradation of soil health developed from decline in soil organic matter or organic carbon. Alongside decline of microbial population in soil due to chemical intensive farming is also evident. Soil microorganisms play very important role in building soil fertility and crop productivity. It is established through research that 85% of these microorganisms are beneficial. Rebuilding of this soil microbial wealth essential to advance any further in productivity. This actually would require use of microorganisms capable of developing different components.

#### **Recommendations**

1. Initially panchayat samities / blocks should establish bio-fertilizer production plant for the block area to be run by trained village women for selling to farmers. Technical plan of the BFPP, culture of the organisms, and training will be the responsibility of KVKs, RRS, RRSS, and SAUs. The program should include rhizobium, azotobacter, azospirillum and PSB initially.
2. Azolla production and maintaining culture can be taken up by trained women in each Gram Panchayat where water bodies are available. Need of Azolla for transplanted rice and poultry feed for the village should be met.

#### **D. Water in agriculture**

West Bengal has large water area in ponds, 'beels', 'baors', 'jhils', 'khals' and so many others. They are mostly under traditional fish culture and culture of water chestnut, 'sapla', crabs, snails, etc. remaining unproductive or under productive. Reclamation of such water bodies that are silted over long time has not been thought of. A colossal wastage of resource needs urgent correction.

##### **1. Water resources and water areas**

**Types of wetlands with use pattern:** Besides land, water areas are also important productive geographical areas particularly and for a state like West Bengal. The data available in this regard show pond and tank areas for fish culture. Out of a total of 2.76 lakh ha 1.94 are culturable, whereas 0.55 and 0.26 lakh ha are semi-derelict

and derelict respectively. Besides this another 2.10 lakh (of which 22.85% only are culturable) is lying in brackish water area. River area of 1.72 lakh ha and canal area of 0.80 lakh ha area possibly not under fisheries program, constitutes another large water area. Reservoir, beels and baors together constitute 0.57 lakh ha. Besides all these large water areas, there are innumerable small pieces of water areas like 'nayanjulis' and large depressions like 'jola' 'daha', etc. that are to be defined as water areas which in total occupy still larger areas than the former. Data on wetlands in West Bengal are under 5 categories. Beel or almost permanent water bodies are 31,000 ha, Inundated lands are 44,000 ha, marshy areas are 43,000 ha, saline water areas are 4,00,000 ha and wetlands besides dams and reservoirs are 6,500 ha totaling to 5,24,500 ha. Variation in data needs plot by plot checking since the data is very important for agro-economy of the State. Some of these are under aquatic crop cultivation like 'water chestnut', nymphaea (shaluk), hogla, shola, madurkathi, sitalpati, sarkathi, etc. and possibly not included in fishery area. These water areas are resources to be considered for their scientific utilization after reclamation following standard techniques.

## 2. Water resources and irrigation

One of the most important inputs in agriculture is good quality and adequate quantity of water. Irrigation is one answer to increasing population since it increases productivity, and cropping intensity thereby assuring food security. Simultaneously overexploitation and overuse of irrigation water in a mismanaged mode is destructive for the economy and ecology of an area. Day by day water is becoming more and more a precious commodity. Conservation of every drop of it with scientific planning of water resource use and scientific water and irrigation management is very important. In India 6/10<sup>th</sup> of crop output comes from irrigated fields that are only 1/3<sup>rd</sup> of total crop acreage.

**Future crisis:** The second World Bank Review has expressed deep concern about the future of irrigation sector in India. It is heading towards a major breakdown due to deterioration of public irrigation works e.g. cumulative neglect of repair and maintenance of the State canal system as well as alarming depletion of ground water. Behind this is absolute decline in public investments in irrigation sector during the eighties.

**Climate variation:** Climate of an area and water resource management are related. During summer tropical hot, humid West Bengal has 37- 20<sup>o</sup>C temperature while in winter 25-13<sup>o</sup>C. In the western districts it goes upto 40-45<sup>o</sup>C although in the mountainous region it is within 30<sup>o</sup>C. Humidity during summer to monsoon season is high. Onset of monsoon is in June and it recedes in October.

**Pattern of rainfall and temperature:** The average annual rainfall in Gangetic and sub Himalayan regions is 1459 and 2759 mm respectively and number of rainy days

comes to 90-95 days a year. Winter is short and not severe (7-17<sup>0</sup>C) except in mountainous region where it is long and hard (2-8<sup>0</sup>C) sometimes dropping down below freezing point. Winter is more or less rainless with 1.5-2.0 mm/day open pan evaporation\*.

**River basins:** While rainfall is the main supplier of water river basins are the main geomorphic framework playing key role to maintain various components of the hydrologic cycle. River basins include Brahmaputra with sub-basins like Sankosh, Raidak and Torsa, in Jalpaiguri-Coochbehar, Jaldhaka in Darjeeling-Jalpaiguri-Coochbehar and Tista in Darjeeling- Coochbehar. Ganga-Bhagirathi River basin covers an extensive area with wide range of subbasins namely, Mahananda in Darjeeling- Dinajpur-Malda, Punarnabha-Fulhar in Dinaj-pur-Malda, Atrai in W.Dinajpur, Pagla-Bansloi, Brahmaputra-Dwarka, Mayurakshi and Ajoy in Birbhum-Murshidabad, Damodar in Hooghly-Burdwan-Howrah, Darakeswar-Gandheswari in Purulia-Bankura-Hooghly, Silabati in Bankura-Medinipur, Kangsabati in Purulia-Bankura-Medinipur, Kaliaghai in Medinipur, Jalangi in Murshidabad-Nadia, Churni in Nadia, Bhagirathi in Murshidabad-Nadia-Burdwan-Hooghly-Howrah-24 Parganas and Rupnarayan in Hooghly-Howrah-Medinipur.

**Water demand and supply:** Basin-wise availability of surface and ground water as in 1985 is published with regard to 22 river basins and 4 large drains of West Bengal. From a 84,234 MCM total water available in Atrai basin to 328 MCM water in Haldi drainage basin through 16051 MCM of Bhagirathi, 14759 MCM of Mahananda, 13487 MCM of Jaldhaka and 13203 MCM of Torsa among the larger ones and 6912 MCM of Raidak, 9801 MCM of Damodar and 1051 MCM of Rupnarayan, 4568 MCM of Subarnarekha and others. Thus on a gross basin area of 76,24,100 ha, 13.29 mham\*\* of surface water and 1.46 mham of ground water totaling to 14.75 mham of available water in the State. Specialists feel that under present technical, geological and infra-structural constraints possibly 40% of this may be actually utilizable. The likely demand by 2025 is a total of 10.85 mham including industry, power, domestic, navigation and others in which agriculture's share will be 5.39 mham. Thus we have 6.77 mham utilizable out of 14.75 mham available. However, there are marginal differences among different estimates. In the tube-well irrigation sector failure to maintain minimum safe distance between one and the other have been a strong complaint. Out of the total available water, ground water is only 9.9% while surface water is 90% of total.

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\* Open Pan Evaporation - Surface water evaporation measurement method.

\*\* Mham - Million hectare meter.

Continuous shrinkage of water-holding bodies, both natural and artificial due to erosion of soil and silting remains completely neglected. Reclamation is urgently needed. But no such steps are being taken.

### **Recommendations**

1. De-silting of reservoirs, canals and rivers should be taken up seriously even though it requires huge investment. First of all a national level authority for reservoirs and canals have been suggested. Secondly the work on entire stretches of canals, channels and small rivers and creeks should be disbursed among adjoining local bodies all over the State keeping regular annual budget provision apart from the ongoing scheme budget.
2. Tank excavation in drainage choked areas should be considered imperative. South 24 Parganas model associated with land shaping and IFS should be followed. Saved resources and public properties shall ultimately justify the expenditure. Planting on the banks should be included.

### **3. Development of water resources**

**Creation on a massive scale of a very large number of ponds / tanks, and desilting of water bodies:** In West Bengal development of water resources require three areas of interventions. 1) Creation of large storage reservoirs by erecting high dams across rivers in the upper reaches, taking care of environment and inhabitants, 2) Creation of small reservoirs by erecting small dams across small rivers and streams at suitable sites, and 3) Exploitation of ground water through DTWs and STWs selecting judiciously the sites and upto a limited quantity. Hence it appears that development of small water bodies remains the best options. Creation of large number of small water bodies can be taken up in a massive scale by excavating new ponds and renovating existing ponds which will also generate income and employment in rural areas, so important in the present context. In regard to large inundated and swamp areas the strategy can be of excavating the central area of swamps to a sufficient depth so that inundated area shrinks making more land available for cultivation. Desiltation of choked rivers may be in entirety or only opening a narrower flow as required for playing its drainage role. Such excavation may have intermittent low dams allowing the flow as also holding some water for fishery and local use. Recharging ground water artificially and promoting natural recharge and soil storage through forestation soil conservation etc. Recycling industrial and municipal wastewater as also establishing compulsorily recycling system in 'pucca' houses be adopted as general policy. Surface and ground water use should be conjunctive. Instead of planning development of water resources district or block-wise they should be drainage basin or sub-basin wise.

The third minor irrigation census summarizes the situation as below.

Type of structures	Number of structures	Culturable command area,Ha
Dug Well	39,373	27961
Shallow tube well	603667	1169106
Deep tube well	5139	183152
Surface flow	53781	329399
Surface lift	107595	385431
Total	809559	2095849

**Status of tanks and similar water bodies in the districts:** Tanks are very important surface water reservoirs distributed all over the State. Even after having many natural ones filled up due to habitation and other developments over decades, the number that are still remaining are of immense value both in terms of environment, fish and aquatic crop culture, irrigation and minimization of flood effect during monsoon. At present a total number of 1,61,757 irrigation and 7,56,422 of non-irrigation tanks exist in the State giving a total of 9,18,179 a valuable natural resource indeed. It is true that addition in number is also taking place. The strength of 3.4 lakh odd in Medinipur and 2.16 lakh odd in South 24 Parganas need attention. These tanks are not only the standing means of water recharge but also are climatizer and source of irrigation in addition to their water carrying capacity. Burdwan, Hooghly, North 24 Parganas, and Birbhum with around 50 thousand tank strength and Bankura, Howrah, Dakshin Dinajpur, Malda and Murshidabad with 15 to 22 thousand strength are also contributing toward all these. Alarming is the situation in Jalpaiguri, Coochbehar, Uttar Dinajpur and Nadia having less than 10 thousand strength and naturally with a poor water carrying, recharging and irrigation potential. A reference to the document on tank numbers published by State Planning Board in 1976 reveals the extent of loss of water carrying tanks due to pressure of habitation development in last three decades. Taking water bodies as vital structures and resources for such high rainfall state reclamation, and creation of new water bodies needs special emphasis in the interest of good agriculture and good living.

#### 4. Status of irrigation in West Bengal

**Irrigation present – future:** The major irrigation potential created upto 2005-06 is 1583.705 thousand ha with Subarnarekha and Teesta barrage projects being still under implementation due to delay in land acquisition. Of late fund from Bharat Nirman Project may improve the situation. Nine medium irrigation projects are continuing in Purulia. The three Hanumata IS, Tatko IS and Patloi IS together are expected to bring 1000 ha under irrigation.

**Blockwise estimate:** As expected minor irrigation in the State has been given maximum emphasis. State Water Investigation Directorate jointly with Central Ground Water Board following Ground Water Estimation Committee has completed estimating ground water in 269 blocks of the State excluding 59 salinity affected blocks and 13 mountainous and sub-mountainous blocks in the north. This shows net annual water availability to be 27.46 billion cubic meters. The estimate designated 231 blocks as 'safe', 24 as 'semi-critical' and 10 as 'critical'. To combat the problems of ground water depletion, arsenic, fluoride and iron contamination of ground water in a number of blocks (81 and 45) the State Government passed regulation titled 'West Bengal Ground Water Resources (Management, Control and Regulation) in 2006. More specifically out of 3 hundred plus blocks critical blocks are Bhatar, Manteswar, Nalhati-2, Daspur-2, Nanur, Goghat-1, Mayna, Boroa, Bharatpur-1, Bharatpur-2 where groundwater use has been prohibited and surface water use has been suggested. Area wise groundwater survey shows arsenic contamination in 81 blocks areas and fluoride contamination in 49 blocks that are unsafe for use.

**Groundwater extraction:** Till 2005-06, 3844 HDTW, 609 MDTW, 3703 LDTW, 13924 STW, 3686 MRL, 102 Midi RL, 1294 Mini RL, 233 Surface flow Minor Irrigation, 158 Water harvesting Tanks, 114 Pump Dug Wells and 7388 Open Dug Wells have been developed. In addition there are projects like repair, renovation and restoration of water bodies in South-24 Parganas and Uttar Dinajpur to create additional 7456.87 and 2028.64 hectares of irrigation potential respectively. Through accelerated Irrigation benefit Program in drought prone areas, RIDFVII, RIDFX, RIDFXI, RIDFXII, accelerated development of minor irrigation, Sub Himalayan Development Project, Community Irrigation Development and Command Area Development and management programs further development of irrigation potential is in the process.

Ingress of tidal water of Hooghly river in large coastal areas of Howra, Hooghly, Purba Medinipur and North and South 24 Parganas through drainage out-fall of the river has enabled growing summer rice and rabi crops in over 1,44,400 ha.

**Water from reservoirs / canals:** Major irrigation command operates by releasing water from reservoirs through main canals, branch canals, distributaries, irrigation minors and finally to irrigation outlets. The regulatory structures at distributaries and minor levels are mostly broken causing hindrances for water to reach target causing loss of water. CADA has to work for making field channels and maintenance and so far 10-12 % area is covered. Farmers' practice so far is to prepare field channels in rabi and boro seasons but not in kharif. In kharif canal water is available for 60 days (mid July to mid Sept), in rabi it is on rotation for 60 days (Dec to end Jan) whereas in boro (summer) on rotation for 60 days (Feb to mid April). But for lack of information about the periods farmers tend to overirrigate.

Prior notice on calendar of water release can save water as also the crops from excess moisture stress. For a deep tube well command (2 cusecs, 40 ha) also a prior understanding between farmers and DTW owner, may be through beneficiary committee system, is required for its best use.

**Rainwater harvesting:** In situ rainwater harvesting can be achieved by increasing infiltration rate with the help of deep plowing, profile modification, vertical mulching and keeping the soil surface rough. On lands having 1-2% slope, water field bunding, land levelling, contour ditching and cultivation along contour ensure conservation. Those with 2-6% slope, graded contour bunds can be constructed and on 6-33% slope, bench terrace can be made. Ex situ rainwater harvesting is required for high intensity of rain in short duration causing high run-off and poor soil moisture storage. Here (semi arid western area) water collection is made in dug out ponds; check dams, percolation tanks and weirs by nullah-bunding, gully control, etc. This is highly location specific.

**Participatory management:** The 20,000 minor irrigation projects now looked after by beneficiary committees are now being handed over to farmers for their participatory management in maintenance, etc. Better water use efficiency, efficient irrigation methods that are technically feasible, viable and socially acceptable need also be slowly introduced. Pressurized irrigation system e.g. drip and micro-irrigation need popularization in fruit orchards, plantations while widely spaced other crops of high value, may be introduced in western districts of West Bengal.

### **Recommendations**

1. As a long term goal ground water tapping should be gradually minimized or stopped. Creation of substitute surface water store should precede this. Annual average rainfall all over the State being more than 1200 mm the quantum of water received appears sufficient provided most of it is harvested and stored.
2. Introduction of drip, sprinkler, etc. methods of micro-irrigation wherever possible may reduce our total water consumption for irrigation of orchards, plantations and vegetable fields.
3. In command areas construction of field channels should be taken up as a major development program since it will minimize loss of water.

### **5. Block-level water budgeting**

**Future water security:** National Water Commission claims that the present state of 83% of irrigation water being fresh water may decline to 76% in 2025 and 65% in 2050 creating the real water crisis. Consequently food production may also decline around 14 million tonnes during 2021- 2025. Crop production will continue to require large quantities of water with a good distribution round the year. In West Bengal also irrigation practices with unplanned frequency and higher depth of

irrigation present low water use efficiency. Over-use of water leads to qualitative deterioration of water, – irrigation or potable. Moreover many breaks of monsoon and erosive rainfall in a very short time span often cause surface run off. Hence attempts to make region (block)-wise water budgeting are urgently needed. These will minimize the imbalance between over and scarcely irrigated plots. World Bank Site selection for rainwater harvest and also selection of crops, varieties and crop sequence are important issues that need to be sorted out by experts.

### **Recommendations**

1. Extension workers and agronomists in villages in all meetings or training programs should discourage flood irrigation and train people about storing and judicious water use.
2. In boro fields and in up and medium land of aman rice fields System of Rice Intensification (SRI) should be introduced. Agronomists of North 24 Parganas and Bankura may extend their expertise. Growing transplanted rice without standing water as in SRI will reduce water use to a great extent besides significantly boosting yields.
3. In view of the scarce water resources of the State and future threat in relation to availability of irrigation water both in respect of quantity and quality for raising crops, an advisory committee is to be made for micro level crop planning and water budgeting in the state.

### **6. Soil moisture management and ‘Paira’/ ‘Utera’ system**

**‘Paira’ System can raise 3 rainfed crops:** In rainfed system the moisture potential due to excessive rainfall for a long period (April to October) in West Bengal areas with flat and low/medium lands in the districts of Howrah, Hooghly, Burdwan east, Nadia, Murshidabad, Malda, North and South Dinajpur, Jalpaiguri, Coochbehar, Purba and Paschim Medinipur and North-24 Parganas is high. Conservation and use of soil moisture obtained from rainfall can be very well used for year round growing of crops in these areas with ‘paira’ system. This system can raise three rainfed crops in seasons like rabi (November to March), pre-kharif (April to July) and kharif (July to November) in place of only one i.e. kharif rice. Paira is a no-tillage, relay crop that follows kharif (aman) rice. In alluvial soils on low-medium lands crops like barley, wheat, mustard, grasspea, lentil, linseed, oat (fodder), safflower, sunnhemp (for seed), niger, pea, gram, coriander, black cumin, etc. could be grown in rabi season. After this crop in April-May, pre-kharif crops like aus rice, jute, sesame, maize, mungbean, cowpea, cucurbits, amaranth, kulthi, mesta can be raised. Dhaincha as green manure could also be grown. Following this in kharif (July) season with high rainfall and standing water kharif rice is the only option in medium and low lying areas. However in high land maize, black gram, green gram, sesame, cowpea, jute, mesta, napier may be grown.

**Paira:** As the technique of broadcasting seeds over the preceding crop (aman rice, 5 days before harvest) at maturity on muddy or moist soil without tillage are the 'paira' cropping with grass-pea khesari (*Lathyrus sativus*), lentil (*Lens culinaris*), etc. The seeds are broadcast 2-3 days before rice harvest (before germination of paira seeds). Soil moisture is conserved enough to sow pre-kharif jute, mung bean or others after normal tillage. This cropping system conserves moisture to allow growth of three crops as rainfed in the areas mentioned earlier.

### **Recommendations**

1. A paira crop either of khesari, lentil, mustard, spices or dhaincha as green manure should be introduced in massive scale in the districts of Howrah, Hooghly, Burdwan east, Nadia, Murshidabad, Malda, North and South Dinajpur, Jalpaiguri, Coochbehar, Purba and Paschim Medinipur and North-24 Parganas in rain-fed aman fields.
2. Depending upon requirement or market demand paira crop should be selected from a range of suitable legumes specifically khesari, lentil, etc.

