Part One

Introductory Chapter

Agriculture in West Bengal
Contemporary Scenario and Contextual Issues

The West Bengal State Agriculture Commission started functioning formally from January 15, 2007 with the inaugural meeting held on that day. A critical perusal of the terms of reference of the Commission (vide Annexure Item 1) was followed by the inaugural address by the Chairman (vide Annexure Item 2) that covered the following aspects: (i) geographical-agricultural features of West Bengal, (ii) status of field crop production with emphasis on cereals, pulses, oilseeds and discussion on factors/constraints of crop production with particular emphasis on changing climate, use of various inputs, fertilizers, irrigation, etc., (iii) status of horticultural crops, covering fruits, vegetables, flowers, plantation crops, spices, medicinal plants, etc., (iv) livestock and fishery with emphasis on production of milk, egg, meat, and fish (inland and marine), etc. (v) agricultural marketing, (vi) agricultural credit, cooperatives, self help groups, etc.

The policy decisions pertaining to increasing production of various agricultural commodities to meet the requirements of more and more people in the coming decades highlighted the need for greater emphasis on ecologically sustainable management practices for soil fertility conservation, seed production, pest management and the issue of adoption of holistic organic farming systems, wherever feasible. Several other issues specifically involving SHGs in various rural development projects, increasing easy rural institutional credit facilities and risk coverage mechanisms were emphasized by the members of the Commission who, in general, were supportive of the statements and policy regimes covered in the inaugural address.

The Commission has worked diligently over the last more than two years with the help of a large number of duly formed sub-committees and working groups composed of subject matter specialists for in-depth analysis of the agricultural scenario of the State and possible corrective/remedial measures keeping primarily the interests of the poor small and marginal farmers who constitute the overwhelming majority of the farming community as well as the single largest block of the consumers of agriproducts and commodities in the State. An interim report was submitted to the Government on January 18, 2008; a fruitful discussion on the 126-page report with the Chief Minister and many of his colleagues was held on April 15, 2008 and useful suggestions emanating from the discussion have been incorporated in the final report.

Contemporary Scenario

The database at the start of the present initiative being over two years old, it would be useful to provide a more updated version mostly based on the latest Statistical

Handbook: West Bengal 2007 and Economic Reviews (upto 2007-08) complied by the Bureau of Applied Economics & Statistics, Government of West Bengal.

Table 1: West Bengal: Salient general features and agriculture related broad information

	Census 2001	Current estimates (2007)
Area (sq km)	88,752	
Population	80,176,197	86,659,000
Density of population (per sq km)	903	976
Male (%)	51.72	51.53
Female (%)	48.28	48.47
Rural population (%)	72.03	-
Urban population (%)	27.97	-
Percentage of workers (%)	36.77	-
Percentage of nonworkers (%)	63.23	-

		Year
Percentage of cultivated area out of total area	64.91	2006-07
Cropping intensity (%)	182	2006-07
Per capita production of food grains (kg)	183.6	2006-07
Yield rate of rice (kg/ha)	2,593	2006-07
Yield rate of jute (kg/ha)	2,545	2006-07
Percentage of cultivators among total (main+ marginal workers)	19.18	2001
Number of agricultural labourers among total workers (%)	24.97	2001
Number of cultivators per 100 ha of cultivated land	103	2001
Number of agricultural labourers per 100 ha of cultivated land	134	2001

West Bengal (2007)

Divisions	3 (Burdwan, Presidency and Jalpaiguri)	Gram Panchayats	3,354
Districts	18 (excluding Kolkata)	Villages	40,782 (37,945 inhabited)
Sub-divisions	66		
Development Blocks	341	Non-municipal towns	256
		Municipalities	120
		Police Stations	478
Panchayat Samities	333	Municipal Corporations	6 in 2007

(see District Profiles in the Annexure Item 8 for more information)

Agricultural field crops

Over the last six years of the 21st century from 2001-02 to 2006-07 (both years inclusive), detailed data for selected crops on area coverage, production and productivity, etc. when recalculated using the index numbers for the assessment of different production parameters would show that overall agricultural growth rates have plateaued with marginal ups and downs; quantitative loss in one being compensated by gains in another and vice-versa. The data presented in Table 2 and line diagram in Figure 1 on area, production, cropping intensity, net area sown, yield per unit area, etc. when plotted on the basis of their respective index numbers (base year 1981-82 as 100) over time would categorically bring out the fact that with our present system of farming there is little possibility of any breakthrough especially in view of the already manifesting adverse consequences of climatic aberrations (a part of the global climate change about which more specific information are given later in the contextual issues).

The detailed data presented in Annexure Item 6 on field crops would show a decline in production of oilseeds and pulses that besides area shrinkage, would be partly attributable to climate changes. The situation in respect of jute and mesta has also been similar and total fibre production (primarily jute and mesta) with jute contributing to over 98.5% of fibre production, that increased by 14 lakh bales (of 180 kg each) from 7,522 thousand bales in 2000-01 to 8,939 thousand bales in 2001-02, showing a 18.8% increase in a single year, has since remained stagnated.

A serious issue in Indian agriculture in general, and West Bengal in particular, is the acute shortage of pulses and oilseeds. As such, some observations on the same are given hereunder.

Pulses and oilseeds: The pulses that constitute a major item of the vegetarian diet are showing a declining trend over the last six years; the production in the year 2001-02 was 219 thousand tonnes, that subsequently came down to 154 thousand tonnes in 2006-07, showing a 42% decline in the aforesaid period. The domestic requirement in 2007 was over 11.07 lakh tonnes (at 35 g/capita/day) showing a deficit of 9.35 lakh tonnes annually. Although arhar (*Cajanus cajan)* may be successfully grown in certain areas, including semiarid Paschimanchal tracts it would be impossible to acquire self sufficiency in pulses production in the near future unless the Commission's suggestion of compulsory introduction of at least one legume in the crop sequence is implemented (which additionally would be conducive to soil fertility maintenance).

India has been importing edible oils for quite some time since the late seventies and early eighties of the last century. However, import of edible oil came down by 95% and export of oilseed cake reached a record of Rs.1,794 crore in 1991-92 with the effective steps taken by the Technology Mission on Oilseeds (TMO) of the Government of India. Further, the initiative of the National Dairy Development Board (NDDB) in the TMO period was crucial and a very healthy growth rate of oilseeds was noted during 1986-1997. However, the situation has been reversed in the last 10 years (1997-2007) with decline/decrease in production causing negative growth rate. According to D. M. Hegde and R. Venkattakumar (2008), "The liberalization of Indian economy fundamentally changed the import regime of edible oils. The edible oil import that stood just at 1 lakh tonnes in 1992-93 increased to 55 lakh tonnes in 2004-05" (*Indian Agriculturist* **50** (1) p.74, 2008).

Table 2: Index number of agricultural area, production, productivity, cropping pattern, cropping intensity, productivity per hectare of net area sown of selected crops and net area sown in West Bengal

(Base : Triennium ending crop year 1981-82 = 100)

Year	Area	Production	Productivity	Cropping pattern	Cropping intensity	Productivity*	Net area sown
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1990-91	109.8	162.7	148.2	114.2	111.8	165.7	98.2
2000-01	110.3	210.2	190.6	128.8	113.4	216.0	97.3
2001-02	119.4	240.6	201.5	126.8	120.4	242.5	99.2
2002-03	115.6	225.4	195.0	130.1	120.2	234.3	96.2
2003-04	117.5	236.8	201.5	126.8	120.5	242.9	97.5
2004-05(R)	115.1	234.0	203.3	128.3	116.2	242.2	96.6
2005-06(P)	114.5	232.9	203.4	130.7	120.4	244.9	95.1
2006-07(P)	115.4	227.0	196.7	133.8	121.4	238.7	95.1

P=Provisional *per hectare of net area sown of selected crops

Notes: (1) Index of cropping pattern in the j-th year = $\frac{\sum aij\ Yio\ Pio}{\sum Cio\ Yio\ Pio} \times 100$

Where, Cio = $\frac{\sum aio}{aio}$ = Proportion of area under the i-th crop in the base period

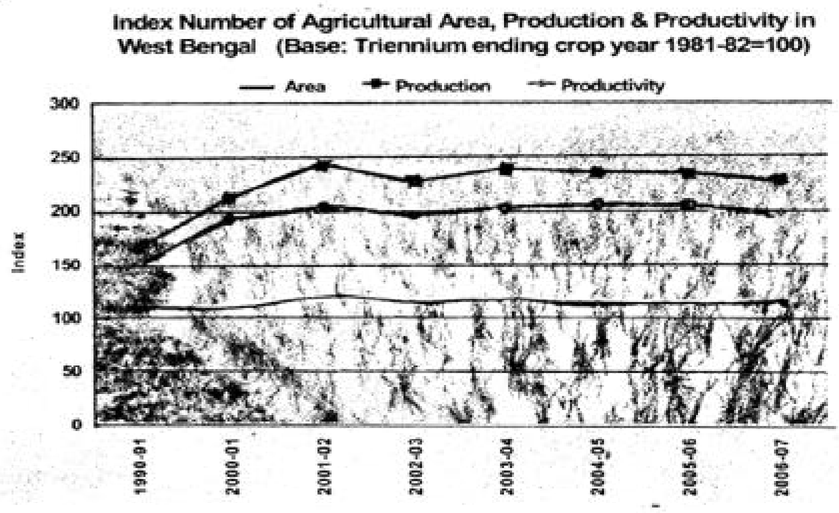
Cij = $\frac{aij}{\sum aij}$ = proportion of area under the i-th crop in the j-th year

Yio = Yield per heactare of the i-th crop in the base period.
Pio = Price per unit of the i-th crop in the base period.