## **7. Drainage**

**Drainage problems:** Being located in the downstream of the Ganga basin and developed out of deposition of silt carried by rivers and rivulets from distant hills and plateau areas the southern part of the State in particular is often water logged and flooded with surplus water during monsoon. The causative factors of water-logging are adverse land topography, high rainfall with 90% of it being received during the four monsoon months of June through September, release of stored water from the upstream reservoirs and the ingress of tidal river and seawater. Water logging and salinity jeopardize agriculture on about 3,275 m ha land constituting 56.3% of the cultivable area in the State. Five out of the six agro-climatic regions of the State in north south and eastern parts are affected in almost every year depending upon the magnitude and duration of rainstorm. Total and occasional waterlogged area in new alluvium region is 11.52 and 8.3 lakh ha respectively. However chronically waterlogged area is maximum that is 4.57 lakh ha in coastal saline region. The State has a total of 13.28 lakh ha of chronically waterlogged area in all 4 alluvial plains. This demands urgent intervention. Besides requiring huge investment the interstate and international involvement and high population pressure leaves very little space for construction of flood embankments, large storage structures, etc. Excepting the Himalayan foot hills and North Chhotanagpur Plateau the entire State is a flat plain often called flood plain criss-crossed with rivers and rivulets intercepted with many saucer shaped depressions and basins. Some of the rivers have catchments outside State boundary. Drainage problem has not received required attention pushing this State back to the position of one of the worst flood prone states inviting along with others huge regular loss of agricultural crops and bank erosion, silting of existing channels, canals and dams and physical,

chemical and biological degradation of agricultural lands. Affected area in coastal zone is mainly in four basins like Keleghai, Pichabhanga, Rasulpur and Haldi. Except Keleghai, the other three suffer from tidal inflow of seawater also besides flooding. The inadequacy of carrying capacity of decadent rivers and silted drainage channels have aggravated the situation. Inundation often destroyed 7.23 lakh ha of cultivable land in this region. For new alluvial region the entire Nadia and parts of Malda, Murshidabad, North 24-Parganas, Hooghly, Howrah, Burdwan, and North–West Dinajpur districts are waterlogged. Chronically affected 3.22 lakh ha cultivable area and 8.30 lakh ha occasionally flooded area mostly during June to September need interventions like surface drainage, pumped drainage for lowlands (paddy) and ground water recharge; raised-bed pond system for low lands and desilting of ponds and rivers are also required. Evidently following different means of drainage improvement, creation of a large number of water harvest structures and extensive recharging network are very important

### **Recommendations**

1. Various flood protection works, clearing of drainage congestion and anti-erosion measures as recommended earlier are the steps required to be taken.
2. Protective ring bund should be erected to arrest excess run off load and sea water intrusion.
3. Intermittent surface drainage to reduce salt load in summer is required.
4. Conjunctive use of brackish surface water and fresh ground water will be useful.
5. Ground water recharge system development to minimize water logging suggest more interventions.
6. Plans for building three main drainage lines along rivers Teesta, Jaldhaka and Mahananda for North Bengal and three main drainage lines along rivers Bhagirathi, Damodar and Ichamati for southern and western areas of West Bengal should be drawn and considered. Linking other areas with these mainlines utilizing other minor rivers according to convenience will be required.

## **8. Management of calamities and flood**

**Rain water flow related problems and mitigation:** Floods are becoming more important due to their recurrence destroying large area under crops as also properties and life. In West Bengal flooded area is increasing every year. With increased global warming this is gaining importance particularly in coastal areas. West Bengal being situated in lower Gangetic plains and the stretch of land both north and south Bengal is having a number of basin-like depressions. Silting of river beds is leading to all this. Urgency is being felt for its remedy. The considered views of engineers based on Kapil Bhattacharya's opinion expressed long back, are that the ambitious and utopian plan of connecting rivers in north with those in south

will not only fail to solve the problem but is likely to initiate more hazards. He emphasized creation of large water bodies on beds of choked rivers by putting cross-dams. Central line of a river may also be made deeper using speed of the flowing water itself and by creating 'char land' arranging silting on the two banks artificially.

### **Recommendations**

1. Using the speed of flowing water the central line of a river should be kept open. Erecting artificial obstructions on banks silting on banks should be induced to create 'Char lands' on the banks of the river.
2. Central authorities should be established for regular planting on the banks and excavation of barrages and reservoirs.
3. Central authorities should take charge of de-silting of major rivers like Ganga, Hooghly, Teesta, and others following 'Central line policy'. This is expected to reduce bank collapse.
4. State Government should also create bodies to regularly excavate the central line of other rivers to allow free flow of water.
5. Dykes and bunds in coastal areas should be raised to check ingress of tidal water from sea.
6. Forest Department should consider implementation of projects for river bank planting in partnership with local bodies concerned.

### **E. Resources and inputs**

With the changes in the socio-economic conditions of the farmers in of the State slow mechanization of agriculture is taking place. Small tractors and power tillers are gradually occupying the fields. Pumps, submersible pumps, threshers for crop growers, and motorized boats for fishermen, cold chain for perishables have entered the arena sometimes back. Electrification of most of the villages has attracted farmers to cheaper power. The scenario is changing fast.

#### **1. Farm machinery and power**

**Power and energy scenario:** Productivity in agriculture depends greatly on availability and proper use of farm power by farmers. During last 5 decades farm power availability in India was on an average 0.25kW/ha (1951) and 1.35kW/ha (2001). In 1951 97.4% of this was from animals and in 2001 power from mechanical and electrical sources is 82%. Mechanization in agriculture progressed faster in northern states. However with late start and having mostly small and marginal farms it is gradually picking up in this state in case of smaller machinery. As an index tractor numbers have increased fast in states like Punjab (82.5/th ha), Haryana (62.9/th ha), West Bengal remaining at 2.9/th ha but power tiller number is higher (2.8 /th ha) in West Bengal compared to 0.0 in Punjab and Haryana.

Following the same logic Kerala has 2.6 and TamilNadu 1.5. The economic conditions also mattered.

## 2. Machinery and mechanization

**Cost analysis:** For encouraging better farm management, timeliness, higher output, and higher productivity of land and labor is advantageous in definite situations only. But often there are situations where this becomes inevitable to make agriculture profitable. If initial investment can be afforded mechanization leads to lowering of cost of land preparation. For example rice field plowing with conventional indigenous plow costs Rs 1800/ha it is Rs 675/ha by a hired power tiller that is less by 35%. Transplanting of seedlings by manual labor costs Rs 1700/ha and Rs 569/ha by six-row mechanical transplanter. Harvesting the same crop with sickle costs Rs 1000/ha and Rs 665/ha with a vertical conveyer reaper. After harvest traditional threshing by beating costs Rs 750 while with a paddle thresher it is Rs 600/. Besides lift pumps, seed drier, sprayer, power thresher, etc. are also available to support agriculture. Farmers' Cooperative and big farmers may be encouraged for using medium range machinery like self-propelled rice transplanter, reaper, etc. Modern equipments include laser land leveler, rotavator, sub-soiler, zero-till drill, happy-seeder, raised bed former, ridger-seeder, inclined-plate planter, automatic potato planter, aeroblast orchard sprayer, straw baler, multicrop thresher, sprinkler and drip irrigation system, etc.. Use of too labour-extensive machineries, in conjunction with agrichemicals herbicides must be avoided in view of uncertain future consequences. The hardpan formation below the surface soil through use of tractors and power tillers though economical may be counter productive in the long run.

**Big agro-based implements:** Reputed Indian or foreign manufacturers of power tiller, small tractor, thresher, sprayer, transplanter, pump, etc. may be contacted to have factories for production of this machinery in West Bengal. Considering the large number of small and marginal farmers in the villages of this State village people with investment capability may be encouraged to develop implement banks to rent out such implements against state level regulated rates to our predominant small and marginal farmers. This organization may require consultations and interested persons at district level may give an organized shape.

**Small industries:** For paddy processing development modern rice mill with bran separator, modern pulse mill, modern mechanical oil expeller, evaporative cooled storages, accelerated jute retting machine, lac processor, fish transport vehicle and solid state bio-gas plant are of the required to meet the requirements of today's agriculture.

**Training for maintenance and repair:** Repair and maintenance shops are required. Training of interested implement sellers and village youths may create a lobby for taking this charge. Introduction of new implements may also benefit having such organizations. Government agricultural engineers placed at district or block level under a separate directorate of Agricultural engineering or as a part of Agro-Industries Corporation have to inspire and advise such organizations in the State. Days are coming when West Bengal agriculture will depend much on mechanization for its further progress. So presence of such engineers close to villages will be necessary.

### **Recommendations**

1. Companies having reputation of manufacturing agricultural machineries should be contacted for establishing factories in West Bengal to meet the fast increasing requirement of the State.
2. District level training cum implement supply shops are necessary for agricultural development. Entrepreneurs should be encouraged through training and facilitating capital on loan from financial institutions.
3. State level training institute for agricultural equipments and machineries, their designing and specifications is needed. This should be organized by the SAUs.

### **3. Bio-resources and agriculture**

**Bio-resource documentation, conservation:** Bio-resource conservation i.e. conservation and enhancement of the bio-resources like flora, fauna, microflora and microfauna collected and maintained by different organizations all over the State may be documented and continued to be maintained by respective organizations and communities with BDB as nodal agency as per provisions of PVVFR, 2001.

**Present status of conservation:** Variety of all life on earth i.e. bio-diversity is the crucial foundation of agriculture. One of the 12-mega diverse countries is India owning 7.8% of global recorded species. Its wealth of traditional and indigenous knowledge exists as coded and informal knowledge. As a party to the Convention on Biological Diversity, 1992 India also has to facilitate access to genetic resources by other parties subject to national legislation and on mutually agreed upon terms. Crops and animal resources that are cultured by humans are simply selections from the bio-diversity of our planet. The discipline of agriculture thus is amply represented in the National Bio-diversity Authority. The State Bio-diversity Board created out of The Biological Diversity Act, 2002 advises the State Government on conservation and equitable sharing of the benefits arising out of the utilization of bio-resources or about the need for regulation of use of such resources. For ecologically sustainable use of biological resources in agriculture the State has to have a documented account of the bio-resources with guidelines of their extent and

mode of conservation and use. Along with identification of overexploited resources and development of awareness for its prevention shall also be equally important. Agriculture itself is a selection process. Among the around 3000 species cultivable for human use possibly only around 300 are in cultivation for reasons of producing more for human consumption and again only about 30 species are being cultivated covering most of the cultivable land surfaces. At this juncture of human civilization improved techniques need to be developed to integrate farmland use with surrounding land uses such as habitation, forest, reserve land and water to promote conservation of bio-diversity. The land use modes that are incompatible with conservation of bio-diversity should be done away with gradually. IRRI findings (1990-91) on cleaning of bunds and natural bushes increase pest pressure on rice crop have been reported. Fukuoka, (1978) supports this view. Crop and animal diversity under different agro-climatic regions increase sustainability of agriculture itself. Awareness development about influence of bio-diversity on agriculture should also spread to all communities around again for a deep understanding in diversity. To make a beginning for assuring long sustenance of agriculture and humans on this planet a program is suggested to be spread all over the State. SAUs and other general universities require studying and evaluating large number of varieties of different crops, animals and fishes. To conserve them the efforts of research of concerned field and institute seems to be very temporary. But such personnel in different institutes, NGOs and individuals spread all over the State are covering quite a large volume of resources. The State Bio-diversity Board may contact these agencies to ascertain the value of the resources and then decide to discuss with such resource persons the mechanism of their conservation by the same agency or individual. As incentive the bio-resource keepers may be offered some incentive/cost from the Government in exchange of maintaining and permitting documentation of these resources of the State. For example Chinsura and Chakdah center for thousands of varieties of rice, resources of oilseeds and pulses at Baharampur should be registered and maintained. Medicinal and Aromatic Plant Center, Mohanpur with hundreds of species of medicinal and aromatic plants, Sub Tropical Fruit Center at Mondouri and Gayeshpur for few hundreds of varieties of mango, litchi, banana, jackfruit and coconut, and betelvine center at Mondouri with a collection of nearly one hundred varieties are to be registered. Tuber crop center at Kalyani with hundred varieties, Forage Project with 350 Forage varieties including 300 rice-beans 30 coix, 14 agro-forestry tree germplasm at Jhargram including 7 accessions of *Acacia auriculiformis* and 55 maize at Gayeshpur are also important bio resources to be maintained. Even Kalyani Municipality for 70 tree species, 26 herbs, 22 shrubs, 12 mammals, 17 Reptiles, 32 Fishes, 7 Amphibia, 83 Birds, 17 macrophytes and 9 planktons can be an example of bio-resource conservation and suggests about our resource strength. Our collection of agriculturally useful microbial cultures at Mohanpur is 15 bio-fertilizer bacteria, 5 bio-control agents, 5 plant growth promoting organisms, 3 edible mushrooms

among beneficial and 7 plant pathogenic fungi and 4 plant pathogenic bacteria. There are many other resources being maintained by different institutions and individuals in this State. Documentation by registering these multi-location resources along with conservation and awareness development can create the situation for their best utilization in agriculture and in other fields.

#### **Recommendations**

1. People's Bio-diversity Register of West Bengal is a stupendous task to be completed. However, the initiative already taken in some cities and villages should be encouraged by all-out people's participation. Environment Department's presence in the work should be made perceptible in all corners of the State. The program has to be spread in all the villages and cities of the State.
2. Conservation of bio-resources *in situ* or *ex-situ* as would be required particularly for those having great agricultural prospects, their registration and commercial exploitation should be taken up urgently.

#### **4. Fertilizers and manure**

INM is an umbrella-term including all aspects from soil health monitoring to increasing fertilizer use efficiency, soil testing infrastructure and system development and even paying attention to economic strata of the farmer concerned before making recommendation.

**Fertilizer use mode should be changed:** In modern agriculture fertilizer has been the key input to reach the potential productivity of a crop / variety. Although fertilizer consumption per ha in 2005-06 reached 130 kg (1.4 kg more than previous year) it is at least ten times less than what is being used in developed countries. Actual consumption in 2005-06 was 6.11 lakh MT of N, 3.58 lakh MT of P and 2.70 lakh MT of K with an increasing trend generally. The main obstacle for its increase in this country as also in the State is possibly financial inability of farmers to invest. The price that is obtained for the produce also cannot support increased investment. As a result as also for conserving or building soil fertility use of organic manure as partial substitute is advocated. The Union Government policy to close down its fertilizer factories being allured of cheap fertilizers at international market sometimes back has now been proved unwise with abnormal increase of fertilizer price. While as a core industry to strengthen agriculture of the country all the factories be on the running in the greater national interest their stepwise modernization also needs to be continuously planned and implemented. It is time that small factory for manufacture of micro-nutrient mixtures be considered and encouraged to assure quality of such products to the farmers. Soil scientists have been considering the heavy leaching of calcium and magnesium from soil under high rainfall conditions in North Bengal. Number of experimental findings suggests that regular post monsoon application of inputs for replenishment of the lost Ca and

Mg can check soil degradation to maintain its fertility. The extensive use of urea and DAP is also slowly but steadily building up soil acidity. Therefore change of the form of nitrogen nutrition is under serious consideration. Secondly some other kinds of N-fertilizer that do not give rise to acidity of soil are now experimented. Future of soil fertility status and its management in concerned areas of West Bengal will definitely depend on these issues. Scope and prospect of use of mineral resources available in the State for such purposes needs to be examined to see if utilizable. Fertilizer production and distribution is no longer satisfactory for the farmers in this country. Producer companies except some cooperatives do not pay needed attention to fertilizer distribution to farmers' level. Since the winding up of the public sector role in this sphere particularly in eastern India fertilizer dumped in a main city is taken to farmers by private players charging any amount as transport cost. Unwise also was the decision to close down fertilizer promotion activity that was offering the most needed lessons of fertilizer education to the farmer for whom loss of a single grain of fertilizer is a great loss.

#### **Recommendations**

1. Government of India should be approached for early revival of the fertilizer factories of the east. Along-with this private factory owners in the State should also be convinced about re-opening of their factories.
2. Farmers should be advised about use of lime for correction of pH of their soil that has turned acidic due to long use of chemical fertilizers like urea, ammonium sulfate or DAP.

#### **5. Manure: production and use**

**More use of organic resources:** This has gained importance for making agriculture more eco-friendly and sustainable. For West Bengal this is important since the required raw materials are available in sufficient quantities with the farmers in their surroundings. Due to increased health awareness people all over the world are getting more and more interested in organic produces. Global demand for organic products is growing day by day. Due to its geographically advantageous location India and West Bengal too has different naturally occurring organic forms of nutrients available. These are green manure, crop residue, biogas slurry, animal excreta, compost, vermi-compost, bio-fertilizer, etc. Organic farming on the one hand reduces cost of production and helps healthy food production being environment-friendly. It also can increase employment and income generation. National Project for Organic Farming in 10<sup>th</sup> plan was with the objective of promotion, production, certification and market development for organic produce in a pilot scale initially centering round the agri-export zones. A protocol of national standard for organic farming following essentially the IFOAM outline and development of a certification procedure for the country to label the organic produce as acceptable in premium market has been developed. However, the charge

in India of getting certificate of organic produce is beyond the reach of most Indian farmers. Awareness development among farmers about the procedure of organic farming is very important. Organic farming has to depend very much on development of production units of composts, bio-fertilizers, bio and botanical pesticides, etc. close to the farmer and certification of quality of such organic inputs are also to meet the specifications of FCO, 2006. Mushroom compost waste, coconut pith, and seeds of so many fruits, etc. be used for manure production. Their drying, grinding and packaging after nutrient analysis be encouraged for development of local enterprises

### **Recommendations**

1. Every farm family should be approached to have its own compost heap or pit utilizing all organic raw materials around. In the event of the family having no cattle, excreta of small animals will also be equally good substitute for cattle dung for compost making.
2. Every family shall have a liquid manure pitcher to ret in water collected soft, succulent leaves available in the premises and diluted to be used as spray fertilizer. The use of adequately fermented (anaerobic digestion) of diluted cow dung- cow urine mixture along with molasses and powdered pulses that are now being routinely used by organic farmers in Maharashtra with great success needs to be promoted.

### **6. Bio-fertilizers**

**Positive and negative aspects of chemical fertilizers:** Use of chemicals as fertilizer, pesticides etc in farming with high yielding varieties have revolutionized crop productivity in last six decades. The practice has spread all over the world. It has great contribution in increasing production of different crops thus addressing the food security issue. Famines mostly have taken shelter in the pages of history although the question of inclusiveness at all levels remained unresolved. Again it has given rise to a number of problems for environment, human health and sustainability of agricultural production. Degradation of soil health however, is of primary concern. Reduction of organic carbon in soil coupled with diminishing microbial load in it is gradually making the soil less responsive.

**Different bio-fertilizers with actual and potential use in farming:** Nearly 85% of soil microorganisms are beneficial in nature causing different conversions of soil chemicals that are essential for the plants to collect their nutrition from soil. Besides organic matter, bio-fertilizers are capable of replenishment of microorganisms in soil. Different kinds of microorganisms have been proved to act as good bio-fertilizers. Commercial production of selected strains of such microbes since 1895 has grown into a large technological umbrella supplying different kinds of bio-fertilizers. These are based on a) N-fixing microorganisms like *Rhizobium* for

leguminous crops, *Azotobacter* for non-leguminous crops, *Azospirillum* for graminaceous crops, *Acetobacter* for sugar crops and others, b) Phosphate solubilizing microorganisms like *Bacillus*, *Pseudomonas*, *Aspergillus* and *Penicillium*, etc. and c) Phosphate mobilizers like mycorrhizae. Many other plant growth promoting rhizo-bacteria like *Pseudomonas fluorescense*, etc. are also in the list.

**Replacing synthetic fertilizer:** Carrier based powder or liquid formulations of these microorganisms are in use all over the country although it has not taken an organized network structure to cater to the needs of the villages. It is envisaged that the practice of regular use of bio-fertilizers of different kinds by the farmers is capable of saving about 30-35% nitrogenous, and 20-25% phosphate fertilizers reducing the cost of production to a great extent in addition to benefiting the soil and the environment. In organic agriculture that promises a premium price for the produce, bio-fertilizers will be essential. Considering the total cropped area in West Bengal bio-fertilizers are going to have a wide clientele all over the State. Prospect of development of small village enterprises seem to have strong prospect subject to taking organized efforts. Initially at each of the 341 blocks 3-4 science graduate youths be trained by identified institutions and be inspired to establish following a model plan bio-fertilizer production, packing and sale centers having constant technology back up from parent institutions. This center in a block shall take care of the villages in the block area, in all issues in respect of the above-mentioned bio-fertilizer related activities.

**Village based Azolla culture:** Azolla culture needs also to be extensively introduced at least for the vast aman and boro rice fields. *Azolla pinnata* is commonly found in India while *A.caroliniana* grows well throughout the year. Shallow ponds, ditches and swampy lands can be used for Azolla cultivation. Cemented tanks of 50 to 100 sq.m. area with 60 cm depth and a layer of soil in the floor and 10 cm standing water is inoculated with 200gm azolla/m<sup>2</sup>. Azolla @ 1.2 ton per ha becomes 10 tonnes in 7-10 days to supply 30-40 Kg N/ha in addition to the organic matter. This however has to be a village-based program. To start with one representative from each gram panchayat be trained by identified institutions to introduce the aquatic fern to them, its multiplication in ponds and waterlogged rice fields and its conservation during summer under deep shade. Thus raw materials for organic farming as well as for substitution of a part of chemical fertilizer can be produced right in the field.

### **Recommendations**

1. Each block should facilitate local youth to establish bio-fertilizer producing unit to supply at a reasonable price packets of these fertilizers to farmers. Such entrepreneurs shall begin with only one or two kind of microorganisms like

rhizobium, azotobacter, PSB, etc after having training and cultures from SAUs and other reputed institutions and capital from nationalized banks. Similar packing, price, etc. should be followed all over the State under technical coordination of the Department of Agriculture.

2. Azolla production program may be taken up by families having a pond or so after being trained and supplied with azolla culture (matter crop) initially required for the purpose by the Department of Agriculture.