(ii) Index of Cropping Intensity = $\frac{\text{Index of area under crops}}{\text{Index of net area sown}} \times 100$

Source: Bureau of Applied Economics & Statistics, Govt. of West Bengal, 2007

Figure 1:



Source: Bureau of Applied Economics & Statistics, Govt. of West Bengal, 2007

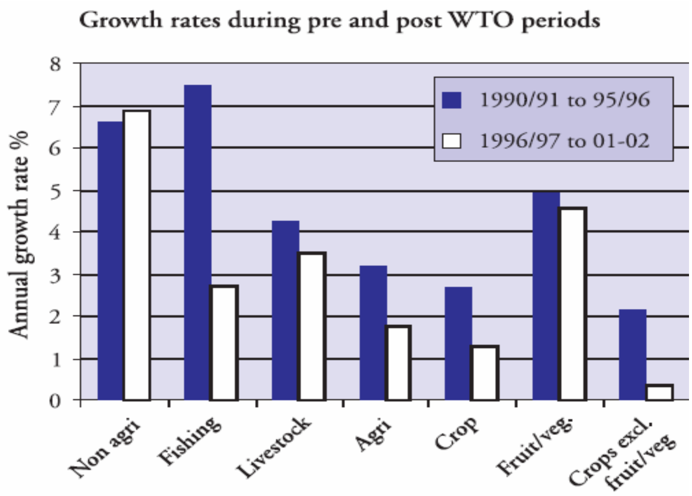
In fact, in the post-WTO 5-year period (1996-97 – 2001-02) other than rice and onion showing minor improvements, the growth rates in the production of all major agricultural crops have shown a significant decline in comparison to the pre-WTO 5-year period (Ramesh Chand, 2004, Policy Brief No. 20, NCAP, New Delhi, see Table 3, Figure 2). Increasing population, and aberrant weather conditions consecutively in the last three to four years not favouring oilseed growers, have further aggravated the impact of liberalization on the edible oil economy. With improved standard of living and increasing purchasing power of urban people, more and more people are migrating to the towns and cities; as such, rural economy is badly hit.

Production of rape and mustard in West Bengal, a traditionally oil deficit State, came down in the last six years between 2001-02 to 2006-07 by 78 thousand tonnes (a sizeable 23% decrease) from earlier 417 thousand tonnes to 339 thousand tonnes in 2006-07. Sesame and sunflower have compensated to some extent but alternatives must be worked out. In the country as a whole rice bran oil has a potential of 14 lakh tonnes per year but currently only 7.3 lakh tonnes are recovered. With proper technological upgradation of the oil extraction process from rice bran, West Bengal as the highest rice producing State can considerably solve the problem, apart from productivity increase of primarily rainfed oil seed cultivation by life-saving irrigation and use of improved crop cultivars. Soybean has a distinct possibility in the western districts; the seeds, which are rich in oil besides the great demand of the soyaoil cake (DOC, deoiled cake) as a protein rich poultry feed would be of great advantage to the farmers if various cultural aspects including specific rhizobium inoculation for symbiotic nitrogen fixation for newly introduced regions are duly taken care of by specialists in the subject.

Table 3: Production performance of selected commodities/groups before and after trade liberalization as revealed by growth rates

Commodity/Groups	Before WTO 1990/91 to 1995/96	After WTO 1996/97 to 2001/02	Change During WTO
Foodgrain	1.51	1.17	Decline
Cereals	1.81	1.71	Decline
Pulses	- 0.60	-2.56	Decline
Wheat	3.27	1.12	Decline
Paddy	1.53	2.25	Rise
Oilseeds	3.91	-3.94	Decline
Sugarcane	2.92	1.74	Decline
Cotton	5.53	-6.06	Decline
Onion	2.96	3.76	Rise
Milk	4.34	4.14	Decline
Egg	5.36	4.10	Decline
Fish	5.16	2.25	Decline

Figure 2:



Source: Chand, R. (2004). Policy Brief No 20. National Centre for Agricultural Economics and Policy Research (NCAP), New Delhi

In view of the aforesaid information on general plateauing of field crops production, it is really difficult to give a positive and quantitative projection on the performances of the food grains sector and oilseeds other than hoping for a status quo rather than a decline. However, in the 11th Five Year Plan approach paper of the Department of

Agriculture, Government of West Bengal, some projections have been made for the years between 2007 and 2012 (plan period). The estimated requirements of cereals, pulses and oilseeds etc. based on population projections for the years 2010, 2015, 2020, and 2025 are, however, given below for comparing the same with the current average production level during 2001-02 to 2006-07, as shown in the last column of Table 4.

Table 4: Requirements (in lakh tonnes) in the years 2010, 2015, 2020 and 2025

Items	Consumption rate (g/capita/day)	Year 2010	Year 2015	Year 2020	Year 2025	**Current Production Level (from 2001-02 to 2006-07) (Mean ± SD)**
Rice	394	128.218	135.063	139.608	144.298	**147.417 ± 2.799**
Wheat	60	19.513	20.568	21.260	21.974	**8.750 ± 0.785**
Cereals (total)	454	147.735	155.622	160.858	166.262	**157.923 ± 3.099**
Pulses	35	11.390	11.998	12.402	12.818	**1.750 ± 0.179**
Food grains	489	159.134	167.630	173.270	179.090	**159.672 ± 3.113**
Oilseeds	45	14.644	15.426	15.945	16.481	**5.743 ± 0.707**
Potato	125	40.678	42.850	44.292	45.780	**69.948 ± 9.213**

The estimated population figures (in thousands) are: 89158, 93918, 97078, and 100339 for the years, 2010, 2015, 2020 and 2025 respectively. The population projections (as on October of each year) are based on data supplied by the Director NAD, Central Statistical Organisation, New Delhi to the Director, Bureau of Applied Economics & Statistics, Govt. of West Bengal.

A 10 percent shifting of land to SRI method in boro rice cultivation in the State, preferably 'organic SRI', would certainly boost productivity by at least one tonne per hectare and besides considerable saving on irrigation water would release enough land for wheat or rabi pulses and oilseeds to meet a part of our domestic requirements.