## 7. Organic farming

From the point of view of food quality and food safety organic agriculture in modern times was initiated in countries that reached highest level of chemical use and productivity in agriculture. In most of those countries production of organic inputs required higher investments for human labour in particular, and hence the produces are costlier in the markets. These largely wealthy societies were happy to pay higher prices for having food articles that are free from chemical residues and pathogenic microorganisms. While organic agriculture could successfully eliminate harmful chemical residues they opened up the chance of microbiological contamination to downgrade food quality and invite other kind of food safety problem. In fact food microbiologists often suspected (subsequently proved to be unfounded) about organically produced food items to carry pathogenic bacteria particularly 0157-H1 strain of *Escherichia coli* and other pathogens coming from organic manure used in their cultivation. Since microbiological contamination is a general issue of food quality control checking and certification is essential for such organic produces all the time. For countries like ours organic farming reduces fertilizer cost since raw material for organic manure production is plenty available at almost no cost. Over and above eco-preservation, food safety, production sustainability, etc. are expected to come along with.

Organic agriculture is gaining momentum among farmers in the country for reasons of the produce getting premium price and for providing food safety to the consumers. This has gained importance since the time when the umbrella organization International Federation of Organic Agriculture Movement (IFOAM) was constituted at Paris in 1972 to provide information and exchange knowledge. IFOAM General Assembly in Brazil developed Regulations for accreditation procedure of organic agriculture in 1992. Certification bodies were constituted to perform evaluation and certify the produce to be accepted internationally. Having a clear demarcation from inorganic agriculture the basic standards set for OA included use of organic inputs at all stages of production like crop nutrition, plant protection, quality control, storage, packaging, transportation, etc. Countries like USA, UK, Spain, and Australia have developed organic systems accordingly and number of organic institutes for standards and technology have grown and framed

standards like ISO 61, ISO 65, EEC Document No.2092/91, Codex Organic Document etc.

**Accreditation and APEDA:** In India formal procedures of accreditation and certification were developed in 1992 and the country applied to the European Commission for recognition of organic tea, basmati rice, organic sugar, honey, cotton, wheat, barley, etc. Subsequently, the Ministry of Commerce constituted a National Steering Committee that finalized accreditation procedures, evaluation norms and certification procedures. Agricultural and Processed Food Products Export Development Authority (APEDA) published them and coordinated the entire work with Tea Board, Coffee Board, Spices Board and Ministry of Agriculture. A National Evaluation Committee was constituted with experts from all Govt. sectors who advise the Steering Committee to recommend certifying firms that are not themselves producers. The system once becoming functional, assures food quality and food safety as well as promoting export of the organic products.

In West Bengal nearly 3 lakh ha of land in the districts of Coochbehar, Hooghly, Birbhum, Purulia, Burdwan, Nadia, Murshidabad and North 24 Parganas are under uncertified or by default organic farming. The main crops under this area are jute, paddy, vegetables, fruits, and flowers and only tea in north Bengal has a significant area under certified organic management (10,000 ha). Our own experience suggest that Darjeeling hills are traditionally organic; not certified organic other than tea since crops like maize, soybean, vegetables, flowers and oranges are primarily grown using only cow-dung as manure. For ecological reasons also such hilly areas should better be organic.

**Organic manure production scenario:** The present state of production of composts consumed in agriculture annually is 40.18 lakh tonnes of cow-dung, 27.80 tonnes of FYM, and 0.32 lakh tonnes of town compost. Production and use of blue green algae (BGA), azolla, rhizobium, azospirillum and PSB are 34.4, 42.8, 54.5, 108.5, 35.5 and 105.2 tonnes respectively. Coverage of area under green manuring is 73,335 ha. While chemical fertilizer consumption rate is 145 kg/ha organic manure consumption is 700 kg/ ha/ crop. China started with large-scale organic agriculture till their farmers gained strength to use chemical fertilizers supplemented by organic for obtaining high yield. It may be suggested that besides development of organic areas surrounding the five agri-export zones, three hill subdivisions of Darjeeling district may be forthwith brought under total organic agriculture creating lakhs of home scale organic manure production units.

**Fertilizer production gap in demand-supply:** Fertilizer production in India is not upto the quantity required. The gap in 1966 was 3.2 million tonnes and the projected production in 2031 would be 6.4 million tonnes. The annual nutrient removal from soil is 25.1 million tonnes whereas the supply from internal sources

including organic manure is only 15.0 million tonnes. For quality regulation of the organics the agencies authorized for accreditation are APEDA, Coffee Board, Spices Board, Tea Board, Coconut Development Board and Directorate of Cashew and Cocoa Development. National Organic Logo has been developed. Nearly one hundred certified organic producers are in the field and the guidelines for production and certification are followed as framed by any of the four certifying agencies. DAOs are to register the interested farmers of the district to make them aware of the rules and regulations. Besides Essential Commodity Act, 1955 number of other enactment have been made to regulate different commodities that are consumed. States like Karnataka, Maharastra, TamilNadu, Kerala, Uttarakhand, Mizoram and Sikkim have resolved to go for organic production in different degrees. Like Sikkim and Mizoram, Darjeeling district may also be targeted for conversion of organic producer. In 2005-06 2500 acres of land was the target area for growing horticultural crops while the target in 2006-07 is 4000 acres in 10 districts. The actual organic area is 1323.88 ha of fruits, 58.045 ha for flowers, 5269.41 ha for vegetable and 167.00 ha for betel-vine. Establishment of one certification unit in the State is urgently needed.

### **Recommendations**

1. While appreciating Government of West Bengal's decision to go for 64 bio-villages in 2008-09 financial year the Commission strongly recommends setting up of at least one appropriate fully organic biovillage in each block during the ensuing financial year. BCKV's small organic farm may serve as a model for organic management. The Department of Agriculture may discuss with scientists in SAUs to select villages and determine the models and other details.
2. The three hill subdivisions of the Darjeeling district should be immediately brought under total organic agriculture with certified organic management.

### **8. Soil ameliorants**

**Rock phosphate; phospho-compost:** Acid soils make soil nutrients like calcium, magnesium and molybdenum less available. Increase in availability of nutrients like zinc, copper, iron and manganese often cause toxicity. The beneficial microorganisms of soil fail to function properly. Crop roots are also damaged. The pH is corrected by careful addition of lime, basic slag and others about a month before sowing. These soil ameliorants are important inputs for agriculture to be used separately from fertilizers. Depending upon the type of soil, degree of acidity and the ameliorant to be used the procedure of treatment of soil should be determined by technologists. The rock phosphate based mineral powder 'Purulia Phos' is slightly poorer than 'Moosouri Phos' but can be brought under wide use in the State for improvement of soil fertility at a very low cost excepting in North Bengal. It can be used for production of phospho-compost in villages.

White powder from tamarind seeds is now identified raw material producing molecules that are good soil ameliorants that improves soil health particularly when degraded.

### **Recommendation**

1. Effort of using lime/ basic slag and purulia-phos and tamarind seed powder to ameliorate soil that needs this should be planned based upon requirement of the soil, proximity of raw material source, quantity required etc.

## **9. Hormones and growth substances**

These inputs are not very common in use. Such inputs increase branches, incites plants to bear more number of fruits and flowers, prevent dropping of flowers and fruits, and induce production of flowers and fruits in off-season. They are also used to induce rooting, remove dormancy, help germination, more seed production, and production of seedless fruits, increase the duration of fruits and flowers to remain fresh etc. Plant growth promoting substances like n-tricontanol, amino acids and brasinosteroids are also in the market for use on crop plants for improving rate of photosynthesis, rate of absorption of water and nutrients and such other functions. On being applied on the crop the hormones are absorbed and translocated by the concerned tissue of the plant and acts influencing the plant metabolism favorably. Three categories of such products are in use. Some of them increasing growth of the plant like NAA, IAA, IBA and GA are commonly used in horticultural crops. Some others like MH, CCC, and TIBA prevent growth and cause dwarfing. The third group including 2-4-D and Ethrel (2-chloroethyl phosphonic acid), etc. are used after mixing with some medium. These are in the form of aqueous solution, or powder and paste as the situation demands. As per fertilizer control order formulated products at production site needs checking of their quality so that user farmer gets the right product and at reasonable price. Production, formulation and sale of these inputs are mostly managed by private enterprises. Government or any suitable body has only to regulate their quality and pricing that is very important.

## **10. Seed production in West Bengal**

It is well recognized now that improved seed quality alone can contribute about 20% for yield. Seed production in West Bengal is in a very poor state of development excepting that farmers have a tradition of collecting and conserving seeds from their produce particularly in case of paddy and few others. But having highest percentage of land under cultivation (62%) and 83% of area having a second crop the demand for seed is very high. For a high diversity of cropping, different types of crop seeds are required. Considering the existence of six agro-climatic regions in the State seeds of most of the crops, can be very well produced in the State involving the farmers. For quality seed production some training and regular supply of true variety seed appears necessary. Producing seed from the

same crop following some prescribed procedure and getting it certified the farmer earns more. For production of hybrid and such other seeds enterprises may develop out of some initiative on the part of development agencies with technical support from technology institutions like SAUs, RRSs, KVKs., NGOs and fund support from financial Institutions. For example a set of data from State Seed Corporation, 2006 shows demand of certified seed of some crops for the State as given below.

Crop	Area, '000ha	Seed replacement rate, %	Seed requirement Req.mt /SRP	Production, mt of Certified seed	State's share %
Paddy	6150	25	76880	480148	62.6
Wheat	365	34	12381	412	3.3
Jute	614	74	3180	18	0.6
Mustard	10	35	848	654	77.1

Going by same logic the required 1259 tonnes of maize seeds, 561.3 tonnes of groundnut, 86386.6 tonnes of potato, 493.4 tonnes of urd, 154.7 tonnes of gram, 170.2 tonnes of lentil, etc. seeds are mostly brought from outside the State. Seed industry has every prospect of development in this state considering others like til, mung, arhar, khesari, linseed, etc that are grown in this State. In fact assurance of good production for a crop comes always from production and supply of quality seeds in the State and having an increasing seed replacement rate. So far production and distribution of seeds in the state is carried out through Government farms under Department of Agriculture, CADC farms and West Bengal State Seed Corporation Limited and national agencies covering mainly food crops. Private growers and agencies are covering almost entirely the seeds of other crops including pulses, oilseeds, fiber and sugar crops, vegetables and flowers and particularly the hybrid seeds. There is a constant effort of utilizing Government farm lands for production of certified seeds and quantity of seeds produced in last two years are 31,409.07tonnes in 2004-05 and 36,911.12 tonnes in 2005-06. Some initiatives are on for hybrid and other quality seed production under private-public partnership. Post-harvest handling and scientific storage of seeds is also important. For producing this volume of seeds for field crops definitely some investment toward seed processor, drier, storage and seed testing and certification laboratory of dependable standard needs to be made. International standard seed testing and research laboratory (ISTA approved) requires modern facilities to certify genetic purity, freedom from infection, seed vigor and seed viability over and above the seed purity to export seeds.

SSC data for the 2006-2007 indicated huge shortfall in seeds of paddy, jute, potato, mustard, lentil, groundnut, kalai and gram, etc.

A well-planned seed distribution system needs to be developed and run free from tradition of utter lack of seriousness for safeguarding poor farmers' interests. The rate of seed replacement should be increased. The State Seed Corporation needs to be given partial autonomy to act like an efficient, independent corporate body to function with speed and commercial outlook.

The entire seed production and seed business aspect is under the provisions of Seed Bill, 2004 yet to be enacted. Confusions in respect of farmers' right to conserve, exchange, or sale of seeds have been questioned by the provision of compulsory registration. Seed Inspector has only to see that farmers abide by the provisions but any non-compliance by seed business company shall be dealt in the Consumer Court if only the aggrieved farmer seeks justice there. This provision is not pro-farmer thereby pushing poor Indian farmers to vulnerable position. The necessary change in the Act is in the hands of Union Government. Hence till the Act is made pro-farmer the State Government should provide some protection to the farmers within its limited resources.

#### **11. Quality seed production technology**

**Seed production programme involving wide range of participants:** Identification of seed production zones like a) Birbhum, Bankura, Purulia and West Medinipur for rice, wheat, maize, jute, groundnut and potato and b) Murshidabad, Birbhum, and Nadia for pulses and oilseeds and organizing seed production program through large number of farmers or their cooperatives arranging their necessary training can be taken up by a strengthened SSC with support from the Department of Agriculture and SAUs. Breeder and Foundation seeds are to be supplied by SAUs and State Government farms where establishments nearer the zones be earmarked for production of BS and FS. The entire program has to be chalked out. Strengthened SSC shall take initiative to involve all partners including farmers' representative to plan seed production program for say 10 field crops. Similarly for seeds of flowers, ornamentals and medicinals the Department Of Horticulture has to take initiative. Rapid multiplication and timely supply to growers shall require participation of private players too. Establishment of Seed village and Seed Hub for community seed production and involvement of PACs in the program shall take shape in the course of development. Homestead and courtyard seed productions are more feasible for vegetables and flowers having link with the state programme. Networks of seed production shall have the second goal to supply seeds to big seed business to reach other states and abroad. In this program SAUs shall train up selected farmers, making weekly visit to the seed production plot, solve current problems of seed growers through group discussion, monitor rouging and post harvest operation and take part in choice of varieties, procurement price fixation, etc. with Government officers and farmers' representative.

### **Recommendations**

1. To achieve self-sufficiency in seeds for important field crops the West Bengal State Seed Corporation (WBSSC) along with participation of other suitable partners should chalk out appropriate plans and launch a comprehensive seed production program for the State.
2. Government farms should be developed as model of seed production farms and besides producing seeds it should act as nucleus of seed village to be organized around the state farms.
3. Horticulture Department should launch appropriate programme for production of seeds of important vegetables and flower crops to meet the requirement of the State. Tribals in Paschim Medinipur, Bankura, Birbhum and Purulia should be trained and inspired for production of seeds of amaranthus, okra, spinach, lablab bean, gourd, pumpkin, etc.
4. Breeder and Foundation seed production and supply should be ensured. SAUs and State farms have to share the responsibility.
5. Primary Agricultural Cooperatives (PACs) have to take responsibility of producing certified seeds by establishing seed villages like Gontra, Nadia. NGOs may also share the responsibility provided they adhere to specifications prescribed by Certification Agency.
6. SHGs should be organized to take up the job of threshing, drying, cleaning and grading of produced seeds.
7. Rural farmers should be trained to produce high quality seeds especially of the locally adapted crop cultivars and properly maintain their genetic purity and physiological qualities to save the seeds for themselves and also for exchange with neighbours.
8. Considering the importance of production and certification of good quality seed in relation to augment of production and productivity of different crops in the State an advisory committee should be made to make the State self sufficient.

### **12. Hybrid seed production**

The State has not made much headway in production of hybrid seeds of the field crops. Years back rice hybrid seeds were released by the Department of Agriculture but did not succeed for some technological reasons. Besides producing at a higher rate, hybrid seeds of field crops like maize and rice their seed production is labor-intensive thereby assuring employment generation in villages.

**Production details:** Hybrid maize seeds of variety HQPM should be produced in this state using CML-163 as male and CML-193-1 as female parents. For kharif season seed sowing is done between June 15 to July 15 and in rabi November 10 to December 10. Five kg of female line seeds and 3 kg of male line seeds are sown in an acre at 3-5 cm depth, 60-75 cm spacing between rows and 20- following male: female and male ratio as 2:4:2 or 2:6:2. Required nutrition and 4 irrigation are

altogether given. Arrival of male flower and grain formation in female cob takes place. Earthing up at knee height, removing off-types by uprooting and weeding is done before anthesis. The most important operation starts in each afternoon by removal of male inflorescence on female plants immediately on their emergence, male rows being marked with sticks. Seeds are harvested only after the bracts covering the cob are dry. Mung, kalai, etc. can be grown as inter crop in such field also. About 500 kg hybrid seeds can be produced per acre that can be sold @ Rs 45 per kg.

Rice hybrid seed production technology is a solution to a virtual stagnation in rice yield. Since 1989 when India adopted this technology from China 23 hybrids have been released from Central and State Variety Release Committees including 18 bred by public sector Institutions and 5 from private sector. These hybrids on an average recorded 15-20% higher yield than highest yielding varieties in the country. Overcoming the problems of grain quality, higher seed cost and others this technology needs early application in field particularly for West Bengal. Some of the popular hybrids are KRH 2, PA6201, PHB 71 and Sahyadri among generals and DRRH 2 among fine grained that is early duration also. The rows will be east-west beginning and ending up with male lines.

#### **Recommendation**

1. Seed producers having link and access to established hybrid seed producing companies in South India may be encouraged to take collaborative program of production of hybrid seeds of rice, maize, oilseeds and pulses (if there be any recommendable variety) and selected vegetables in the State with some facilities by State Government like providing land.

### **13. Seed production for crops with commercial prospects**

**Rice:** Exportable non-basmati non-hybrid rice varieties like Sona, Masuri, IR 64, Pusa 44 are also promising. Some of our long time known quality rice varieties like Tulaipanji, Radhunipagol, Dudheswar, etc. promise very high market appreciation once they are registered under Geographic Indicator (GI) clause respectively of Dinajpur, Murshidabad and 24-Parganas. Their yield is no less satisfactory; these need to be duly branded and taken to the market after enough publicity.

#### **Recommendation**

1. Organized initiatives are urgently required to enlist our high quality crop varieties and proceed for their registration under GI through Patent Information Center, Kolkata and then invite enterprising seedsmen to take over for commercial use.

**Wheat:** West Bengal produces only 1550 tonnes of wheat seeds and imports about 90% of wheat seeds from Punjab, Haryana, UP and others. Wheat seeds can very

well be produced and preserved in this State. Keeping not less than 3 m distance foundation seeds procured from genuine sources should be sown in mid November following standard procedure. Farmers enlisted may be trained in clean cultivation while keeping the crop disease free. Special care may be taken providing boron nutrition. Seeds certified be dried and stored dry in suitable container. Seeds with 98% purity, less than 12% moisture and very minimum inert material and other seed contaminants are good quality seeds.

#### **Recommendation**

1. Private seed producer should be selected for producing quality wheat seeds required by the State, store them and supply during the season. Payment by growers shall be after being satisfied by growing the crop.

**Jute:** Jute seed production in West Bengal has not struck roots in the State where maximum production of the crop is recorded. People often claim that seed produced in Andhra Pradesh is cheaper. Our extensive discussion with BCKV and CRIJAF scientists working on jute seed production suggest otherwise. One of the options is to sow in late July or early August, cutting of tops after 40 days, spraying urea and harvesting seeds in November. Obtaining 1.5 q seeds/ha sowing 2-3 kg (olitorious) or 4-5 kg (capsularis) will be profitable. Cultivator to retain his own seed before harvesting of jute crop may cut top 20-25 cm of the plant. The cuttings may be planted 3-4cm deep, inclined in well prepared moist land in July end for capsularis and early august for olitorious, 10 cm apart and 30 cm row to row. This is another option.

#### **Recommendation**

1. Selected private seed producer of the State should be given the responsibility for quality jute seed production in the State and supply the same to growers taking payment after the crop has grown satisfactorily.

**Potato:** As long as the quality seed production of potato is not enough in West Bengal another way of reducing transport cost for movement of huge quantity of seeds from distant places may be to produce TPS that are already being produced in bulk by Tripura and Karnataka. The TPS hybrids recommended for commercial cultivation in West Bengal are TPS C-3, HPS I/13 and 92 PT-27. In TPS technology very small seeds (Brinjal seed like) of hybrid potato are grown into micro-tuber first in a very small land area and micro-tubers are grown in field. The technology thus demands very little storage, no transportation etc and promises disease free crops. Micro-tuber and mini-tuber production in a large tissue culture green house may be taken up. Private Indian farm with reputation may be assigned the job.

### **Recommendations**

1. State can very well have large tissue culture space to develop a micro-tuber laboratory. This unit should be under private control or at SAU to take charge of producing quality micro-tuber seeds for the growers under technical supervision of scientists of SAUs to evade regular transport expenditure as also some dreadful diseases (late blight last year) coming through tuber seeds from other states.
2. In the last season 195 q of potato foundation seeds of 4 varieties and only 45 q of certified seed of Kufri Ashok were available at State Seed Farm, Anandanagar on 1<sup>st</sup> week of September. This should also be strengthened to meet a part of the requirement.

**Comment:** A regular transparent macro-potato-seed production network should identify the supplier of Foundation seeds, grower of Certified seed and so on indicating the quantities to be produced. While this chain of macro-seed tuber production in potato requires 4-5 years of time with increasing chance of infection outdoor, the indoor mini and micro-tuber production program takes 2 years and the seed remains free from pathogen infection.