Horticultural crops

The scenario for horticultural crops specially fruits is, however, better and between 2003-04 to 2006-07 total fruit production increased by 6 lakh 25 thousand tonnes (31% increase over the period), showing a noticeable increase in the productivity of mango (from 5.94 t/ha in 2003-04 to 7.02 t/ha in 2006-07) and banana (19.51 t/ha in 2003-04 to 25.53 t/ha in 2006-07; see Part Three Chapter II on Horticulture for detailed data). Total vegetable production in the aforesaid period increased from 10,919 thousand tonnes in 2003-04 to 12,088 thousand tonnes in 2006-07 (10.7% increase over the period, with tomato recording 16.1% increase between 2003-04 to 2006-07). In case of flowers also growth rate has been favourably maintained but mention needs to be made of rose and tuberose that demonstrated a phenomenal rise of 56.6% increase in a single year for rose (28.20 crore sticks in 2006-07 against 18.01 crore sticks in 2005-06 with virtually no increase in area) and 27.06% rise for tuberose (46.12 crore spikes in 2005-06 and 58.87 crore spikes in 2006-07).

Projections for horticultural crops: In view of the more encouraging performance of vegetables, fruits and flower sectors, whereby self sufficiency has been achieved with large surpluses in vegetables in particular, a serious rethinking of the issue of overproduction is urgently called for in vegetables. The per capita/day availabilities of vegetables have been 361, 359, 373 and 386 grammes in the years 2003-04, 2004-05, 2005-06 and 2006-07, respectively against the requirement of 250 g per capita/day. Obviously three possible options to effectively tackle the situation would be either to tap the markets in the adjacent states; or diverting a part of the surplus for preservation, processing and storage, even at the household level for year-round nutrition, or ideally, with a little more initiative to go for quality production through organic and near-organic practices (such as NPM) as the problem of insecurity of production in the vegetable front is virtually nonexistent. Any possible in-conversion reduction in yield per unit area in the initial years would be very much within the tolerance limit and is expected to be duly compensated by increased net income.

In case of fruits also, per capita availability/day has been 67, 70, 74 and 84 g in 2003-04, 2004-05, 2005-06 and 2006-07 respectively against the State norm of 60 g per capita/day with huge prospective surpluses due to significant increase in area under fruits particularly in the arid and semiarid tracts in the western districts.

Livestock and fishery

A summarized version of the 18th All India Livestock Census in 2007 shows that the total number of bovine animals (mainly cattle and buffalo) is nearly 2 crore in the State of which cattle constitute 96.2% (out of the total 1 crore 92 lakh animals) and buffaloes 3.8% (total 7.64 lakh in number).

Desi cows (indigenous cattle) are 86.2% of the total cattle, while improved cross-breeds constitute only 13.8% of the total cattle population. West Bengal has a large population of goats (1.51 crore) that far outnumbers sheep which are 15.77 lakh in number. Pigs show a total of 8.145 lakh and rabbits only a little above fifty thousand, obviously not very popular as yet (Table 5).

Table 5: 18th All India Livestock Census, West Bengal, 2007
Livestock population of West Bengal

Total cross breed cattle:	2,642,142	Total rabbit:	50,440
Total indigenous cattle:	16,546,112	Total dog:	1,739,163
Total cattle:	19,188,245	Total fowl:	
		Desi :	29,137,939
		Improved:	22,805,228
		Total:	51,943,164
Total bovine:	19,952,041	Total drake, duck duckling	
		Desi :	11,237,665
		Improved :	809,226
		Total :	12,046,891
Total sheep:	1,577,170		
Total goat:	15,069,054	Other poultry birds Turkey, quail and others	
		Total :	253,439
Total horse and ponny :	6,222		
		Total poultry birds	
Total pig:	814,543	Total:	64,243,494

Total fowls are nearly 5.2 crore in number with *desi* and improved types constituting 56.1% and 43.9% respectively of the total. Ducks are 1.2 crore with the *desi* types far outnumbering the improved ones constituting 93.3% and 6.7% respectively of the total. Other poultry birds such as turkeys, quails, etc. are 2.53 lakh in number, giving an over all total of 6.42 crore for domestic birds in the State (Table 5). The detailed information on animal resources development are given in Part Three, Chapter III, section A to H.

Fish production

The high annual growth rate of 5.84% between 1990-91 to 2000-01 showed some reduction and demonstrated an annual growth rate of 4.4% between 2000-01 and 2004-05, improving to 5.3% by the next year (2005-06) and attained thereafter within a single year a 8.35% annual growth rate (recording an increase of 91 thousand tonnes over the previous year's catch of 1,090 thousand tonnes from inland sources). Together with the marine sector catch of 178 thousand metric tonnes in 2006-07 the fish production recorded an all time high of 1,359 thousand tonnes (overall 8.72% annual growth rate) which is really commendable. Fish seed production also rose by 5.6% (13.2 billion in number in 2006-07 against 12.5 billion in 2005-06). For detailed information on fishery and aquaculture Part Three, Chapter IV may be consulted.

Table 6: Fish production projections

	Year 2010		Year 2015		Year 2020		Year 2025	
	Prod.	Req.	Prod.	Req.	Prod.	Req.	Prod.	Req.
Total (lakh tonnes)	15.26	16.27	18.27	17.01	21.59	17.72	26.19	18.31
Surplus (+)/deficit (-) (lakh tonnes)	-1.01		+0.99		+3.87		+7.88	
Availability (%)	93.8		105.8		121.8		143.0	
Excess (+)/shortfall (-) (%)	-6.2		+ 5.8		+21.8		+43.0	

Prod. = Production, Req. = Requirement
Requirement based on State Government norm of 50 g per capita/day

Projected fish production and future requirements: The prospects of fish production in view of the performance of the fishery and aquaculture sector in recent times is indeed bright and by 2010 nearly 94% of the requirement of the State may be met (only 6.2% shortfall) and in 2015 the surplus would be nearly one lakh tonne (5.8% surplus production). In 2020, West Bengal may be in a position to meet the demands of neighbouring states with over 21% surplus production that in the next 5-year period may reach a figure as high as a 40% surplus fish production.

It would, however, be highly desirable if special efforts are given to mass culture of indigenous fish species that would not only preserve West Bengal's unique fish biodiversity but may prove highly remunerative to the fishermen also.

Milk production

West Bengal is a milk deficit State; milk production still depends greatly on low input requiring desi cows which are low yielders compared to the improved crossbred cows; even then there is an average 3.1% annual growth rate in cow milk production. Buffalo and goat milk contributions to total milk production are 7.7% and 3.1%, respectively (see Part Three, Chapter III, section H for detailed information).

The rate of increase in milk production is more than double the human population growth rate in the State; as such, the deficit would gradually narrow down as duly quantified by the ARD department (see Table 7).

Projected milk production and future requirements: In 2006-07, total milk production was 3,983 thousand tonnes; that in 2010 is expected to go upto 4,460 thousand tonnes. However, the requirement would be higher to meet the demand for an additional nearly 45 lakh people with (estimated milk requirement 5,858 thousand tonnes in 2010) and the total shortfall would be 1,398 thousand tonnes (i.e. nearly 24% shortfall).

Table 7: Milk production projections

	Year 2010		Year 2015		Year 2020		Year 2025	
	Prod.	Req.	Prod.	Req.	Prod.	Req.	Prod.	Req.
Total ('000 tonnes)	4,460	5,858	5,108	6,123	5,850	6,378	6,700	6,592
Excess(+)/shortfall(-) ('000 tonnes)	-1,398		-1,015		-528		+108	
Availability (%)	76.1		83.4		91.7		101.6	
Surplus (+)/deficit (-) (%)	-23.9		-16.6		-8.3		+1.6	

Prod. = Production, Req. = Requirement
Requirement based on State Government norm of 180 g milk per capita/day

The deficiency would be met up only in 2025 when with current rate of increase in milk production, annually 6,700 tonnes of milk would be available through domestic efforts against an estimated requirement of 6,592 thousand tonnes (leaving a small surplus of 1.6%).

Upgradation of *desi* cows using high yielding Indian breeds and provision of more feed and fodder through integrated farming would enable the State to achieve self sufficiency much earlier. Another possibility would be the augmentation of buffalo population wherever feasible. It should be remembered that in India over 1/3 of the bovine population are buffaloes, while in West Bengal buffaloes constitute less than 4% of the bovines making a significant difference in milk production per animal.

Egg production

There is a huge shortfall in the supply of eggs in the State; the data in the first 6 years of this century show an average annual growth rate of 2.32% for domestic egg production. Although the same is higher than human population growth rate in the State, much more effort should be given to egg production with greater emphasis on improving backyard poultry as well as scientifically managed layer farms with improved breed of birds, besides provision of more poultry feed, maintenance of hygienic condition and monitoring of bird flue and related incidents (see Part Three, Chapter III for information in details).

Projections for egg production: The State produces roughly only 30% of its egg requirement, as such the gap is formidable and unless some radical change is ushered in raising layer birds it would be difficult to attain self-sufficiency in egg production soon.

Table 8: Egg production projections

	Year 2010		Year 2015		Year 2020		Year 2025	
	Prod.	Req.	Prod.	Req.	Prod.	Req.	Prod.	Req.
Total (number in million)	3,379	8,916	3,851	9,320	4,389	9,708	5,002	10,034
Excess(+)/shortfall(-) (number in million)	-5,537		-5,469		-5,319		-5,032	
Availability (%)	37.9		41.3		45.2		49.9	
Surplus (+) /deficit (-) (%)	-62.1		-58.7		-54.8		-50.1	

Prod. = Production, Req. = Requirement
Requirement based on State Government norm of 100 eggs per capita/year

Accepting the present pace of development, only 50% of the requirement of eggs may be met by the end of 2025.

Meat production

The total meat production in the State in 2006-07 crossed 5 lakh tonnes, with an average annual production of 4.69 lakh tonnes over 2001-02 to 2006-07, with goat meat (chevon) contributing 31.1%, poultry 30.9%, bovine meat 27.7%, pork 6.96% and mutton (sheep meat) 3.45% of the total production. The annual growth rates in the aforesaid period have been 2.94%, 2.89% and 2.44% respectively for goat meat, poultry and bovine meat (see Part Three, Chapter III, section G for details).