**Pulses:** Both the country and the State are in shortfall of pulses importing 1.47 million tonnes in 2004-05. Supply of good quality seeds is absent. Taking care about this aspect Andhra Pradesh has achieved 9.36% increase of productivity of chickpea. While for productivity increase, seeds of better varieties of chickpea, pigeon pea, lentil, mung, kalai, khesari and field-peas need to be multiplied in our State under definite seed production programme, the local elite varieties like *sonamung* be multiplied, grown, registered and branded for premium market.

### **Recommendation**

1. Selecting the varieties program for seed production of pulse crops like chickpea, pigeon-pea, lentil, mung, kalai, and khesari should be produced in farms in Red and Lateritic Region under the supervision of the Department of Agriculture.

**Oilseed:** Similarly quality seed production of oilseed crops like mustard, groundnut, sesamum, sunflower etc are also to be taken up. Hybrid sunflower seeds can be produced in this State profitably with seed rate ha being 8-10 kg and harvesting 20-25 q/ha.

### **Recommendation**

1. In Berhampur farm certified seeds of oilseed crops like mustard, groundnut, sesamum, niger, and linseed should also be produced in quantity required by the State.

**Maize:** Hybrid seeds of maize should also be produced in the State after the Government has indented the quantity to the business group reputed in this sector. State has tremendous scope of producing maize crop to meet its demand for animal fodder and feed, human requirement of grains and vegetables. This C4 crop has capacity to produce more per unit area using more fertilizers. Naturally requirement of seeds of different varieties of maize within the State is urgently required.

#### **Recommendation**

1. Maize seed production both of selected composite and hybrid varieties should be organized in western districts. With proper management practices seed yield may reach above 5.5 tonnes per ha. This will fetch good return for the farmers joining the program.

**Seed processing:** At the initial stage considering three districts in the west and two districts in the center of the State, development of district-wise infrastructure for seed processing, storage and packaging as also seed testing be considered. Seed business demands quality and to meet the demand of the State only a big business can very well grow. This will open up employment opportunities and income generation.

#### **Recommendations**

1. Number of regional seed processing, packaging and storage infrastructure requires to be developed in State-private partnership.
2. People of producer villages should be organized into cooperatives or SHG to purchase from growers, undertake primary processing and then sale to the subsequent, packaging and storage for sale.

### **14. Fish seed production**

West Bengal produces surplus seeds of major carps. But most important is production of seeds of small and other fishes having higher commercial value.

#### **Recommendation**

1. Small hatcheries for catfish, prawn, mourala, parse, bhetki, and galda (*Macrobrachium*) should be organized facilitating rural youth with training, bank loan and infrastructure development.

### **F. Production systems**

On the basis of a communication from Department of Agriculture it appears that total production requirement of State during 2015- 2016 in respect of food grains will be 187.14 lakh tonnes, total oil seeds 17.22 lakh tonnes, potato 47.84 lakh tonnes, vegetables 95.68 lakh tonnes, fruits 38.27 lakh tonnes and like wise. The estimate has been made on the basis consumption rates (in grammes) like rice-394g, wheat-60g,

pulses-35 g, oilseeds-45 g, potato-125 g, fruits 100 and vegetables-250 g per capita per day.

### 1. Crop production and crop sequence

**Sequence suggested:** Agro-climatic regionwise crop sequence for the State can vary widely. There always is a technologically sound crop sequence. Farmers' choice however differs for economic and social reasons. The essential component of a crop sequence has to be at least one leguminous crop. For hilly region (foothill to 1500 m) rainfed system may have early maize or summer vegetable in pre-kharif, early or medium rice and a fallow rabi. Rainfed area, however, shall have medium hybrid maize in pre-kharif, medium rice or soybean or vegetables in kharif and potato/ wheat/ barley/ vegetable in rabi. Terai region may have jute-kalai-khesari/ tori/ tobacco/ sunflower in rainfed and medium land, jute-rice-khesari/ linseed in lowland. In irrigated area jute-medium duration rice-wheat/ potato/ tobacco/ vegetables for up and medium land and in lowland grasspea / green manure-late rice-medium boro rice. Red lateritic area may have in upland fallow situation-short duration maize/ vegetable/ groundnut/ any pulse crop- tori /sunflower, in medium land fallow-maize/ rice-rai / groundnut/ linseed/ safflower and in lowland fallow-rice-khesari/ lentil/ linseed. In irrigated area on upland situation crops that can be grown are maize/ mung/ sesamum/cowpea/ vegetable-maize- tori/ maize/sunflower/wheat, in medium land maize/ sesamum/ mung-groundnut/ vegetable-tori/ wheat/ potato and in lowland situation one may grow grasspea- rice-wheat/ potato. In coastal saline, non-irrigated region uplands may have fallow-select vegetables-chilli/ watermelon while medium land should have fallow-rice-barley/safflower/sunflower crops and under low land situation green-manure-rice-cotton/ khesari/ barseem/ vegetable are good. In remaining new and old alluvial regions, given the soil condition and rainfall, lands be kept covered round the year with crops or varieties giving maximum economic return. The pre-kharif season can always have a leguminous green manure/ fodder or a vegetable with little care of moisture conservation. This region followed by terai and coastal saline region must have one paira crop so that tilling is avoided and the crop cover actually acts as moisture conserving living mulch. The next few lines come from a long experience with paira cropping.

**Paira in sequence:** Aman or kharif rice on 4112.9 thousand hectare area in the State is entirely rainfed. Centering round this primarily rainfed crop the areas under medium and low flat land situation with alluvial soil host of crops mostly pulse and oilseeds can be grown with retained soil moisture during rabi season as paira that is no tillage crop. The crops include grass-pea, lentil, gram, pea, and rajma among pulses, linseed, safflower among oilseeds, and fenugreek, coriander, among spices, oat among cereals and sunnhemp for seeds. These crops may be followed by jute in pre-kharif after either of grass-pea, lentil, oat, sunnhemp, gram and pea or by

groundnut after grass-pea, lentil, oat, sunhemp, gram and pea or by mung bean after oat, sunhemp, gram and pea. This offers wide options for a rainfed 3-crop system with one rabi crop as paira. Paira legumes do not require any NPK fertilizers but non-legumes do require 60:30:30 per ha. Production economics of such cropping system ranks maximum benefit by pea, gram, lentil, and grass-pea in order as paira. The soil moisture content in rice-fallows in dry months from December to March are 21.3%, 19.2%, 16.2% and 11.5%. When a crop (grass-pea) exists as a cover these percentages are invariably higher. This is the message to be used in future crop planning. The philosophy of paira is a long practiced tradition in Bengal agriculture that is now being advocated in the name of 'No till' or 'Zero till' with the ultimate objective of mechanization and chemical herbicide use which will definitely invite environmental, agroecological and social problems..

So far rabi paira crops have been discussed. The land to be selected for rainfed pre-kharif paira crop would be those where irrigated crops like wheat, potato, mustard, boro rice, oat or vegetables were grown in rabi. The object is to utilize the rest of the moisture in the soil. Just before harvest of the irrigated rabi crops like wheat, potato, mustard, seeds of selected varieties of mung/bean/ maize/ sesame/ jute/ mesta/ cowpea/ aus rice/rice bean be sown at double the usual seed rate to be followed by rabi crop harvest and laddering lengthwise and crosswise with wooden or bamboo ladder immediately after. Here selection of variety is important and expert suggestion is Pusa Baisakhi/ Sonamung, Kalindi (black gram), Navin (jute), IET 579/Khitish (aus rice), Co-1 (cowpea), Sada/Lal (mesta), Kalyani-1(rice bean). The technology and timing are simple to be followed. Cropping system research clearly indicated highest productivity (22,708 Kg/ha) in paddy-potato-jute system but highest cost: benefit ratio (2.46) in paddy-paddy-cowpea system. Besides these two paddy-paddy-sun-hemp and paddy-mustard-jute are also quite good.

Shortfall in **wheat production** (980.5 thousand tonnes, 2004-05) is also bothering growth of food industry towards fulfilling the consumption need. Possibly for industries requiring 'pasta' some area needs to be devoted to cultivation of durum wheat. One way of increasing wheat area and production is sowing of seeds immediately after harvest of aman rice without wasting time to till the land (paira) selecting PBW-543,443, 343, HD273 for timely or PBW-533, HD-2733 late sowing.

Red-lateritic districts of the State should be used for extensive **maize cultivation**. Maize grains are in high demand for development of animal feeds. This State having so little per capita cultivable land needs much to develop animal resource based production in villages. Again for shortage of land there is little scope to produce green fodder in large quantities. Growing sufficient quantity of maize will provide the concentrate part of animal feeds, particularly for the growing poultry industries. Soybean as a source of oil and the DOC as animal feed strongly deserves

the attention of policy makers, as being a legume, it would be of added advantage. The organized programme tying up requisite number of farmers, entrepreneurs and technologists can change the scenario. Besides growing food industry producing flakes, popcorn, etc. has also great demand. The maximum promise for this area may come from growing corns yielding sugar, oil, etc. that are so important for our State. Specific industrialist with concerned expertise may be contacted and program may be chalked out. This would be commercial venture in which farmers included, as raw material suppliers will benefit economically besides opening up job opportunities. Baby corn production on a large scale may meet the requirement of urban people of the State. In hill region also maize stands very good prospect. Experimental findings have confirmed composite varieties like RCM-1/3 (yellow) and RCM-2 (white) to be best performers. Seed minikits of these varieties may change the scenario in hills becoming a place for supplying raw material of animal feeds. This certainly will bring economic gains to the hill farmers.

**Oilseed production** has to increase manifold. Production of kharif groundnut in up and medium lands with good drainage in the red-lateritic tract providing gypsum as incentives to farmers is expected to bring a sea change. Similarly rabi sunflower in saline tract after paddy supplying seeds of right variety involving large number of farmers shall ease our edible oil crisis. As mentioned earlier, as a leguminous oilseed soybean needs to be considered seriously. These programme taken up as mass programme should also be accompanied by appropriate industrial solvent extraction programme. Mustard requires only technological intervention. Good land preparation (very small seed), laddering before and after sowing assures to maintain same depth of seed at sowing and same height and time of maturity of plants. Harvesting in full mature stage in early morning eliminates podbursting and seed loss during harvest and avoids loss of 5% oil when harvested at 50% maturity stage. Sulfur nutrition should be assured in all oilseed crops.

**Pulses:** Production increase in case of pulses is also possible in this State. FAO/WHO recommends 55g for non-vegetarian and 80g for vegetarians every day. Production of 1.67 lakh tonnes (2004-05) in the State covers only 15% of the need. The crops that are competing with pulses are occupying more and more area excepting wheat and boro rice. Varieties must be replaced with Sweta/Chuni for pigeon pea, Panna/ Sonali for mung, Sarada/ Kalindi for Kalai, Asha/Ranjan for lentil, Nirmal, Ratan for Khesari, Mahamaya-1/2 for chickpea and GF-68/Dhusar for peas. This along with 10-20% annual seed replacement shall increase production by 20-30%. Taking little more care in timely sowing seeds in rows, weeding, *Rhizobium* application on seed before sowing, and good soil and pest disease management can lead to good profit for the farmer. Paira khesari alone can cover vast areas. Rabi pulses should be included under crop insurance and support price for the same should be increased.

**Cultivars:** Varieties of crops recommended are Shatabdi, Rasi, Sasyasree, and Khitish for irrigated rice, Rasi and PNR 381 for uplands Manassarovar, Swarnadhan and Sashi for shallow water land, Sabita, Madhukar, and Bhudeb for semi-deep water, Neeraja, Jalapriya, and Jitendra for deep water and CSR 10, CSR 13, CSR 27 for saline soils. In both kharif and boro hybrids recommended are CNRH 3, DRRH 2 and JKRH 401. Improved varieties of Indian mustard are Sej 2, JD 6, Pusa Bold, Toria- PT 507 and Panchali, Yellow sarson- Ragini, Jhumka and Subinoy. However, replacement of toria with early mustard varieties has been suggested. Short duration aman rice ensures early sowing of mustard that is so important. Among vegetables hybrid tomatoes like ARTH 3, BSS 20 or hybrid brinjal like JBH 1, ARBH 541 are recommended. Early maturing Kufri Surya has been suggested for rice-potato-sesame or jute cropping system replacing Kufri Jyoti.

**Fodder production status:** Fodder production is of great necessity for the State. Annual green fodder requirement for the State is estimated to be 92.6 million tonnes and only 1.9 mt is produced at present on available 1.8% of total land. Concentrating on red laterite and coastal saline tracts crops like rice bean, *Stylosanthus seabrana*, guinea grass, napier, bajra be introduced in large scale in lateritic and other areas. For coastal region *Coix* should be introduced. Another important way is to make large scale planting of top-feed species of plants like subabul, *Glyricidia*, *Inga dulcis*, etc. in which leaves and pods could be good fodder. Another step that the Department of Animal Husbandry should take up is to build up statewide infrastructure of storage-cum-preservation system (stores, silage, etc) of green fodder. This may be in the mode of multiple enterprises with private village investments and little Government incentives. But this network would be most important to support a productive animal production system. Grazing lands need better management both administratively and technically. Village panchayat members be trained for the purpose and the animal owners excluding BPL category be charged at a nominal rate to build up an effective system.

**Feed block and feed pellet** production for animal and fishes at each block utilizing local resources and proven technologies from SAUs can be good support for animals in villages. Animal feed block machine installed will utilize excess dry fodder.

For each locality or field suitable **crop sequence, timing and varieties** have to be selected as per advices of ADOs or knowledgeable farmers. For instance medium-up and uplands in Paschimanchal have minor fruit crops as best options which after establishment may provide good growing space for some vegetables. Rice can only grow in lower lands followed by pulses or oilseeds. Similarly saline soils in South 24 Parganas may have sunflower or cotton after harvest of transplanted rice. Before

transplanting rice such inundated saline lands in North 24 Parganas may be used for raising tiger prawns for short period after which land is puddled to transplant rice. There may be thousands of combinations for lands in other areas.

**Cropping systems** depend much upon farmers' requirements and demand of his produce in local market of crops agro-ecologically adapted. The most important factor is now becoming the social context. As an example a farmer family in New Alluvial Region opted for tuberose in traditional paddy field for better market in the eighties. In the nineties they went for bananas for better income. They have shifted to guava /mango in 21<sup>st</sup> century for reduced number of family members to look after agriculture. The next step expected is farming family leaves farming for better options in non-farming sector. This is also taking place very slowly. This social transformation cannot be ignored while planning agriculture.

### **Recommendations**

1. At the onset of monsoon rice bean should be grown as fodder and food crops that can act as a cover crop to reduce soil moisture loss besides food and fodder.
2. Drought resistant *Stylosanthes seabrana* and Guinea grass should be grown in red lateritic area. *Coix spp* can be grown in saline area to meet the fodder requirements of the respective zones. Improved varieties are Bidhan Coix-1, Makuni guinea grass, Bidhan rice bean-1 and 2, and EC 408405 or Humilis for Stylo.
3. Top feed species like subabul, *Glyricidia*, and *Inga dulcis* should be seeded in new bunds in July or on sloppy lands (50%) also preferably in east-west direction.
4. Selected shade-tolerant fodder species should be grown in the floor of forest fringe and orchards.
5. Considering that a large area of cultivated land in this State is under aman rice crop sequences should be planned centering it. However, the duration of aman rice in field is to some extent regulated by the variety to be put in the desired crop sequence. Under all circumstances where water control is possible, an adoption of System of Rice Intensification (SRI) is strongly recommended.
6. Each combination should preferably include one leguminous crop.
7. In rainfed area paira cropping with khesari or lentil or mustard or even kalojira or sunnhemp avoids tilling of land and shortens duration.
8. In view of the large deficit between present requirement and production of pulse and oil seed crops in the State as well as is its magnitude in the coming years, an advisory committee is proposed to be formed for pulses and oil seed crops in relation to its strategic inclusion in the cropping sequence throughout the State with an aim to reduce the gap between requirement and production.

## 2. Farming system

West Bengal being a state of small and marginal farmers (90% of operational area under control) requires off-farm or backyard activities like dairy, poultry, fishery, goatery, piggery, etc. for enhancing their income and livelihood security. FS approach is quite traditional and common among our farmers for generations. In the present context of declining productivity of major crops, draw down of water table, degradation of natural resources like soil and increasing input costs, farming is becoming non-profitable day by day. National Farmers' Commission mentioned the NSS finding that states that 40% of Indian farmers want to leave agriculture given a better option. West Bengal Human Development Report, 2004 also indicated a high percentage (state average 12%) of migration of farmers to non-agricultural job highest being from Howrah (70%) followed by Darjeeling (65%) and others.

**Farming system at different regions:** One study at the Central Agricultural Research Institute, Andaman and Nicobar Islands possibly presents a model integrated farming system that provides resource-poor farm family nutritionally rich fresh vegetables, milk, egg, meat etc in addition to the food grains. The one hectare land accommodated 8 cropping systems including paddy to sugarcane, a range of vegetables, flowers, spices and fodder on the one hand and 3 cows, 2 bullocks, poultry and fishes following unique multi-tier spatial designs giving net income of Rs 2,59,985 from crops, Rs. 29343 from cattle, Rs. 17464 from poultry and Rs. 1840 from fishes.

Studies at Durg, Chhattisgarh were in search of a sustainable mixed farming model integrating crops, livestock, poultry and ducks using them in complementary manner on a 3.5 acre land holding resulting good production and generation 571 man days (385 in arable farming) almost uniformly round the year. Orskov's experience in South East Asia (2004) of multi-culture in coconut and oil palm plantations with grazing cattle has improved soil fertility, cattle milk yield and nut and copra production.

The FS has to be developed according to the existing situation in the concerned agro-climatic region. Small and marginal farmers may get livelihood security through this multi-culture even in red-lateritic tract in better way since it ensures soil fertility build up.

**Few suggestions for agro-climatic regions:** In new alluvial region while crops in the field may be rice, potato, sesame, bhindi or mustard in suitable sequence, the animal rearing may include cow, goat, poultry or duck as may be chosen. Upgrading of cow using bull that has record of parenting a calf that is best milk producer among locals, growing fodders and arranging concentrate feeds made with local resources.

Similarly in **old alluvial region** having crops like rice, potato, bhindi, sesame and mustard in suitable sequence the farmer may go for similar animal rearing program. Farmers having ponds may go for mixed fish culture and duck rearing. All these can enhance best utilization of family labour as also increase in income and family nutrition. Studies under AICRP Cropping System Research under BCKV have established the increased income by 2.7-5.2% in new alluvial region and by 2.38-8.70% in old alluvial region.

In **hill region** besides field crops like paddy, maize, soybean winter vegetables in hill summer, squash, ginger, large cardamom, etc. are grown. Fruits like oranges, peach, plum are grown in homestead gardens. Cattle, sheep, khaki campbell duck, and jhora fishery are quite remunerative. Good quality orchids and other flowers and ornamentals, cacti and succulents are good.

**Terai region** produces all the field crops including capsularis jute, rice, wheat, groundnut, potato, different vegetables, ornamentals, aromatics, medicinals and spices keeping the options wide. Cattle, poultry, goats, pigs on the one hand and different fishes on the other can come in the farming system. Culture of tasar, muga and eri are quite promising.

**Coastal saline region** have not many options of combinations. Most of the field and vegetable crops, flowers and medicinal, fruits and fodders grow. Cattle, goat, sheep, pig and poultry on one hand and different fishes, silk, etc. on the other may offer different farming systems chosen by farmers' own option.

**Red-lateritic region** also do not have many options. Minor fruit orchards may accommodate vegetables, groundnut, pigeon pea and maize along with small animals like goat, sheep, pig and poultry. Lac culture and tasar culture are two important components. Crops like cotton or sugarcane may have different combinations. Large animals will require larger investment.  
(See Annexure on Farming systems)

### **Recommendations**

1. Farming systems matching with farmer's economic strength and requirement should be planned based on his own and local resources and possibilities. However, every farm-family must have animals small / medium / large in manageable numbers, fish culture in his pond, bee-keeping box under his one or two fruit trees to support his crop agriculture, animal rearing leading to income increase, human resource utilization and family nutrition.
2. Mutual dependence between crops, animals, fishes, etc. should be best exploited to harvest the synergistic benefit that is so much required for livelihood and

nutrition security of the farming family and income and employment increase for family members.

3. An integrated farming system model have food-grain, vegetable, flower, one or two top-feed fodder and fruit-plants, spices and medicinal plants along with one or two cattle, goat, sheep or pig, duck and fowl, bee boxes, fishes and others as is possible to ensure food, nutrition, income, employment for the family members.
4. The Commission strongly recommends the adoption of the System of Rice Intensification (SRI), in situations permitting regulation of water, besides intensive research and extension programmes of SRI in our State. Incorporation of seed invigoration in SRI with the ultimate objective of sowing sprouted rice seed directly in the field avoiding transplantation should be critically studied to avoid raising of nurseries and the more difficult-to-do transplantation of very young seedlings in the field.

### **3. Multipurpose agricultural farm**

In the fallow lateritic uplands in Paschimanchal multipurpose agro-based area development has great prospect. Some of the earliest privately developed agro-based productive areas include the one developed in Bankura by the Late Satish Dasgupta, and another in Paschim Medinipur at Seva Bharati, Jhargram by the Late Pabitra Kumar Sen.

One recently developed farming enterprise at Jhargram over 300 acres of fallows with additional features and organic farming motto has met with recognition and success. These initiatives of converting fallow lands into commercial productive units could be taken as model for area development having multiple objectives including mixed farming dependent on local work force and resources side by side with natural museum and resting hubs to assure publicity and marketing of its produces.

Another in Burdwan with similar characteristics covering over 200 acres of fallow land with commercial agriculture as one of its motto has also been developed. Large fallow lands may be converted to attractive multipurpose goals including total farming system, orchard development, field, vegetable, medicinal and flower crops interspersed with cottages for nature park visitors and takers of produces in a beautiful environment creating employment and income for local people.

One horticultural farm in North 24-Parganas having a rich collection of varieties of horticultural crops has developed tourism facilities in the garden making the enterprise more viable.

### **4. Crop diversity increase**

This is good for soil health, and for removing market glut or distress sale of agricultural produces in the market. New and commercial crops suitable for different areas have been identified. A basket of information about suitable crop-

options along with their time of sowing and other aspects of technology may be available with the farmers. Availability of seeds is also to be assured.

**Ramie in North Bengal:** For instance ramie (*Boerhaavia nivea*) producing long, strong, alkali resistant and finest bast fiber needs to be cultivated in large scale in north Bengal. Organized effort on the part of the district will help growth of a new, quality cloth and paper industry to feed the domestic and export demand, enhance income of farmers and employment for unemployed.

**Paper pulp from mesta:** Another case in point is development of kenaf or mesta (*Hibiscus cannabinus*) based paper-pulp industry in the western part of the State covering areas of Birbhum, Bankura, Purulia and Dinajpur. The shortfall in paper pulp supply for paper industries in the State shall no longer remain a problem.

After a long and intermittent effort cotton is being grown successfully in the State to meet the demand of the mills. Besides South 24-Parganas, it is rightly being introduced in the western belt. This commercial crop shall not only increase the industrial strength of the State but also increase income and employment of people.

**Wet land plants:** Crops like water-chestnut (*Trapa bispinosa*), makhana (*Euryale ferox*), madurkathi (*Cyperus tagetes* and *C. coriobosus*), sitalpati (*Clinogyne dichotoma*) etc can be cultivated in large (525 thousand ha) water areas in addition to about 10-11 lakh ponds in this state. Water chestnut contains 23.3% carbohydrate and 4.7% protein and only 0.2% fat. The carbohydrate is easily digestible and used in selected purposes. All these are commercial crops and only require policy support of the State for their good processing and marketing. Their cultivation program if encouraged by the State shall help in the conservation of water bodies.

**Marshy land crops:** Some other plants with medicinal properties like kalmi (*Ipomoea aquatica*), brahmi sak (*Bacopa monnieri*), helencha (*Enhydra fluctuans*), etc. grow in marshy land. Their cultivation by women folk in villages fetches them some income contributing to the economic strength of the family and for use as traditional medicinal herbs.

**Bamboo** is another crop production of which could be encouraged by distributing bamboo saplings from propagating centers like BCKV, Kalyani and others. This very fast growing crop has immense prospect of supporting the farm families in different ways. It can also promote cluster/chain of small village industry development assigning from village to downtown one group of families each for production, processing, machining, chemical treatment and final product making following the Chinese model.

**Cane/ bet** are a creeper that can be extensively grown on trees of forest fringe to be supplied as raw material for furniture industry that can grow in adjoining villages.

Several other crops with commercial prospect like *Aeschaenomaene*, kulekhara, vetiver, camphor, vanilla, coffee, muscara (*Abelmoschus moschata*), etc. should be included in different situations.

The entire plan of crop-diversity increase shall minimize the chances of epidemic development by pest or diseases as also the rate of soil degradation. This is of great importance and one of the most eco-friendly techniques for reducing crop loss due to loss of fertility and catastrophic diseases and pests.

### **Recommendation**

1. Selected crops traditionally grown in some parts of the State may be introduced in some more areas. Considering the need for selection and adjustment of some of them according to the agro-climate, economic conditions and need of the farmers the system of introduction be decided.

### **5. Farm forest development**

Farm forests are usually devoted to growing multipurpose tree species (MPT) in uncultivable land pieces, however small they are, around agricultural farms by the cultivators for obtaining some more of their requirements like fuel, fodder, and some timber needs also. Some of the selected species include sonajhuri (*Acacia auriculiformis*) for fuel and fodder and ordinary timber and gamar (*Gmelina arborea*) for good quality timber. For the former exotic lines have given highest plant height and maximum diameter at breast height. Agri-silvicultural system study suggests crops like rice, groundnut, cowpea or black gram in between rows of selected multipurpose trees plantations may be practiced as a suitable combination. Even in teak (*Tectona grandis*) plantation under suitable spacing these four field crops performed well. Gamar is also usable in such a system. Technologies for silvi-agricultural and silvi-horticultural system that have been developed need application in western barren lands for economic gain of the local poor. Farmers' field demonstration of such productive systems at Keshiary, Bidisha (NGO), Baghaberia, Chandkumari (Sabong), Dharampur (Naihati), Gayeshpur (Nadia) and Dharampur (N. 24-Parganas) by BCKV may constitute foci for such programs. Tree species for different agro-climatic zones have been identified. They are sonajhuri, jhau, siris, arjun, neem and white poplar for saline tract, saal, karanja, mahua, siris, khaer, babul, palas and mahaneem for lateritic tract, karanja, arjun, sisu, snai, mysore gum for wet land, and gamar, sisu, teak, jhau and black siris for ravine area. Economically sisu, gamar, siris and ghora neem for fuel, fodder and timber, glyricidia, subabul and sesbania for fuel, fodder and manure, jhau, eucalyptus and ambu for pole, aonla, ber, arecanut, bael, ata for fruits, and arjun, ber, palash, and kusum for commercial insect rearing. These plants and systems selected properly for a family or a region may contribute economically and environmentally.

### **Recommendations**

1. In the barren uncultivated lands of lateritic and other regions farm forests should be developed generally by planting sonajhuri, gamar, teak and eucalyptus for meeting requirements of fuel, fodder, timber, etc. Growing rice, groundnut, black-gram, or cowpea between rows of the plants mentioned above will provide more food and biomass.
2. For saline zone nurseries producing sonajhuri, jhau, siris, arjun, neem and white poplar should be established to supply seedlings for wasteland planting program to launch.
3. In laterite tract nurseries for producing and supplying seedlings of saal, karanja, mahua, siris, khaer, babul, palash, and mahaneem to cover wastelands should be established.
4. For wet lands in different areas karanja, arjun, sisu, snai, jarul and mysore gum are selected species. Waste wet lands need these seedlings for planting.
5. For ravine area seedlings required to be produced and planted are gamar, sisu, teak, jhau, and black siris.

Village people should be asked to form groups to take up the job of seedling production and planting. Forest Department has to provide training and seeds, etc.

Following the system being developed in Vietnam it is suggested to utilize forest floor engaging more fringe-area people in addition to the existing forest protection committees, and issuance of permits for collecting minor forest products.

### **6. Cultivation of edible microbes**

Growing crops in green house is a necessity in many temperate areas to avoid frost injury and low temperature problems but not much in our State. Only commercial high-value crops like flowers, vegetables, succulents and cacti are grown since they can afford this high expenditure. In West Bengal this was taken up in Darjeeling hills since long and it has now spread down in plains. For field crops, specific commercial purpose is required to go for such expensive practice only for export.

**Mushroom growing - Self entrepreneurship:** A very important indoor cultivation / culture practice is growing mushrooms for additional nutrition for the family and income generation. Practically fungal species like *Pleurotus*, *Calocybe*, *Volvariella* can be grown in this State indoor or sometimes under tree shades even over 8 months avoiding the hard summer. The seeds of mushrooms are produced only with some indoor facilities like steam-sterilizer, incubator, refrigerator, and heater, Laminar Air Flow Cabinet, etc. under technical supervision. Two- three persons may be trained in the microbiological technology and extended bank support to build up the facility one at each block of the areas of the State except sub-humid western tract. Say 100 women mushroom producers trained for the purpose may

surround each mushroom seed production center. They will require one thatched shade with mud-wall and raised floor. These growers will purchase mushroom seeds from the block center to grow on chopped fresh straw. These growers will together form say 10 SHG to pack fresh mushroom in poly-bags and sale in identified semi-urban habitations and also consume themselves assuring family income and nutrition security. SAUs should take the responsibility of training, advice and cultures of the fungi. Considering that West Bengal is producing huge quantity of the raw material (rice straw) and also has developed technology for this highly technical production system, this employment and nutrition-generating program should be taken up in full swing.

### **Recommendations**

1. In each block at least one Mushroom Seed Production Centre (MSPC) should be established. Training youths (2-4 per block) in this job and supplying culture by SAUs, while providing loans to such persons for infrastructure development may start the process of such development.
2. About 100 women surrounding each MSPC should be trained by mushroom seed producers to grow mushroom after purchasing seed packets from MSPC and arranging fresh straw after harvest of rice.
3. Separate team / teams with members of mushroom growers should be formed to market mushroom in nearest town.
4. Mushroom grown refuse should be dried and ground into manure powder since it contains 2-4% nitrogen due to presence of mycelium.

**SCP-Feed:** Livestocks in this State are short of nutrition. Both green fodder and concentrates are in short supply. One of the most modern techniques of producing proteins, vitamins, etc. is microbiological conversion of cellulose rich greens into Single Cell Protein (SCP) by growing identified bacteria (*Xanthomonas* species) on such substrate. This also requires indoor-microbial culture facilities like that of mushrooms. Such facilities created at the block level by entrepreneurs will be good concentrate supplier.

### **7. Insect based production**

Requiring not much of prime agricultural land for cultivation of crops like mulberry, growing of trees like arjun, ber, som, soalu, cultivating castor or palash, kusum, etc. can be done on marginal lands in villages. These plants are hosts of a number of different beneficial insects found as silk insect (*Bombyx mori*), tasar (*Antherea pernyi*), eri (*Philosamia ricini*), muga (*Antherari assamensis*) and lac insects (*Laccifer lacca*). Cultivation of these insects on plant or leaves from the respective plants has immense prospect. The quality fiber produced by first three insects and lac produced by the latter may help grower to earn a lot of money. While silk insect requires indoor culture others are grown on the plants concerned.

**Mulberry silk - Status and production data:** Production of mulberry silk has increased from 8.29 lakh kg in 1990-91 to 15.53 lakh kg in 2005-06. Due to introduction of HYV of mulberry, leaf production has increased. Area under mulberry could also be increased from 30,032 acres by initiating its cultivation in other areas. Producing good quality mulberry leaves for rearing the insects scientifically through following modern reeling and weaving, etc. procedure in details seem to be very good profit making. Silk industry may grow in Malda, Murshidabad, Uttar and Dakshin Dinajpur and other districts of the State. Protection of cocoons and their drying steps are very important. This is achievable through training from Government Sericulture Department and SAUs.

### **Recommendation**

1. Development of mulberry gardens on marginal lands on the one hand and establishment of family based center for production of different items for silk culture infrastructure, reeling centers and market for selling polu on the other are required for increase in silk production.

**Tasar:** Tasar silk is produced in a limited scale, with production being only 0.27 lakh kg in 2005-06. So far tasar insects are reared in situ on standing host plants like arjun, sal, ber and asan plants. Covering of the insect larvae on host plant leaves to protect them against birds is necessary although this increases the cost of production. The success of one BCKV scientist in indoor rearing of the larvae should be taken to farmers. It is a good option for low cost production. This fiber and cloth from it has more demand in the market and promises a price better than mulberry silk. Organized development of this production system should be taken up in western part of the state. Technology for indoor cultivation as developed in BCKV may bring a change in the economic conditions of the tribals and other backwards in those areas.

### **Recommendations**

1. Programs should be taken to spread tasar cultivation on host trees in lateritic zone on a large scale.
2. Indoor cultivation of tasar insect following technology developed by BCKV should be initiated in concerned areas.

**Eri or endi:** Production of eri silk unfortunately has come down from 0.11 lakh kg in 1990-91 to 0.05 lakh kg in 2005-06. This insect has been grown as small venture in some areas in this State. Possibly decline in cultivation of castor- its host plant is the reason behind. There remains, however, ample scope to launch a program of its spread in terai area.

**Recommendation**

1. In different corners of terai zone castor areas should be developed at least in 100 spots on marginal lands to boost up cultivation and production of eri silk.

**Muga:** Muga silk is traditionally grown in Assam, Manipur, Meghalaya and Coochbehar district of West Bengal on leaves of som and soalu plants. This is also a very good quality silk that has demand in the market.

**Recommendation**

1. Muga production should be spread in Coochbehar by increasing 'som' and 'soalu' planting. Groups may be formed to look after this program in partnership with the Forest Department.

**Lac:** Natural lac has tremendous demand in the country and outside. Development of lac culture on different trees like kusum, palash, ber, etc, by backward communities is taken care of by Backward Class Welfare Department of the Government.

**Recommendations**

1. Processing of lac and its marketing should be emphasized so that the producers get remunerative price.
2. Distribution of lac-stick should accompany training of the persons selected for the job.

**Bee keeping:** West Bengal produces quality honey through bee keeping (*Apis mellifera*) as also through collection from forests (*Apis dorsata*). Honey has tremendous demand in medicine industry and otherwise. There is a global concern due to a significant decline in bee population caused by large scale use of pesticides leading to colony collapse disaster (CCD). Their cultivation in boxes yields upto 130 kg/year/box that is highly remunerative. Production of bee wax is another income source. Exploitation of two others namely royal jelly and bee toxin, if properly developed, could be very profitable. A quality testing system has been developed in Haringhata, Nadia. Enormous possibility of employment and income generation for landless people exists through this profession.

**Recommendations**

1. Awareness generation on bee keeping is essential not only for honey but for sustaining the productivity of agricultural and horticultural crops as well as many other forest plants that are cross-pollinated by bees; as such necessary steps by all concerned organizations on an emergency footing should be initiated.

2. Bee keeping should be a family program for every cultivator family in all the agro-climatic zones. This will necessitate production of bee boxes in large scale in all the districts. Persons should be trained and supplied with specifications.
3. Extractors should be manufactured by local artisans providing them training and specifications.
4. Packing and marketing of honey produced are very important issues.

This area of production system can occupy a major development program involving village people after obtaining training and technology from SAUs.

**Specialized farming:** Farming these days extends to unusual areas and places. In fact these kinds of farming are developed and being practiced for different periods in different situations.

For example road development with time has created ‘nayanjuli’ that is being utilized for growing different crop plants like banana, swamp taro, drumstick, etc. and wet seed bed of rice. In cities ornamentals are cultured in pots with cinder where application of nutrient solution is resorted to. Quality flowers like chrysanthemum, rose, etc. are produced in amateurish style. People are growing creeper vegetables mostly cucurbits, chilli, tomato, brinjal, etc. meeting small family needs.

Fly-ash ponds of thermal power plants, mine-waste lands and such others are also cultivable. Model farming on Kolaghat fly-ash ponds by BCKV has demonstrated the commercial feasibility of such ventures.

Farming under different kinds of cover from green house or poly-house to agrinet covers allowing entry of different quantum of sun light for growing different kinds of quality and commercial ornamental plants from sim-carnation, to roses, etc. In post-monsoon season sandy river banks and ‘diara’ lands can be brought under cultivation through ‘thupi’ system using organic manures and sowing seeds of crops like potato, groundnut, watermelon, cucurbitaceous vegetables etc.

### **Recommendations**

1. Roadside farming should be organized both in terms of extending support through providing technology, planting material and growing the crops and also marketing since roadside farming is done by poorer section of people.
2. Amateur flower and vegetable growers mostly in cities should be given training, while supplying planting material. Unemployed and non-student youth may be encouraged to take up this profession of pot cultivation, potted plant supply, etc.
3. Waste lands left by coal miners may be brought under cultivation of different crops/ trees. The SAUs should take up necessary steps to develop technology and farming mode for their best use.
4. Selected crops be grown by SHGs on sandy river banks and diara lands in post-monsoon season with spot application in ‘thupi’ of organic manure.

## **G. Crop protection**

Crops grown have enemies – biotic and abiotic. Abiotics include weather problems, physiological problems and nutritional problems. From acid rains to sun scorching though are not very common needs local attention. But deficiencies, toxicities, moisture stress and excess are amenable to management. Good agriculture practice needs to be emphasized. Even poor storage conditions may lead to loss of crop produces. For instance ammonia leakage or poor air circulation in cold store may cause rotting of stored potatoes. Brick kiln fumes are causing black tip of mango a case of acid injury. Deficiencies of boron or molybdenum destroy cruciferous vegetables and shortfall in moisture causes fruit fall in many crops. Even sudden irrigation or rains after a long period of drought or no irrigation leads to cracking of many vegetables like radish, cabbage, etc.

### **1. Environment, climate change and disorders**

The essence of climate change for these days is global warming that is a global process, as such, correction of that has also to be global. But at every stage conscious effort to minimize emission is needed. Even in India there are states with zero forest area. A correction is necessary. West Bengal in this regard has a positive growth having 13.38% forest area while vegetation cover is 27% of the geographical area of the state. Excepting Kolkata and Howrah districts all other districts have some forest area. But situation in districts like Hooghly, Murshidabad, Nadia, Uttar and Dakshin Dinajpur demands improvement. Schemes like protective afforestation, eco-conservation in Darjeeling and Purulia, economic plantation in degraded forest areas of Duars and Terai, coastal shelter belt plantation in Medinipur, plantation of quick growing species in lateritic area and rehabilitation of mangrove forest in Sundarbans are going to indirectly benefit agriculture of the State also. Inter-planting of select agricultural crops between plantation lines during first three years in high rainfall areas in North Bengal is a praiseworthy scheme of the Forest Department.

Excessive use of ground water in agriculture has direct and indirect adverse effects on agriculture and environment. Increasing surface water resource and substituting a large portion of ground water use in agriculture with surface water is environment-friendly.

Spread of electricity supply in all villages expected to be achieved in West Bengal in 2009 is also going to reduce use of fossil fuel thereby cleaning the local environment. It needs to be reminded in this connection that electricity generation by coal or other fossil fuel-fired thermal generators by itself is not environment friendly. Substitution of a substantial part of chemical fertilizer with organic manure and pesticides with bio and botanical pesticides are also pro-environment.

Increasing crop diversity again is environment-friendly approach being proposed in this report.

Bio-safety regulations are required to be framed and strictly followed to protect our agricultural environment from contamination by GM varieties or weed seeds or so. Finally the most important issue is to prepare to combat the environmental hazards like floods, droughts, hailstorms, etc. which cannot be accurately predicted or stopped but can only be managed. However, planned preparation on the basis of medium term forecasts and if possible short term forecasts can minimize the extent of crop loss and to quickly arrange post-hazard cropping schedules.

### **Recommendations**

1. Planting selected trees in ails (field boundaries) lying in proper direction may contribute reduction of carbon dioxide in air by more efficient carbon assimilation. They also act as effective bird perches and provide loppings for compost making, fuel, etc.
2. Conservation of soil and water would correct problems and thereby reduce cyclone *i.e.* hazards and droughts.
3. Providing the bare land a crop round the year covers it suitably.
4. Minimizing tillage on soil through paira cropping, and organic farming is required.
5. Correctives for all the specific problem types mentioned above also can protect crops or their produces to some extent.
6. Agricultural scientists, engineers, meteorologists, statisticians of repute in the State should be invited to sit together in a Standing Committee on Disaster Management to design the work plan for the coastal districts. State Council of Science and Technology and Department of Environment may also do the needful.

## **2. Crop protection from pests and diseases**

These days crop protection is relying much upon integration of different methods of protecting crops from pests and diseases causing minimum damage to the ecosystem. Well planned management programme based upon the environment and population dynamics of pests and pathogens need to be undertaken. The object is only to keep pest or disease or weed pressure on crop below the level that can cause economic loss. There is no essential need of total elimination of pests, pathogens or weeds. Adoption of economically justified management steps with minimum intervention in the crop field ecosystem and surroundings would help to achieve due profitability in crop production. Sustainable agriculture has its foundation in i) integrated nutrition and irrigation management, ii) integrated pest-disease and weed management, and iii) integrated farm management. The biological bases of integrated pest-disease and weed management include enhancement of organic matter of soil, maintenance of the structure of soil and enhancing the number and activity of soil microbes. Selection of local popular crops, increase of resistance in crops against pest and diseases and selecting among newer varieties that are eco-

friendly in the area is also important. These are indeed the basic tenets of ecologically sustainable organic farming as well as low-input farming systems. The impact of global warming being felt in the fast change in the pest, disease and weed pattern in the field in different seasons has necessitated new approach in crop protection.