Although those values for annual growth rates are higher than projected population growth rates of West Bengal it would require a long period to overcome the nearly 50% shortfall in meat production in the State at present unless more attention is given to livestock feed and fodder production and scientific management practices.

Meat production projections: A relatively medium term projection upto 2025 given by the Animal Resources Development Department is discussed hereunder.

Table 9: Meat production projections

	Year 2010		Year 2015		Year 2020		Year 2025	
	Prod.	Req.	Prod.	Req.	Prod.	Req.	Prod.	Req.
Total ('000 tonnes)	551	976	623	1,021	705	1,063	798	1,099
Excess (+)/shortfall (-) ('000 tonnes)	-425	-	-398	-	-358	-	-301	-
Availability (%)	56.5	-	61.0	-	69.05	-	72.6	-
Surplus (+)/deficit (-) (%)	-43.5	-	-39.0	-	-30.9	-	-27.4	-

Prod. = Production, Req. = Requirement
Requirement based on State Government norm of 30 g meat per capita/day

West Bengal presently produces about one-half of its requirement of meat for domestic consumption that in the years 2010, 2015, 2020 and 2025 may progressively rise to 51, 61, 69 and 73 percent (i.e. reaching nearly 11 lakh tonnes in 2025) respectively. However, with proper integration of the livestock sector with the crop husbandry sector thereby assuring more fodder and feed it would be certainly possible to achieve the target of self sufficiency much earlier.

Input management for sustainable productivity

Soil fertility management

There are documented evidences of a wide range of adverse effects of industrial agriculture on soil fertility specifically attributable to the lack of soil organic matter (SOM) which determines not only the biological characteristics of the soil but also its physical and chemical properties. The top soil microenvironment teeming with millions of micro-organisms is intimately associated with the operation of natural nutrient cycles (e.g. nitrogen cycle, phosphorus cycle, etc.); these organisms need organic food for their own nourishment as well as appropriate conditions for their asymbiotic and beneficial symbiotic associations in the rhizosphere. Bhattacharyya and Kumar (2005 see table 10) have given the estimated potential and actual availability of such sources along with their respective nutrient values taking the total from all over the country (potential availability) and actual 1/3 availability (for calculation of nutrients availability in terms of N, P, K).

There are, however, wide differences in literature regarding the estimates of potential and available plant biomass and animal manures further complicated by the absence of quantified data on their relative uses as fuel and manure.

Microelement deficiency is not expected in organic farming because the composts of vegetative materials, animal manures, etc. would be capable of providing the essential elements required only in very small quantities. The widespread deficiency of micronutrients has been one of the consequences of the green revolution technology that emphasized on three major nutrient elements (NPK) only. The occurrence of micronutrient deficiency in India is strongly correlated, except in a few cases, with the intensity of the adoption of green revolution technology as amply demonstrated in Punjab and Haryana where farm mechanization almost totally replaced bullocks (cattle raising by farmers for draft purposes in general lost priority) losing thereby the additional large benefits of cattle manure. The situation was further aggravated and compounded by the utterly thoughtless practice of burning crop residues *in situ*, thereby foregoing the two most important sources of organic matter, depriving in the process, the soil not just of its natural fertility only but also the vital sources of micronutrients with long term adverse consequences on plant growth and development.

Table 10: Organic nutrient sources in India, their potential and actual availabilities and nutrient values

Component	Potential availability (million tonnes)	Actual availability (million tonnes)	Nutrient value (million tonnes)
Crop residue (a)	603.46	201.11	4.865
Animal dung (b)	791.66	287.45	3.474
Green manure (c) (area covered)	4.46 (million ha)	data not available	0.223
Rural compost	184.30	184.30	2.580
City compost	12.20	12.20	0.427
Biofertilizer	0.01	0.0094	0.307
Others	96.60	data not available	0.907
		Total	11.940*

*Net nutrient availability after 30% deduction = 8.358 million tonnes.

Source:P. Bhattacharyya and D. Kumar (In: National Policy on Promoting Organic Farming, *Proceedings of National Seminar*, March 2005 p. 8)

(a) Actual availability given as 1/3rd of potential availability, a possible 2/3rd use of crop residue, weeds, etc. would add another 4.865 million tonnes of nutrients.

(b) Availability of dung also given as 1/3rd of potential, in this case also a 2/3rd use of animal dung would contribute another 3.474 million tonnes of nutrients.

(c) An obligatory cultivation of at least one legume in the crop rotation schedule either as a main crop (e.g. khesari, soybean, pigeon pea), or any other suitable pulse crop (food crop), or a green manure crop such as the common dhaincha (*Sesbania aculeata*), or waterlogging tolerant *Sesbania rostrata*, drought tolerant tephrosia (*Tephrosia purpurea*) or miltipurpose green manure-cum-cover crop, *Phaseolus trilobus*, would be capable of meeting the rest of the nutrient requirements. Globally fixation of nitrogen by legumes alone is 60% more than chemically synthesized commercial nitrogenous fertilizers.

Although the estimates given in the aforesaid table may appear to be short of the national requirements, the 2/3rd non-availability of livestock manure as mentioned in the table when fully recovered and appropriately used in gobar gas plants to yield biogas (primarily methane, giving smoke-free flame) as kitchen fuel, the burning of certain crop residues for fuels (giving lot of smoke) would be expected to reduce significantly. As such, much more biomass would be available for nutrient recycling besides making the household environment (overall rural environment as well) a lot more clean and hygienic.