**Non Pesticidal Management or NPM** has now come to replace IPM since pesticide lobby has virtually trapped the IPM to make pesticide use a compulsory event in IPM. In Andhra Pradesh pest and disease control has been made a programme of cultural, biological and traditional techniques of pest management using farmers' innovation and all the local resources for the purpose with the initiative of the Society for Elimination of Rural Poverty (SERP) and Center for Sustainable Agriculture (CSA)

Some common steps are soil solarization to restore soil health and general sanitary measures in field as also in storage. Practicing pruning of infected plant parts and rouging of infected plants, nutrition management, spacing, drainage and irrigation management are no less important. Selection of tolerant varieties, correct timing of cultural operations, optimum depth of sowing and such other practices have also been suggested for having a better crop health. Bird perches, trap crops, light traps, pheromone traps, use of neem seed kernel extract, spraying fermented urine and dung of cows are important components of NPM.

Using proven traditional knowledge in crop protection is important. Monitoring the balance between pest and predator-parasite or pathogen and suppressor microbe in field has to be the basis for decision making in regard to chemical intervention. Experts expressed concern about disease and pest problems of rice, potato, mustard, vegetables, coconut, mango, guava, rose, tagetes, china-rose. Wilts of trees like gamar, sisu, bakul, khiris, etc. are also destructive. Integrated methods have been suggested using cultural methods, bio-pesticides and botanical pesticides developed from *Trichoderma*, *Bacillus*, *Paecilomyces*, *Pseudomonas*, and plants like neem, citronella, karanja, porashi, etc. These along with some traditional knowledge are the upcoming remedies.

### **Recommendations**

1. Allowing natural eco-system in and around the crop field to continue which routine pesticide use be avoided helping the natural balance of pests-predators or pathogens-suppressor to continue.
2. Use of mild repelling agents like kerosine emulsion, or tobacco decoction, cattle urine preparations or erecting birds' perch or dead toad/crab 's foul odor can be made.
3. Use of traps – light, pheromone, etc. should be launched in a massive way.

### **3. Bio-pesticides and botanical pesticides**

The need of the hour is to develop bio-pesticide and botanical pesticide production network throughout the state by inspiring local educated youth to establish block level production unit after being trained in SAUs. Each establishment requiring around Rs.7.0 lakh only as investment as the farmers of the State are now ready to accommodate quality products in their production cost. Technology, cultures of fungi and bacteria and time-to-time advice will come from experts in SAUs.

VAM or vesicular arbuscular mycorrhiza are a group of specialized obligate saprophytic fungus that grows on or in roots of plants helping them to draw nutrient from a wider area in soil. As a result they work as an extended root system of the plants concerned. They can be grown and applied as inoculum to the roots of some crop plants to absorb more nutrient particularly phosphate.

Botanical pesticide production program depending on simple local technology may be based on neem, citronella, casuarina, mahua and karanja products. Formulation of neem and citronella oil based EC and granules have been standardized and can very well be taken in production process to check soil borne diseases and some pests. BCKV can provide necessary technology.

#### **Recommendations**

1. Blockwise bio-pesticide production centers have to be established. Rural youth should be trained and supplied cultures of *Trichoderma*, *Pseudomonas*, *Bacillus*, *Beauveria*, *Metarrhizium*, etc. by SAUs and facilitated to receive capital and build up infrastructure for the purpose.
2. Growing and cultivation of identified trees and crops to supply raw materials of botanical pesticides should be initiated. Production centers for neem and citronella oil, EC or granules, should also be developed with lower investment. SHG should be organized.
3. Training and culture of *Trichogramma* and other insect predators and parasites should be mass produced in the form of egg-cards for sale to farmers.
4. Training of extension staff and innovative farmers on identification of NPV affected larvae in crop field and procedure of their multiplication should be done by KVKs and RRS of SAUs.
5. Taking technology from SAUs VAM production on roots of potted plants like maize and its collection and application on to the roots of some trees at the time of planting is recommended.

### **4. Plant health clinic**

Establishment of Plant health clinics one at each district by State Agriculture/ Horticulture Department manned by plant protection experts will provide necessary strength to the crop protection programme.

**Weed management** has to be planned as per crop season and cultivation conditions. Specific management practices emphasizing manual programme are required for nurseries, upland, transplanted and direct seeded crops. Very often growing intercrops, mulching, zero tillage along with hand weeding or hoeing are best solutions.

#### **Recommendations**

1. Plant health clinic should constitute a part of Agri-clinic at the block level having experts supported with digital plant health guide in CD at the block 'Tathya Kendra'. The digital PHG should be developed by selected experts of the State given assistance in CD development under guidance of the universities.
2. Transplanted rice cultivation should shift to SRI system in 'Boro' and up & medium aman lands and increased weed pressure should be controlled exclusively with paddy weeder. Direct seeding of pre-invigorated sprouted paddy seeds should be developed to avoid the problem of very young seedlings (2-leaf stage) without injury to the tender roots.
3. Local artisans should be trained and provided specifications for producing paddy weeders required in a village.

#### **5. Registration of local elite varieties**

Services that are now urgently needed are registration of our local elite crop variety resources that have extraordinary characters and prospects. Proper documentation of the rich resources of rice, mung bean, black gram, cucurbits, turmeric, chilli, tea, mango, indigenous fishes, goat, pig, sheep, duck and poultry is urgently needed and a consortium of concerned scientists in the State should be constituted to prepare the outline of procedure we require to follow in this regard. There is also a need for registering pure cultures of agriculturally important fungi, bacteria, etc. that have been identified for their excellent characters in our SAUs and other institutes.

#### **Recommendations**

1. Documents should be prepared for our elite and special varieties like the rice cultivars tulaipanji, radhunipagol, badsahbhog, kanakchur, sitasal, sonamung, black gram, cucurbits, kalo kachu, pathar kuchi, tomato, akashmukhi chilli, Darjeeling tea, lakshmanbhog, himsagar, fajli mango, black bengal goat, garole sheep, ghungroo pig, maurala, parse, bhetki, kachki, tangra and many other fishes.
2. Cultures of Rhizobium strains, Azotobacter, Azospirillum, PSB, Volvariella, Calocybe, Pleuratus mushrooms, *Trichoderma harzianum*, *Bacillus subtilis*, *Pseudomonas fluorescence*, etc. cultures should also be registered.

## **H. Post harvest activities**

Post harvest activities in our country continued to be in 'primitive' stage for long time. Harvesting and storage has been technologically very weak resulting in high percentage of loss. Packaging remained traditional while storage conditions were far below satisfactory standard. While more than 80% of agricultural produces are processed in developed countries we continue to be in the 10- 15 % range. Our food habit does not allow this to grow since we are mostly uneasy with ready-to-serve system. All these required technological and industrial changes in outlook for future progress.

### **1. Harvesting, storage, grading, packaging**

To make agriculture profitable to the maximum extent, operations starting from harvesting need attention. Some examples may clarify. Harvesting mustard at full mature stage leads to bursting of pod and loss of seeds. Harvesting half-mature pods leads to around 5-6% loss of oil. Harvesting full mature at early morning prevents any loss for the pods remaining wet. For cereals and pulses stopping irrigation 7 days before harvest is required for the mature grains to have 14-15% moisture. After the crop reaches the specific stage giving signs it should be harvested on a dry day. Threshing, drying, winnowing and bagging be done quickly. Moisture in grains to be stored must come down to 8-10% or as per storage requirement. West Bengal produces a total of 158 lakh tonnes of cereal grains and 1.54 lakh tonnes of pulses. Storage structures are required accordingly. Pulse grains moistened with oil keeps better. Major grain market yard may require necessary facilities for better preservation.

**Jute and Mesta** crops after harvest require retting for fiber production. Traditional retting must be strengthened with concrete slabs to be used as weights. Alternately using simple ribboning machine retting may be done in concrete vessels with clean water. These will take care of quality of fiber—color and lustre to help the farmer getting better price. Fungal (*Aspergillus/ Penicillium*) or bacterial (*Clostridium*) cultures may be used.

There remains scope for grading of produces especially of fruits, vegetables and flowers as also improvement of packaging that attracts the consumer. In case of post-harvest treatment of potatoes with brick powder and bagging in net-bags for cold storing and marketing are important steps to be followed.

### **Recommendations**

1. Farmers' awareness development meetings should be organized to tell them about correct stage of crop and field for harvest dealing each crop separately.
2. Specifications of drying grains and spot checking of moisture content have also to be taught. Jute retting in water bodies should be at least improved by use of

- concrete weights. Ribboning and retting in concrete tanks with less water should be introduced on a large scale. Microbial culture use should be popularized.
3. Grading system has to be introduced in case of all the crop produces so that the farmers get remunerative price.
  4. Each village should plan development of storages with emphasis on major produces of their fields. Each block should plan for at least one multi-chamber cold store.

## **2. Agricultural produces and food processing**

Presently this is done in a primitive and outdated manner in the country and the State. Only 10% of the food grains and 30% of the fruits and vegetables are processed in this country. Even these are also not modern in terms of methodology. In fact processing of agricultural produces, their preservation, packaging and extension to consumers, technology development and certification are yet to take shape. It has to be produce-wise some of which may be discussed.

**Rice:** India produces 91.79 million tonnes of paddy (2005-06). 100 kg of paddy contains 22 kg husk, 5 kg bran, 2 kg germ and 71 kg white rice. Byproducts like husk and bran are also valuable provided they are rightly and timely separated. Age-old hullers cannot do this. Over and above they break 20% of grains. All are mixed and difficult to be separated since de-husking and polishing takes place simultaneously. Bran is unfit for oil extraction (6.75 lakh tonnes worth Rs 2000 crore). Modern rice milling techniques need to be extended. . Development of solvent extraction plants for bran-oils is possible if they are rightly and timely separated. Failure in production of these raw materials in technologically viable quantities is not encouraging establishment of these mills. The existing system of production of rice powder, muri, chira, khoi, etc. their packaging and distribution need modernization for quality improvement and good market. An organized sector has to grow out of this so that rice-processing industry gets a comprehensive shape in the State. Different food articles fermented and non-fermented are produced and consumed using rice and pulses mostly in home scale. Many of them could be commercialized in ready-to-eat form and marketed.

### **Recommendations**

1. Modernization of rice mills to minimize broken grains and quickly polish out bran to extract oil is strongly recommended.
2. Husks should be used to generate electricity as is already being done.

**Jute:** Large number of Jute mills in this State are outdated. Only product is gunny bags and a few others. While technologies for product range diversification are ready at NIRJAFT, Tollygunge their application is yet to be fully commercialized. Production of diverse consumer goods from jute fiber and the stick from cloth to

gunny, paper pulp to quality carbon, hard board to caplon, bags to jackets, etc. are in the product list of NIRJAFT- technologies. Many other products can be developed and jute based raw materials can be fruitfully utilized.

### **Recommendations**

1. Geo-textiles should be produced and used for preventing land slides, erosions and in road-making. SHG should be organized to take up production program of woven and non-woven products from jute through development of an effective marketing system.
2. Paper pulp and paper production industry development using whole jute plant is to be seriously taken up by appropriate industry house(s).

**Sugar and alcohol:** Similar is the situation with sugar industry in the state. The State is in short supply of both sugar and alcohol. It should initially increase production of the raw materials like sugarcane, sugar-beet and suitable variety of corn to a great extent. Based upon this, establishment of modern mills in these sectors may take place. Sundarban Alcohol Factory based on sugar beet requires restarting after having a second raw material (rice) supply so as to run it for another 200 days after sugar-beet has supported 100 days. As the market stands such sugar or alcohol factories should have options of production of both, and if required sugarcane molasses also, for commercial viability. Since the state has dearth of both sugar and alcohol, the project should not be closed down.

Sugarcane production be introduced in non-traditional areas in Purulia also to support sugar mills in Nadia and Birbhum. Sugarcane bagasse can be used as a useful composting material.

### **Recommendation**

1. Sugar beet factory in South 24 Parganas producing alcohol should be revived by producing sugar beet nearby to run the mill for 100 days. Running the mill for another 200 days in the year will require saccharification unit and supply of rice grains. Even low cost F-grade rice from storage godowns serves the purpose. The mill should be authorized for bottling of alcohol and use of sugarcane molasses for alcohol production that has good demand.

**Paper:** Another sector where we have enough raw materials being produced but mills have not come up is paper pulp production from kenaf or mesta. The State is short of supply of papers. Still mills converting whole plant to paper pulp has not yet taken shape.

Large-scale propagation of bamboo becoming feasible with new technique its large-scale production has become possible. NIRJAFT has the technology.

**Flour:** Wheat production in the State is again on the rise. Food industry demands pasta made from durum wheat that we have to grow. Besides flour, suji, etc. have high demand.

**Maize:** Maize grains are in great demand for food, feed flakes, etc. Our State has to develop corn flake, corn sugar or corn oil industries. Animal feed production needs supply of corn. Yellow maize is required for poultry feed.

**Edible Oil:** Groundnut, soybean, sunflower, etc. can support edible oil industry with solvent extraction technology. Confectionery groundnut is in great demand for food industry. Soybean cultivation could be spread in hills and other areas including western lateritic tracts.

**Fuel oil:** Production of jatropha, karanja, neem, mahua, jojoba, etc. for oil is going to have high demand once production area for seeds of these crops spread in western part of the State. However, research on various aspects including species/variety selection, agrotechnology, oil percentage, etc. is very much required before recommendation for mass production.

**Potato:** Potato could be raw material for so many processed items and West Bengal is surplus in production. For processing, potato requires storage at moderate low temperature (not below 5<sup>0</sup> C) after treatment with sprout suppressant like CIPC or IPC. From powder making, as such, production of wafer, french fry, and cubes, etc. that has demand in all markets so processing industries may further develop. Fried products like chips, french-fries, dehydrated products like dice and granules and canned products have great demand.

**Handloom:** Bengal has a long tradition of handloom use for production of cloth. In fact history of cotton mills in Bengal suggests that cotton was once upon a time a crop of this State. Success in growing cotton in saline tract as well as in lateritic tract has opened up the prospect of growth of cotton mills with local raw material supply and also growth of handloom industry. The State has produced million meters of handloom cloth in 2005-06 showing an increasing trend during this millennium. Sales turnover of Cooperative Societies (2210) was Rs32.39 crore in 2005-06. Moreover handloom sector employs 6.66 lakh people. Growth of agriculture in this area has importance.

These are very important areas where raw material produced in agriculture could get premium price with development of these industries.

Agricultural development depends upon development of all these industries also to a great extent. Farmers' income depends very much on these programs of development of agriculture and industry hand in hand.

## **I. Technology, infrastructure and agricultural development**

### **1. Biotechnology**

Biotechnology is one of the powerful tools that are being used over thousands of years in various forms e.g. fermentation and clonal propagation, food, medicine, etc. The older biotechnology, now referred to as 'soft biotechnology' includes, tissue culture that has greatly benefited agriculture. The more recent genetic modification through widely used in many fields including agriculture has, however, generated a lot of controversy specifically in respect of genetically modified crops (GMCs) that dominates the agricultural scenario of North America and is almost totally corporate sponsored. Genetically modified varieties of maize, soybean, cotton, etc. are being cultivated in several other countries and rejected in many others. Creation of these varieties being in the hands of transnational companies seeds of GM crops cost too much for average Indian farmers. Besides varieties strengthened with Bt (Cry) genes are posing health and environment problems too. Government of India has empowered its Department of Environment to monitor these varieties through GEAC. The system being left to the care of private seed company is creating problems of different kinds. Not a single step toward maintaining bio-safety or environment protection is visible inviting controversies all over.

#### **Recommendation**

1. The West Bengal State Agriculture Commission reiterates its decision on the ban on field trials and commercial cultivation of GM crops in West Bengal. Following the release of the IAASTD report it will be wise to keep watch on the highly controversial issues including GM crops the development of which is entirely under the control of multinationals. Environmental and biosafety issues as well as difficulties of the small and marginal farmers should be satisfactorily resolved before introducing GM crops in the State.

**Soft biotechnology** has already made a space in the area of producing commercially successful tissue culture plants of banana, citrus, papaya, mahua, coconut, ginger, potato, large cardamom etc in huge numbers in short time making them virus free. Such planting material production units need to be developed in the State taking technology from SAUs or other institutes of the State.

#### **Recommendations**

1. Private production centers of tissue culture plants of banana, coconut, citrus, mahua, ginger, large cardamom, etc. should be encouraged.
2. Regulation of the quality of such products is very important and should be organized by the Government. Establishing freedom from viral or bacterial infection through apical meristem culture requires expertise, as such,

infrastructure, so important for future of agriculture should be properly developed.

3. Production center of micro-propagated saplings of medicinal plants like sarpagandha, aswagandha, thankuni, kalmegh, chirata, ginger, turmeric, ghritakumari, tulsi, citronella, neem, brahmi, pudina, amlaki, nayantara, anantamul, basak, etc. may help in saturating different areas of the State with medicinal plants that are in good demand.

## **2. Computer, compact disk and IT for agriculture**

Since agriculture is practiced in remote villages communication of recommendations, and information dissemination need to reach distant corners. It is now conceived that development of block level nodes of IT network can very well take all information by e-mail within seconds. Call centers at each GP or cluster of blocks may serve as knowledge banks for the farmers via ADO/KPS. They can have direct link with SAUs and Directorate to receive specialist advice.

Market information may be provided through this network. Advice on market price, market location, and kind of transport to be availed may help farmer to maximize his revenue. CD may be developed on specific crop health problems like pest, disease or nutrition in question–answer format involving experts. Copies of the CDs should be made available to all the blocks or ADOs when they are equipped to read.

### **Recommendation**

1. Call centres at each block with digital technology and knowledge bank with one IT personnel of the same village should be established to offer advices to farmers taking it from the conserved CD through a computer.

## **3. Agricultural wastes and bioenergy**

**Bio-waste, rice husk electricity:** Agricultural crop residues and wastes accumulating after crop harvest like arahar stalk in Jan- March, groundnut shell and mustard husk in Apr-Jun, rice straw and husk in Jun-Dec, maize stalk and cob in Aug-Dec and many others provide huge quantity of bio-waste that can be used to generate energy for agriculture. These are in use traditionally. Recent use of rice husk for generation of electricity (WEBREDA) in West Bengal is scientific and holds promise for a bright future. Either of biomass based thermal power plant in decentralized form or biomass gassifier to use solid biomass for conversion. The later, however, cannot be dispersed. To produce 1 kWh electricity 0.9- 1.1 kg biomass is required. Composite development plan for agriculture may naturally include this aspect also.

### **Recommendations**

1. Following WEBREDA technology small bioenergy generation plants should be developed in each gram panchayat using agricultural wastes including rice husks etc.
2. Bio-gas plants should be established by farmers having livestock for meeting the energy-need of the family kitchen using animal excreta and chopped greens and crop residues.
3. The State Government should explore the possibility of using NREGA funds for labour use (in the installation of gobar gas plant) besides giving adequate subsidy for materials such as those used in the construction of gas chambers, pipelines, burners, etc.

### **4. Biofuels: Biodiesel**

Biodiesel can be produced from plant seed oils and animal fats. Processed jatropha oil (by trans-esterification) can be used as biodiesel. It may be mixed with the petro-diesel and used in engines.

Several economic gains potentially arise out of the cultivation of jatropha. It can bring into use wasteland in the State, generate rural employment, prevent soil erosion and improve the quality of the soil. The produce in the form of straight (un-processed) jatropha oil may be used for lighting, lubrication and cooking as well as for making of soap and candles, etc. Once an adequate area of land comes under jatropha cultivation, biodiesel units can operate profitably and may be set up. An increasing use of domestically produced biodiesel would contribute greatly to relieving India's dependence on imported oil. Experiments are on such that straight seed oil may be blended with kerosene and diesel at the local level to run pumpsets, generators and tractors.

Other than jatropha, some promising tree species (tree borne oilseeds) have been evaluated as source of seed oil. Indigenous species like karanj, neem, tung, mahua and sal all bear seeds that yield oil fit for conversion to biodiesel. Though currently India's biodiesel programme has been based on jatropha seeds, for reduced operating cost a multiple feedstock-based strategy is needed. These trees can easily supplement jatropha to yield seed oil that serve as feedstock for trans-esterification units for the commercial processing of biodiesel.

Some additional benefits accrue from the plantation of these indigenous oilseed-bearing trees that can be regarded as a long-term investment. Leguminous species like karanj can fix atmospheric nitrogen and enhance soil fertility. They are important sources of minor forest produce like leaves, medicines, flowers and fodder for the local population. It is desirable therefore to use these indigenous species for afforestation of degraded lands in West Bengal.

## **5. Rural infrastructure for agriculture**

West Bengal agriculture is in the way of transformation to commercial agriculture from subsistence agriculture. After satisfying the need of the family of the grower, the growth of agriculture depends upon remunerative price of agricultural produces in market. Nearness of location of the market, the standard of the market and communication to that including roads and transport system are very important. After becoming a bulk and surplus producer of a commodity, the development of storage system and processing organization encourages agriculture in the next phase. However, before that road development is most important for progress of agriculture as also the nation. Recently International Food Policy Research Center has stated on the basis of a study that road development worth of Rs 1.0 crore means 1650 persons coming out of BPL clutch, 24% increase in agricultural productivity, 55% creation of non-agricultural job and 31% increase in wage.

Barring the closure and de-hire /release of some godowns and warehouses during 2005 and 2006 storage capacity has been increasing steadily in this State. In 2004 it reached 2,15,000 tonnes capacity that stands now at 2, 16,150 metric tonnes. Besides there are nearly 400 cold stores including more than 50 multiple cold stores.

### **Recommendations**

1. Besides having more north-south and east-west 4-6 lane corridors of National and State Highway status villages should have road connections through PMGSY.
2. Electrification of all villages, increased irrigated area and assured supply of quality inputs are necessary.
3. Community threshing floor, storage godowns and cold store are required in every village.

## **6. Industry and growth of agriculture**

Industries using raw material from agriculture as well as those producing machineries, inputs, etc. required for agriculture act as incentives for growth of agriculture. During 1995-2005 252 number of industries in food (Rs 1,546.68 cr), 22 in leather and rubber (Rs 162.34 cr). 17 in paper, wood, ply (Rs 159.61 cr), 91 in textile (Rs1,629.10) some in fertilizer among different chemical industries indirectly promoted growth of agriculture. During 2006 also huge investment in these sectors and in jute, leather, tea, silk, edible oil, etc. might also have contribution.

Small industry development in all the districts including more than thousand units in Kolkata, Howrah and Purba Medinipur and more than 500 units in Burdwan, Paschim Medinipur, Murshidabad, Nadia and North 24 Parganas during 2005-06 also contributed.

### **Recommendations**

1. Industrialization and urbanization should continue to extend indirect support to agriculture by providing better market as also machineries, inputs for increasing production and processing facilities for providing better for agricultural produces.
2. Small industry development with organized marketing of their produce should continue to grow with all government support.

Industry development and urbanization should be encouraged to minimize human pressure for job in agriculture. Population dependent on agriculture should come down to avoid further pressure on land fragmentation of small holdings in course of time.

### **J. Rural development through panchayat**

Panchayat in West Bengal strengthened with delegated administrative and financial power and participation of larger number of local people in local development activities is particularly promoting agriculture directly and indirectly. Their annual plans include components related to irrigation, water and soil conservation, land development, supply of all kinds of inputs – all aimed at alleviation of rural poverty. Activities like renovation of water bodies for harvesting and conservation of more water in a village and introducing micro-irrigation, fallow and unproductive land development, horticultural plantation under social forestry, watershed development and distribution of various inputs from seeds-saplings to kids-chicks and fingerlings to poorer people are directly contributing to agricultural development. Stage is now set for strong convergence of all activities of the concerned line departments with panchayat programs at Gram Panchayat, Panchayat Samiti or Zila Parishad levels as is required.

**Panchayat functioning:** Devolution of functions to panchayats or the people is the declared policy of the State Government based upon the 73 rd amendment of the Constitution. Devolution of functions requires to be followed by devolution of fund and functionaries of all the concerned line departments. The Commission strongly feels that close coordination of all line departments engaged in rural development activity is an essential prerequisite for integrated development. Panchayat management by imposing three 'F's *i.e.* fund, form and functionary need be continued. As was the situation before introduction of 'one line administration' in the State, all the extension officers of line departments need to be made available in block premises with Panchayat Samitis for implementing programs interacting among themselves and especially by involving farmers in large numbers. In this context capacity building of panchayat bodies is very important for their playing the key role perfectly. At district level also continuous interaction of Standing Committees with technical personnel of line departments is also necessary.

To make them available the West Bengal Comprehensive Area Development Corporation system in the State has rightly been transferred to Panchayat and Rural Development Department. The Commission considers this a wise decision to build up this structure having number of agricultural farms under their control as a strong input for production and supply system emphasizing the biological inputs. Taking a district-wise approach to production of quality seeds of crops, animal resources, fishes to the extent of meeting requirements of the district should form a part of the district plan.

### **Recommendations**

1. Panchayat structure in the State should be utilized for coordinating the services to meet the requirement of farmers with technical experts of the line departments particularly at block or PS level.
2. At gram panchayat and block level, personnel should proceed in development work in unidirectional way following the course outlined by Rural Development Department. Creation of Rural Engineering and Technology Cell and conducting all public works and road development as also irrigation and public health under common departmental leadership is required for speedy and desired progress of agriculture.
3. Capacity building through trainings of different category of people should be organized by panchayat samitis with technical experts of line departments.
4. Line department activities in regard to agricultural development in a village or block or district be in coordination with panchayat and sister line departments.
5. Input production program through Comprehensive Area Development Corporation (CADC) by Panchayat and Rural Development Department (P and RD) should be in coordination with line department programs of input production and supply.

### **K. Rural development and organizations**

The panchayat system, self-help groups and cooperatives are key organizational forms that function in villages being made of the people, for the people and by the people. They are mutually related and play as partners in village and especially in agriculture development. Besides the above the nongovernmental organizations (NGOs) are also contributing significantly to agriculture and rural development as awareness generators and facilitators.

#### **1. Panchayati raj**

The key organization in the villages for facilitating rural and agricultural development in a state is the panchayati raj system. In West Bengal an elected PR system is functioning being elected by villagers every 5 years as per the regulations of the country. Delegation of administrative and financial power to this 'village government' has been so far the best in the country. Agriculture of the State has immensely benefited from this system.

Two other systems that have come to strengthen the village reconstruction and development along with panchayat are self-help groups and cooperatives. Sparsely distributed NGOs are of no less importance. But when the question of developing all 40,000 odd villages comes probably SHG and cooperatives have a very big role to play. However, the cooperative systems running for a long time in West Bengal also could not make much headway excepting in the rural banking sector in the recent times.

### **Recommendations**

1. At village level Gram Panchayat Pradhan should have some village youth as secretary for guiding and leading activities of line departments like Agriculture, ARD, Fishery, Horticulture and Food Processing, etc.
2. Panchayat samities at block level should have identified village youth as assistant to Sabhapati to lead and coordinate implementation of line department activities and implementation of different development projects.

### **2. Self-help groups**

*Details given in separate section.*

### **3. Cooperatives**

*Details given in separate section.*

### **4. KVKs**

It has been a national policy to establish was to have one KVK in each district. In West Bengal the quota was recently fulfilled. Being a center equipped with number of agricultural scientists, a small agricultural farm and access to modern technologies KVK selects suitable technologies to transfer and integrate those in the farming system of the district. Its intervention to develop agriculture in diverse direction and show the farmer different options to increase productivity, income and improve livelihood is expected to bring the desired change. KVK can be the center of new technology, new variety and new farming system for the different areas of the district. It can collect traditional knowledge from among farmers, sharpen them and transfer to them. It is mandated for arranging trainings, interactions between scientists and farmers and demonstrations for the benefit of the farmers.

Some of the KVK activities in West Bengal as in Bankura, South 24-Parganas and others have earned recognition among farmers of the locality as well as at the national level. Early steps to improve KVK activities in all of the districts in West Bengal are very much necessary.

### **Recommendations**

1. KVKs should organize trainings round the year for capacity building of the farmers.

2. KVKs should arrange 'counseling camps' in farmers' field for taking some urgent message to the farmers.
3. Special efforts should be made to meet aged and experienced farmers of the village and record in detail his experiences and traditional knowledge and technology.
4. KVKs should offer under approval of SAU – certificate and diploma courses to educated rural youth and SHG members to develop enterprise.

## 5. NGOs

NGO activity in West Bengal agriculture has not been as impressive as in many other states, specially in the South of the country except some under Paschimbanga Vigyan Mancha (PBVM), Sri Ramakrishna Mission Ashram, Nimpith (SRAN), Tagore Society, PRADAN, DRCSC, Service Centre, Kalyan Sankalpa and others. To encourage their growth as well as to regulate and control negative activities in the name of NGOs following recommendations are being made.

### Recommendations

1. NGOs should be encouraged to participate in developmental work of villages especially backward ones maintaining transparency and auditability of their organization to the Rural Development Department.
2. Rural Development Department should hold annual meeting for stock takings and progress about their activities and for assigning any responsibility for development work.

Selected NGO specially involved in agricultural and rural development works in the State should be considered for allocation of government sponsored project funds for specific rural welfare-oriented programs.

## 6. State agricultural extension network

A recent study on the agricultural extension work throughout the State has revealed some truths. Of the 5 identified extension activities of ADOs in blocks, farmers' training was found to be the most important one. Besides importance of demonstrations, IPM, soil testing and changing cropping pattern were identified to be in the relative order of importance. From all the information about present activities it is clear that there is little opportunity for the ADO to act as per his / her own understanding of the local situation and capacity. Furthermore ADO after completing this entire routine program would find little time to attend to farmer's queries on technical agricultural issues. Capacity building of ADOs and KPSs through regular refreshing courses has almost vaporized with the T and V system becoming very irregular. Regional monthly workshops linking the scientists in RRS and Extension Officers of the department has also been discontinued. As a result capacity building of farmers and extension officers is not taking place. The ratio of

farmer to extension worker being enormous in size, the only option left is to train up and equip regularly innovative farmers under Panchayat representation to effectively lower the ratio.

An effective extension system will decide how quickly technology transfer and integration in the farming community takes place. Extension system has to have linkages with research on one hand and extension education and training on the other. In West Bengal all these functions are dispersed. Extension system under the Department appears not to have anything to receive from the SAUs. The two are running not in unison but parallelly a unique situation in the country in which the State Department is possibly remaining satisfied with their own research and SAUs having no assigned responsibility excepting producing trained manpower. Some researches are still being continued under the Department of Agriculture contrary to the policy of having well known responsibilities for agricultural universities to participate in agricultural development in the country. The new ATMA mode of extension education and training under SAMETI which is with a NGO seems to be contradictory to the National Policy and system. While many NGOs are doing excellent work, the linkage and the major relationship between institutions that is so important in agricultural development fails to develop under such a situation. The farmers could have reached the peak provided all these players played in their own position and made it a team game. This disorder needs to be addressed in a serious and pragmatic way.

Agricultural extension education in modern times particularly in the WTO-IPR regime has to build up knowledge bank with deposits like modern technology, traditional knowledge, local innovations, market information and the strength of information technology. (Views on extension education are presented separately).

### **Suggested reforms**

- a) Extension activities should mainly be entrusted to the government line department officials with need based help from SAUs, KVKs and NGOs for which decentralized planning may be made in a coordinated participatory manner with the involvement of concerned departments / institutes and targeted users.
- b) Officials should be entrusted to conduct adaptive trials and evaluate technologies on the basis of agro-ecological and socio-economic criteria. Technical officers should be relieved from routine administrative duties.
- c) In view of phenomenal growth in ICT, e-governance should be strengthened in extension system.
- d) Extension should be planned in such a way so that different components like training, demonstration, information sharing, quality upgrading and marketing are considered in a holistic manner with livelihood improvement as the ultimate goal.

- e) Documentation and evaluation of ITKs and innovations as components of extension system. This service should be provided free of cost in a decentralized manner targeting small and marginal farmers.

### **Recommendations**

1. Different kinds of trainings for different categories of extension workers should be planned, developed and held by ATC, KVK, RRS, RRSS and SAUs round the year for capacity building of the personnel / farmers.
2. State level expert committee should be constituted of agri-academics for formulation of training courses every alternate year incorporating newer ideas and technologies.

Innovative and knowledgeable farmers should be identified (5-10 per village) and brought under Government extension programme against contractual payment for disseminating one particular technology to a population of farmers.

### **L. Agricultural marketing**

*Details given in separate section.*

### **M. Support services: agricultural education, research and extension**

*Details given in separate section*

### **N. Comprehensive farmer insurance scheme**

Agriculture is a high-risk economic activity. Farm production depends on the vagaries of nature to a large extent, even if proper irrigation facility and farm mechanism devices are put into use. Since our farmers who constitute 70% of our population have to depend so much upon vagaries of nature and suffer crop loss almost every year, the Agriculture Insurance Corporation was constituted in 2005 to insure crops of the farmers against any damage or loss. The corporation launched National Agricultural Insurance Scheme (NAIS) in 23 states and 2 centrally administrated areas. Under the purview of the scheme 23 kharif and 25 rabi crops have been included. In 2005 kharif Rs.3,355 lakh payment was made to 1.40 lakh farmers of the State as compensation of insured crop loss. In 2005-06 rabi season 4.83 lakh farmers, mostly small and marginal, insured their crops covering 2.56 lakh ha. In 2005-06 also 1.37 lakh farmers were paid compensation.

Under the above crop insurance scheme risk is covered only on the basis of average threshold yields per unit area, determined by the Agriculture Department of the states for different crops in different climatic zones. The post-harvest yield is determined on the basis of crop cutting experiments conducted in statistically selected spots spread over a unit area of Block/Panchayat Samiti decided in advance by the

concerned Branch of the State Agriculture Department. There is a lot of arbitrariness in the system itself and distribution of compensation against crop losses amongst the farmers is often far from equitable nature. Hence NAIS may be replaced by a user-friendly Comprehensive Farmer Insurance Scheme with the following features.

### **Recommendations**

1. Regarding risk coverage under the crop insurance scheme Gram Panchayat should be treated as a unit.
2. In order to insulate the farmers from financial distress and in the process make agriculture financially viable, production of all the crops, right from sowing to post-harvest operation, including market risks should be covered under comprehensive insurance. The risks covered should include:
  - (a) inadequate germination of seeds sown owing to poor quality of seeds, adverse climatic conditions or natural calamities, below a threshold germination level,
  - (b) inadequate yield of crops below a threshold yield level owing to lightening, hailstorm, massive pest attack, massive crop disease and other natural calamities,
  - (c) fall in market price of the crop at post-harvest stage below the Minimum Support Price, and
  - (d) damage of harvested crop owing to inadequate storage/ processing/ transport facilities.
3. The comprehensive Farmer Insurance Scheme should also cover the risk of death and incapacitation of the farmer in accidents like lightening, snakebite etc. while working in the field.
4. The said Insurance Scheme should further cover the damage caused by massive soil erosion owing to change of course of the rivers, earthquake etc.
5. Since the premium for Comprehensive Farmer Insurance for the proposed coverage will be considerably high, the Union and the State Governments may bear at least 90% of the premium cost for the small and marginal farmers.

The Insurance Scheme should be transparent and wide publicity should be given to it by involving Gram Panchayats.

### **O. Backward villages and development**

Human Development Report, 2004 of West Bengal focused the 'levels of achievement, the areas of concern and possible ways of progress with reference to crucial socio-economic indicators' for the people in an independent and objective manner. The UN in the 1980s declared that human development is human right. The State Government of West Bengal is genuinely concerned about economic and social development of its people through many of the steps it has taken in last three decades especially in the fields of land reforms and decentralization in administration and

finance. Being motivated by a vision of political, economic and social change that is quite different from those of most of the other State Governments in this country West Bengal went forward to ensure rightful tenure of a large number of poor and landless villagers enabling them to stay in their own villages by providing security of tenancy to cultivators and land ownership through *patta* (legal document) to the landless. Policy of inclusive development aims at increase of income of largest number of people of the State. Based upon district-wise health, income and education indices Human Development Index (HDI) of a district or State is calculated. Evidently HDI for backward districts in the year 2004 was 0.44 (Malda), 0.45 (Purulia), 0.46 (Murshidabad), 0.47 (Birbhum), and 0.51 (Dinajpur), the HDI for the State being 0.61. Further detailed analysis of Census Report 2001 identified a total number of 4612 backward villages being in higher numbers in districts of Paschim Medinipur, Purulia, both Dinajpurs, and South 24 Parganas.

The report on “Poverty Eradication in India by 2015: Rural Household-centered Strategy Paper” – is finalized by the Central Government in November, 2008 and declared that out of the 9 tribal dominated states including Maharashtra, West Bengal and others the development of tribal poors and poverty eradication has been most promising in West Bengal and a reward of Rs. 2,96,73,000 has been awarded to Tribal Development Department of West Bengal. In fact the report states that poverty has declined only in West Bengal out of the 9 states even after increase of population. Below poverty line villagers were 9.9% of total villagers in 1973-74 and has come down to 7.8% in March 2005 in West Bengal.

While appreciating special public efforts in such villages in the last few years toward alleviating poverty through housing, health check up, child education, irrigation and road development supports to agriculture through input subsidy, crop insurance, and SHG formation for organizing primary processing of agricultural produces to marketing of produces to nearest market places to achieve remunerative prices. Offering one meal daily to old disabled landless farm labours strengthens this effort.

Continued degradation of natural resources due to increasing cropping intensity and poor soil management resulting from economic weakness of the farmers has led to multiple nutrient deficiency and decline of soil organic carbon. Use of chemical fertilizers without necessary liming of soil has enhanced decline of soil fertility. Replenishment of micro and secondary nutrients is almost absent.

### **Recommendations**

1. All the steps being taken should be further emphasized with an eye to the people of scheduled castes, scheduled tribes, backward and minority communities as also the women folk and children of the villages concerned. Rebuilding of soil fertility by

improving ecosystem services is urgently needed using local organic resources that would not require increased investment.

2. Development of roads in the villages connecting urban areas and reclamation of water-bodies to bring low lands under production should get priority. All out employment generation should be made through development of services, roads, transport and communication development and primary processing and wherever possible livestock integration of crop husbandry systems. Market and storage system development, small scale, cottage, medium industries development and intensive mixed farming also generate employment and income. To provide basic urban amenities in villages should be the goal for rural development.

## **P. Policy proposals**

### **1. Introduction**

Very often development programmes prerequisite framing policies while revising or removing existing ones. In most cases such steps have been or are being taken by the Government. A few more as has been considered by the West Bengal State Agriculture Commission are being discussed. On the following issues some enactments / regulatory orders or orders introducing monitoring or certification system need to be passed to strengthen agricultural development.

### **2. Bioresource Policy**

As per People's Biodiversity Act, 2002, People's Biodiversity Register preparation is to be done all over the country. After having unfortunate experiences in cases of 'neem', turmeric, basmati rice, etc. the Government of India (GOI) has enacted legislations to conserve and protect bioresources of the country. The task is colossal and not much effort regarding speedy implementation on the part of Union Government is visible. Following the outline drawn by West Bengal Biodiversity Board each town and village of the State has to organize awareness development programs to prepare a record of its bioresources. Registration of selected resources under GI (Geographical Indications) or otherwise and organizing their marketing abroad has to follow. The State has established a Patent Information Center which has to coordinate establishment of such centres by universities, institutions and line department all over the State to facilitate registration and conservation of bioresources with people's participation. Plant, animal, fish, and other aquatic and forest plant and animal resources and agriculturally important cultures of microorganisms present and identified in this State are to be brought with their specific characters authentically documented and described in the Bio-diversity Register of the State. This stupendous task will require participation of all the concerned scientists and people of the State. The Government in a comprehensive circular may outline the mode of participation from different quarters.

**3. Policy regarding water bodies**

Suitable policies for removing any obstacle for best productive and recreational utilization of vast water areas in the State be framed and brought into action in the proper way.

**4. Production and certification of organic manure, mushroom spawn, bio-fertilizer and bio-pesticide**

Successful production, sale and use of organic manure, mushroom spawn, bio-fertilizers and bio-pesticides and their spread in the State depends on the quality of the products. The quality of these products can be monitored and maintained through an effective certification system. Simultaneously awareness programs should be continued for large scale adoption.

**5. Micronutrient mixture, animal and fish feed**

Regulatory control of quality of these products should be assured through a system laid down by a team of experts and an organization has to be in exclusive charge for the purpose.

**6. Seed production and marketing**

Poor quality of seeds being handled in the name of 'truthfully labeled' seeds must be replaced by certified good quality seeds. This is the primary determinant of the success of agriculture in the State. This has to be checked with a strong hand by issuing needful regulatory orders. Seed business has to be a very reliable system.