It is estimated that annually the total uptake of major nutrients (N, P and K) by crop plants in the country is around 28 million tonnes. Total application of NPK in the form of chemical fertilizers is about 17 million tonnes (N 11.3 mt, P_2O_5 4.4 mt, K_2O 1.7 mt) but less than half (often 1/3rd) of the applied N, one-third of P_2O_5 and three-fourth of K_2O would be actually available to the plants, the rest being irretrievably lost to air and water bodies or immobilized in the soil; as such, the balance of about 19 million tonnes of nutrients are made available by reserves and processes in the soil itself.

China proposes to produce 37% of its requirement of rural energy through biogas production and regenerate over 20 million tonnes of nutrients (more than India's total commercial NPK use/year) through recycling of organic wastes by the year 2015 (see Energy Issues in the Annexure Item 14).

Globally the average nitrogen availability through biological nitrogen fixation in arable soils is over 100 kg per hectare (more in tropical soils than in temperate soils), amounting to 140 million tonnes per year (primarily by legumes) that is 70% more than the use of synthetic N-fertilizers in global agriculture. Loppings from 5 years old gliricidia trees grown on farm bunds have been shown to yield as much as 60-70 kg of N per hectare. Integrated farming systems, involving agricultural and horticultural crops and, livestock rearing (cattle, small animals like goat, sheep, pig, poultry, etc.), would be still more desirable from the soil fertility management viewpoint by small and marginal farmers. Incorporation of fishery and aquaculture into such farming systems would further benefit the farmers; the output of one sector would serve as the input of another in a cyclically operating use-recycle-use mode with the virtually inexhaustible energy of the sun operating as the prime mover of the system (see *Crop-livestock integrated farming systems*).

Mulching: Use of fresh or dry leaves, straw, cut or uprooted weeds and any other plant residues as mulching materials to cover up open space in between crops or rows of crops besides reducing tillage, intercultural costs and associated labour costs in weeding (weeds when covered up would be unable to photosynthesize and eventually perish) is an acknowledged beneficial practice in farming. Mulching promotes humus formation; it reduces evaporative loss of moisture and ultimately increases water holding capacity of the soil. As the top soil (as well as subsoil) remains moist, the microenvironment becomes more congenial for microbial activity essential for the maintenance of soil fertility. The mulched moist humus-enriched soil with its greater water holding capacity would be of advantage to the standing crops in rainfed areas to tide over intermittent dry spells. In due course of time, the organic mulching materials would constitute a part of the soil organic matter upon decomposition.

Conservation agriculture, zero tillage, etc.

Conservation agriculture, zero tillage, etc. (not identical with the traditional *paira* crop in aman fields of the State) to prevent carbon release from soil and promote carbon sequestration in soil may in the short term give some benefits to the farmers. However, use of machines to save time for early sowing and planting and agrichemicals, specifically herbicides to control weeds must be avoided. The initial subsidies to the farmers may lure them to adopt such practices but long term sustainability of such practices at the level of small and marginal farmers must be worked out and socioeconomically properly assessed. The present initiatives in this regard could very well be strategic moves by the corporate agribusiness sector to promote farm mechanization on a larger scale, promotion of use of toxic herbicides on a wide scale (besides other toxic pesticides) to be duly followed by introduction of herbicide tolerant GM crops. Indeed there are every reasons for our farmers to be over-cautious on these issues. What appears to be labour and time saving and economically lucrative presently, may in the long run, prove to be counterproductive to attain the goal of ecologically sustainable farming.

Water management

Availability of water vis-à-vis irrigation potential

As per data in the Annual Document 2003-04 of the Planning Commission, Government of India, the ultimate irrigation potential of West Bengal is 69.18 lakh ha of which 23 lakh ha would come from major and medium irrigation sources and 46.18 lakh ha from minor irrigation sources. The irrigation potential created upto 2005-06 period is 53.747 lakh ha of which the total of major and medium irrigation is 15.607 lakh ha and minor irrigation is 38.14 lakh ha. The irrigation potential utilized upto 2005-06 period is 42.946 lakh ha of which major and medium irrigation would be 11.606 lakh ha and minor irrigation 31.34 lakh ha. The irrigation potential utilized (42.946 lakh ha) is 79.9% of irrigation potential created (53.747 lakh ha) (Economic Review 2006-07).

So there are two limiting factors in relation to expansion of irrigated area of the State.

i) The ultimate irrigation potential of the State is 69.18 lakh ha. This is arrived by estimating the volume of water. The volume of surface water available for irrigation is derived from all the river basins of the country. The volume of ground water available for irrigation is derived from premonsoon and postmonsoon level difference of ground water measured through piezometric tube water level.

ii) There lies a gap between irrigation potential utilized and irrigation potential created as 79.9% of created potential is utilized and due to siltation, depletion of ground water table as well as other mechanical errors, the designed discharge of individual irrigation structures can not be achieved and it (actual discharge) is gradually declining.