**7. Biosafety regulation**

Bio-safety regulation needs to be redrafted to control problems of chemical residues in produces and food products. Presence of harmful chemicals in inputs marketed and unlawful presence of genetically modified (GM) components in seeds and food products needs strong policy provision and necessary regulatory framework for total control.

This is all the more important in view of the recent confirmation of the harmful effects of GM on fertility and disturbance of the immune system by independent researches carried on by the Austrian and Italian government scientists. The WBSAC in this year urged the State Government to impose a complete ban on field trials and commercial release of GMC s in West Bengal.

**8. Quality control for nurseries**

For assuring genuine varieties being sold from large number of private nurseries all over the State a quality certification and verification system has to be introduced and established in the interest of State's prosperity in agriculture.

#### **9. IPR and GI registration**

State Patent Center at Kolkata has to be strengthened to coordinate this activity all over the State so that the State can harvest benefits of its resources. Each technology institution should be advised to have their internal team to locate transferable technology and patentable knowledge.

#### **10. Cattle, small animal and poultry breeding, etc.**

State has to declare its policy regarding basic principles and outline the programme of animal improvement in the State. Regulation on animal slaughter for its strict implementation may be modified as required.

#### **11. Fishery regulation and fish crop insurance**

Regulations regarding type of net to be used for flowing water fishes and others to save smaller fishes should be implemented. Fishermen going out for marine fishing needs to be protected from foreign intruders by National Coast Guard. Fishery activity has to be brought under agricultural insurance scheme for their security against accidents, calamities, etc. These require to be regulated.

#### **12. Devolution to the Panchayats**

Standing village development programs of the government departments should be coordinated since they are in one way or other mutually dependent for their best performance. At block and GP levels Panchayats have to act as coordinators between line departments and farmers. Incidentally, the Union Government project RKVY (Rashtriya Krishi Vikash Yojana) has also decided that Dept. of Agriculture would coordinate 5-9 departments in the interest of best performance of the project. Necessary regulatory provision should be made for the purpose.

#### **13. Fertilizer production and distribution**

This is a Union Government function that has undergone radical change from the country's original policy of reaching self sufficiency in this field, being very important for the poor farmers as well as agriculture of the nation. By closing down not less than 8 factories of Fertilizer Corporation and Hindustan Fertilizer and others the objective to cut down prices has failed. Now in the name of import parity price, huge fund is being transferred to private players instead of reviving the government fertilizer factories by spending much less amount. Considering the original policy of providing security to large number of poor farmers through fertilizer supply the Commission strongly recommends measures for reviving the factories in Haldia and Durgapur. The Union Government should be urged to adhere to the original policy of self-sufficiency.

#### **14. Introducing bottom-up policy of planning and functioning**

Beginning with interaction with villagers particularly in regard to the development programs under the Departments of Agriculture, Rural Development, Food, Animal Resource Development, Fishery, Irrigation and Water Resources, Cooperation, Electricity, Forestry and Small Industries that are so vital and intimately related to agricultural development. A clear policy statement is required.

#### **15. Mitigation of climate change**

National policy of sharing responsibility of climate change hazards between Union and State be rationalized by removal of its discretionary mode.

#### **16. Credit policy and marketing**

Clear and rational policy regarding extension of credit and extent of market infrastructure development all over the country is a necessity. The Union Govt. should be informed of this view of the WBSAC.

#### **17. Employment generation in rural areas**

Outline of NREGA needs modification in regard to the much needed broadening provisions of categories of work under it and enhancing the number of days of work in a year, ideally to 300 days per year. The Union government should be approached for change of policy out line of NREGA.

### **Q. Some observations and comments**

#### **1. Contract farming**

Some situations like establishment of a processing factory require assurance of bulk supply of a particular variety/ quality of a crop. This requires an understanding between a group of farmers and the company. Such groups of poor farmers may be given the support of panchayat administration during contract making. Different forms like bipartite informal (Karnatak, Tamilnadu), formal bipartite (Punjab & Maharastra) with legislative support and tripartite including Government are some contracts in vogue in different states. Contracts that would ensure continuation of optimally remunerative farming with minimal or zero exploitation of farmers would be welcome especially under the vigilance of a third party public sector facilitator / guarantor.

#### **2. Procurement of grains and fibers**

Procurement of grains and fibers are practiced in a half-hearted manner in case of rice, wheat or jute. A standing transparent policy devoid of regional bias be developed and employed so that there are no year-to-year vacillations. Minimum support price fixation is essential and is done reasonably keeping in view the cost of cultivation and farmers' income required. The public distribution system exclusively for BPL at least may be so organized that grains locally procured may

go to PDS and mid day meal program of the respective state, using central stock only on requisition from the state.

### **3. Minimum support price and market control**

MSP in the context of producers in the country being poor has great importance. It is more so under globalized context. Marketing system may accommodate public-private partnership with an overall control of the State so that growers are not deceived and price situation do not go out of the way beyond any justification. Developed countries support their farmers by giving huge subsidy on commodities that are exported. They even regulate excess production through PIK encouraging their farmers to keep land fallow deliberately. These international situations have to be kept in consideration while framing market policy.

### **4. Income and employment generation and poverty alleviation**

The State has a pledge to remove poverty from among its population. That wants to drive agricultural production increase also in a way that increases employment and income of its people. The target is inclusive and not exclusive growth of the economy. The 2.5 % increase in production during 1972 to 1977 has reached 8.2% during last three years. In agriculture the target 4% increase in production is expected to generate work for 2 lakh. This will happen by increasing @ 2% irrigated area per year meaning 2.7 lakh employments on 2.7 lakh increased irrigated area. In fact NSS data reveal that in last 5 years there is 6 lakh decline in unemployed number in West Bengal against the national trend of increasing unemployment. The present 20% below poverty people will come down by another 10%. The agricultural development being suggested in this report is expected to effect further generation of employment and income as expected in the declared policies of the Finance Department of the State.

Average daily wage rate of male field laborers in this State increased from Rs60.69 (July, 2005) to Rs62.86 (June, 2006). This increase was noted in 15 districts since 2004-05 and declined only in Darjeeling, Dakshin Dinajpur and Bankura. In 2005-06 this was below Rs 60.0 only in Dakshin Dinajpur, Malda, North 24-Parganas, Birbhum and Bankura and Rs 47.95 in Purulia. Although these are evidences of progress if compared with the previous situation but remain quite far from the minimum requirement target of \$2 (Rs 90) per day.

## **R. Action points**

### **1. Backward villages**

As per the Human Development Report, 2004 out of 40 thousand odd villages in the State number of identified backward villages were 4,612. Program was launched for fast and intensive development of these villages. This HD index was calculated on the basis on women education, health, number of farm labour, state of

road connection and income indices. It was generally perceived that the income index was quite low for the people of these villages. A study in BCKV was made taking 1980-constant price. The per capita real value increase of agricultural produce at rice equivalent from 1980-81 to 1999-2000 was highest in districts like Birbhum and Bankura and lowest in Darjeeling. Whether the attraction and migration of people in districts of Darjeeling, Howra and others to nearby urban areas for higher income from nonagricultural sources in these districts has anything to do is a question.

If land and labor productivity are considered as per World Development Indicators, 2003 it is evident that percentage change in yield in kg/ha between 1979-81 and 1991-2001 was 75% in India and Vietnam, 71% in Bangladesh although yield (kg/ha) in France and Netherlands was above 7000, near 5000 in USA and China and only 2,321 in India. In regard to labor productivity in \$ there are very large differences between countries being only 402 in India 712 in Pakistan, 4,798 in Brazil, 13,782 in South Korea and 58,280 in Netherlands. In fact for many small farmers in Asia shortage of capital is a major problem and they need to be helped to increase the productivity of their capital. These backward people should be extended all support in terms of input subsidy, housing, crop insurance, health check up, children's education so that they themselves become equal.

## **2. Reclamation of fallow land**

The annual target of land reclamation should be fulfilled. The area and two kinds of fallow mentioned earlier should be identified in districts and treated following definite plan for reclamation under the leadership of local panchayat.

## **3. Large scale tank excavation for water harvest**

Considering the high annual rainfall in all the districts this should be a regular agendum of development. Its importance in undulated western districts as well as lower gangetic plains is equally important. It will build up a good surface water reserve, continuous recharge of GW and lowering flood ravage in the state.

## **4. Soil pH correction**

In some areas of North Bengal (Uttarbanga) particularly in Darjeeling, Coochbehar, Jalpaiguri the prevailing acidity of soil needs one method of treatment while in lateritic districts correction is to be done otherwise as discussed in previous pages.

## **5. Organic manure production and fertility building**

Very specific plan of organic manure production in every farmer family is the target since this will bring down cost of production substituting at least a part of chemical fertilizer. This is the best way to build up soil fertility. Leaflets should be distributed all over the State.

## **6. Soil test lab development**

As suggested in previous pages district level soil test laboratory with facilities of all macro, secondary and micronutrient analysis are required at KVKs and block level ST labs with facilities upto secondary nutrient analysis. These are to be developed by private or private-public partnership and services should always be paid.

## **7. Revision of soil nutrition map**

The map mentioned earlier should be revised and updated in consultation with NBSSLUP and SAUs and respective part should be provided to ADOs, KVKs so that they act on the basis of this guide.

## **8. Declaration of organic districts**

In the interest of the environment and also the farmers to receive remunerative price some areas may be in consultation with local people declared 'Organic' prohibiting chemical use in agriculture. This could be hills, and adjoining areas.

## **9. Certification of manures, bio-fertilizers and bio-pesticides**

Following the FCO and other orders the certification program should be taken with initiatives from the officers concerned of the department. The producers should be made aware of the procedure of obtaining registration and production license from the Government.

## **10. Liquid manure**

This farmer's technology should be refined and forwarded to all corners of the State through leaflets produced centrally and reproduced in large numbers in blocks. In every meeting or training programs this should be discussed briefly.

## **11. Bio-fertilizer production**

This will require investment of few lakhs only to be done by rural entrepreneurs after training and arrangement of loan for them. The plan and other details should be obtained after training and there should be some monitoring of quality and price so that the venture may be profitable. Initially one at each block town may be established.

## **12. Bio-pesticide production**

Taking technology from SAUs entrepreneur groups should be helped to get organized with bank loans and initial product purchase assurance on behalf of the block programs. Training and mother cultures of the suppressor organisms should be obtained from SAUs.

## **13. Botanical pesticides**

Production as formulated is not there. Formulations have been worked out in BCKV using neem and citronella oils and available for use in product making. As

small production units may not require big investment some units may be developed for their production and use against soil borne disease.

#### **14. Azolla production program**

Using agri-net as shade small homestead units in tanks – natural or concrete should be used and such units should grow with women initiative in large numbers in transplanted rice area to get a good market among rice farmers.

#### **15. Mushroom seed production**

In each block development of one mushroom seed production unit by enterprising women group may require investment of few lakhs only. Training and culture should be available from SAUs. Around 100 mushroom growers who will purchase seed from MSPU and grow mushroom for sale and own consumption should surround each MSPU.

#### **16. Reclamation of rivers, channels, canals and water bodies**

This is another vital program for the state agriculture to remove all the drainage chocking, particularly in downstream rivers in districts of South 24-Parganas, North 24-Parganas, both Medinipur, Hooghly, Howra, Nadia, Malda, Murshidabad and parts of Burdwan, Birbhum and Bankura. On the northern sectors rivers and channels passing through Coochbehar, Jalpaiguri, and both Dinajpurs are to be covered. Funds from NREGS and others are to be utilized. Prompt initiative is required on behalf of Central Government in regard to Ichhamati clearing and excavation of reservoirs behind dams and barrages. This is very important in regard to agri-economy of the State.

#### **17. Campaign –‘no ground water’**

At least in the identified critically affected arsenic districts a campaign is urgently needed to be launched making alternative provisions of water source and water use technologies well known to these people. However MDTW may continue in drainage choked areas.

#### **18. Raising mud dykes by 1 meter in South 24-Parganas**

Considering the global warming factor and concomitant rise in sea water level the first step to protect the coastal villages is to raise the coastal mud-embankments sufficiently and make it wider and stronger all through 3000 km of its length as a national project with participation of local people. This is urgently needed for saving agriculture as also people.

#### **19. Protecting Ganga banks**

Large area of fertile lands mainly in the districts of Malda, Murshidabad, and Nadia are regularly destroyed by Ganga river. Embankments should be strong enough to

save these agricultural land and villages. This should be taken up urgently by the Union Government to fulfill its responsibility to the National River number 1, i.e. Ganga as declared by the central Government.

#### **20. Seed production**

Production of most of the seeds of the crops grown in the State should be taken as a priority. Besides employing farmers in the job through PACS following Gontra model in Nadia some seed business cooperatives initially one at each block based upon expert plan should be organized. State Seed Corporation should be reorganized giving a professional shape with a whole time business management expert as Chief. Consultants may be engaged for a particular seed program say 'potato micro-tuber' to build up the entire set up in some kind of BOT mode. At least 10 field crops should be covered in first year.

#### **21. Crop diversity and commercial crops**

Crop diversification should be encouraged with due consideration to specific localized situations. Prospective crop options should be shown to farmers through demonstration. The farmers should be encouraged to opt through keeping provision for compensation in case of loss incurred due to such options.

#### **22. Development of food processing and food industry**

Initiatives taken already has allowed to develop 252 food processing industries in districts like Howrah, Hooghly, Siliguri, Jalpaiguri, Burdwan, South 24-Parganas and others investing Rs1546.68 crore. These are in addition to traditional textile and jute industries in the State. But the potential is much more. As the trends show it will continue to grow more as urban people are gradually developing habit for ready-to-eat food. West Bengal is yet to have enough milk product industries particularly dry milk-based industry. This truly depends on further increase in milk production. The things that are important is to develop quality control regulations, strong monitoring network system before any safety or serious nutrition related problem comes up. Necessary steps need be initiated by Food Processing Industry Department.

#### **23. Development of grading, packaging and marketing groups**

Groups in the form of cooperatives or SHGs should be organized separately for each type of commodities. For example cereals and pulses require one type of storage, packing, etc. compared to say oilseeds or potato, or fiber, etc. The groups have to develop storage, transport, packaging etc either by contract or themselves. These groups will require training in market information and business management to succeed.

#### 24. On stress area agriculture

**Coastal saline region:** One common thing that is still plaguing development of the three stress areas is failure to use total fund allocation except possibly in coastal area. Coastal area development program being run for longer period of time has equipped the concerned authorities well for development work in the Coastal saline region the other two being created only in 2000 are in the process of infrastructural development.

Coastal saline area in West Bengal comprise 78 blocks in fewer than 4 districts covering 17,448-km area. Area spread over districts of South 24 Parganas, Howrah, North 24 Parganas and Purba Medinipur has been brought under Sundarban Unnayan Parshad to emphasize development. The main stress in this area is soil and water salinity developed due to seawater encroachment, drainage congestion during monsoon and problem of communication in 54 islands separated by creeks and channels. Dependence of a high population (1.36 crore) on agriculture of the area for their livelihood has compounded the situation. Due to increased salt accumulation on soil from winter to summer days second crop in rabi season is limited in 3053.83 km<sup>2</sup> area out of total cultivated area of 9071.66 km<sup>2</sup> and resultant cropping intensity is 151% landshaping work on a large scale would increase cropping intensity and usher more remunerative on integrated farming.

Besides agriculture people in other livelihood include fisher-folk, shrimp fry and crab and shell collectors, besides groups of professional honey (Mowalis) and wood-golpata (Bowalis) collectors. Four situations like extremely saline island soil, relatively less saline upland light soil, less saline medium loam soil and less saline low medium to heavy soil exist.

Existing farming system has aman paddy in kharif, aus in places other than low and grass-pea, vegetables, mustard, potato, watermelon and boro paddy in rabi season. The farming systems determined to be profitable and income increasing are rice, grass-pea, wheat, mustard, sugar-beet, rice-grass-pea-vegetables/ sugar beet, rice cum fish/prawn- summer mung and leafy vegetables, rice-fish-duck-grass-pea and cucumber.

The recommendations of the Commission are reclamation of tide affected and sand coast areas, soil health management on watershed basis with farmers' participation, construction of embankments and sluice gates, recycling of drainage water, aquaculture-cum-irrigation to be practiced by low land farmers, planting of fruit, fodder and fuel trees and rice-cum-fish in deep water. To create more job, income and food farming system including field-vegetable-plantation crops, trees should be mixed with dairy, poultry, duckery, fishery, apiary and mushrooms. Providing adequate fish-seeds and training to farmers brackish water fish (parse, bhetki etc)

and shrimp (*Artemia salina*) culture should be introduced on a large scale. Culture of prawn, shellfishes, mussels (*Perna viridis*) and oyster (*Crassostrea graphoides*) can be introduced in pockets through proper training and support. To produce sufficient fodder for animal folk (including Garole sheep in Sundarbans) para grass (*Brachiaria mutica*) should be introduced on a large scale in swampy areas. On embankments and up, fallow lands massive planting of fodder trees like babul (*Acacia nilotica*), Subabul (*Leuceana leucocephala*) and also *A.albida*, *A.arabica* should be grown to get fodder in lean period.

Massive plantation development of cashew and coconut, etc. in suitable areas needs to be taken up since cashew industries in the country has to import raw material from outside.

Agro-based industry based on coconut, sugar beet, cashew, watermelon, chilli, fish and meat should be developed contacting industrialists having experience in these fields. Modern cashew processing plants with both units of processing nuts (quality fry), apple (wine or jam) and nutshell (oil) have tremendous prospect of development.

**Hill and Terai region:** *Uttaranchal Unnayan Parsad* (UUP) area of 6 districts namely Darjeeling, Jalpaiguri, Coochbehar, Malda, Uttar Dinajpur and Dakshin Dinajpur has been brought under one development agency called Uttaranchal Unnayan Parsad. Besides hilly area of Darjeeling district Siliguri subdivision of the Darjeeling district and terai and alluvial agro-climatic area of 5 other districts are the area of operation. UUP has main objectives like erosion control and flood management, improvement of education and health, agriculture and horticulture, animal husbandry, small industry and infrastructure development. Expressed priorities of development for agriculture are roads and market development, erosion control and flood management.

Crops like maize, soybean, in the hilly area, rice, jute, potato and vegetables need all-out attention using selected varieties, and modern technology to build up our northern food and fiber-producing belt. Mandarin orange orchards need replacement of old plants and strengthening nutrition management. This will require involving people in forming SHGs to produce quality organic manure in numbers in all the villages. Oranges will require packaging and transport and registration and brand development through Geographical Indications way to get a premium market. Commercial prospect of flowers, orchids, cacti and succulents shall be strengthened through investment in modernization of production units, tissue culture labs and creation of packaging and cold transport system. Declaring Darjeeling hills as organic area and concentrating on exclusive organic management (OM) for cultivation in the district for all the crops including orange, ginger, large

cardamom, some medicinal plants and tea will increase demand and price of its produces in national and international markets. Supply of quality planting material may take shape through training at KVK for disease-free planting material production. In Dinajpur we require to concentrate on production of Tulaipanji variety of rice, its registration at Chennai providing DUS statistics and brand popularization through GI (Geographic Indication) and planned publicity through Bengalis dwelling in foreign countries.

In Coochbehar and Jalpaiguri crops like capsularis jute, areca nut, black pepper, tobacco, and potato should be given emphasis for increasing production. Developing of large number of nurseries of selected varieties of black pepper and areca nut may come up through trainings at KVKs. These areas are most suitable for production of pineapple, mushroom and silk of different kinds and simultaneous development of reeling center is important. District authorities should consider contacting pineapple processors to invest giving them an assurance of production and supply of required quantity and quality of raw material. The irregular step of prohibitions of export of areca nut through any port other than one in South India is on the way of withdrawal good news for North Bengal growers.

Mango varieties of mango produced in Malda require separate handling for marketing. Laksmanbhog registration and brand popularization will give a good market for this mango; marketing of pulp of Fazli shall have great demand. Along with in orchards replacement or rejuvenation of old plants with modern technology will enhance production greatly.

In the plains of this area large-scale cultivation of selected varieties of oilseeds and pulses should be launched through mini-kit distribution. Sonamung variety should be popularized as a scented quality pulse. It should also be registered providing geographical identification points so that the brand will bring best price to the growers.

**Red lateritic tract:** Red lateritic tract development under *Paschimanchal Unnayan Parsad (PUP)* having operation area of 74 blocks distributed in Purulia, Bankura, Birbhum, Paschim Medinipur and western part of Burdwan has to promote integrated development including agriculture. The area having undulated, red lateritic shallow soil with difficulties of irrigation has to emphasize different kinds of farming system and crop plan. Uplands (tnar) may be converted to orchards minor fruits or covered with fodder trees to change the environment, to bring back grass cover and creating easier situation for field agriculture. Massive production of maize along with feed industry development, pigeon-pea and baby corn production and marketing to mega cities, seed production for many crops and quality rose production can be good options.