The present gross cropped area of the State is 9,532,607 ha and net cropped area is 5,294,702 ha in 2005-06 (Economic Review 2006-07). So, if ultimate irrigation potential of the State (69.18 lakh ha) is considered against the gross cropped area (95.33 lakh ha), then also there lies a gap of 26.15 lakh ha. This area can not be irrigated through present type of irrigation system, which directly restricts the scope of increasing the productivity and production of different crops as well as increasing the cropping intensity. Here lies the importance of land shaping with 5%/10%/20% model of shallow dug well/pond which would harvest runoff water loss at a further micro-level beyond the present scope of irrigation structures. Keeping this in mind, any increase in net area sown is also to be reviewed in terms of irrigation potential. This is also due to the fact that surface irrigation is having a limitation of availability of water during the summer months in many situations and also the problem of gradually increasing presence of arsenic/fluoride in ground water that would restrict the increased use of ground water for irrigation and domestic purposes.

Future planning for irrigation should therefore be based on harvesting of rain water in various effective surface water harvesting structures, an approach that would also restrict the loss of nutrients in the run-off water along with efforts to reduce the gap between potential created and utilized and technological endeavours to augment both surface and ground water availability. Further, for best possible utilization of available water, crops and suitable farming systems need to be selected. Even rice, the most water demanding crop in our farming system, if grown following the System of Rice Intensification (SRI) will save nearly half of the water now being used for the purpose at the same time yielding an additional one ton of rice per hectare (see System of Rice Intensification: The Tripura Experience in the Annexure Item 12).

Seeds

High quality seeds are most important for successful establishment, growth and development of seedlings. Varieties most suitable for specific regions would be desirable and the different regions in the State often show vastly different agro-climatic conditions. For sustainable farming a range of crops (wide crop biodiversity) as well as varieties within a crop should be selected. Community seed banks are now coming up in many areas where selected crop seeds are grown, processed and well preserved for use by the farming community, these need to be patronized through appropriate training programmes because the dependence on public sector seed agencies may not fulfil the demand for all kinds of seeds.

The private sector companies often sell seeds at prices not easily affordable by the poor small and marginal farmers. The hybrid seeds which can not be saved by the farmers should be avoided as far as possible; further the question of suitability for widely differing local conditions should be critically evaluated. Whenever a new variety is brought in, the experience of other farmers must be shared as there is always an element of risk that needs to be overcome. It must be highlighted that it is the farmers and their predecessors who have domesticated, improved upon and sustained all our crop germplasm that enabled today's scientists to use their basic materials to further work upon and improve.

Hybrid seeds: The heterosis effect (hybrid vigour) is attributed to the improvement of performance of plants obtained by crossing two inbred pure lines (plants that are genetically homozygous and produce offsprings close to near-clones of themselves). The F_1 seeds would produce plants that are superior to their original highly inbred parents but the heterosis effect would disappear after the first generation. As such, it would be pointless for the farmers to save seeds produced from a crop raised from hybrid seeds. In fact, this particular characteristic of the hybrid seed, the farmer's failure to save the seed because of the seed's in-built IPR protective character, has proved so very lucrative for the seed companies with the assurance that the farmer is bound to return to the seller company for each and every sowing.

'Heterosis effect' is yet to be scientifically fully explained even so many years after its discovery in the 1930s in maize. A large number of scientists opine that under low-stress environments, there are actually no significant yield differences between the maize hybrids grown in North America in the 1930s and those from 1990s but there are big differences in yield between the 1930s and high stress environments caused by very high density planting. As such, the ability of today's maize hybrids to give higher yields, under the high stress dense-planting conditions, has nothing to do with "hybrid vigour". According to a recent study, "These changes in stress tolerance are likely the by-product of plant breeders selecting for yield at high plant populations and over a wide range of growing environments" (Bruulsemma *et al. Better Crops* **84**(1), p 9, 2000; also see website: http://tinyurl.com/yg/257). The increases in yield are really due to the old method of selection or population breeding practiced since the beginning of the agrarian civilization.

Some scientists, while agreeing that some hybrids demonstrate hybrid vigour, argue that they appear to produce high yields because they out-perform by a significant margin the parental lines they were crossed from. This is only to be expected, because the yields from the parental lines are depressed by the many backcrosses that breeders must make for them to be stable. Hybridization, therefore, does not necessarily produce improved cultivars, heterosis effect (hybrid vigour) is confined to improvement over the highly inbred parental lines.

Notwithstanding the scientific understanding as yet unresolved, the economic gains of the hybrid seed producers are soaring; often the hybrids cost 15 times of their conventional counterparts partly because of the high costs involved in hybrid seed production. The high input requirements of hybrids would further add to the farmer's cost of production making the situation still more difficult for the resource-poor farmers of the developing countries. Reports from farmers growing hybrid rice in China as quoted by GRAIN tell, "Farmers growing hybrid rice need to use more fertilizers…. It is as if the paddy field has got addicted to heroin" (website: grain.org/briefings/? Id=190). Incidentally, the only commercially approved GM crop in India, cotton, is sold only as F_1 hybrids just to ensure that the farmers are unable to save the seeds (all GM crops, under trial in India are understandingly obligatory hybrids). It is no wonder that a crop breeder of Japan based seed company, Sakata, the world's seventh largest one states, "All of our focus is on hybrids", she says "It's what you can control and keep ownership of ".

It is worthwhile to mention in this connection, that the Seed Bill 2004 now lying before the Indian Parliament is also an attempt to restrict the farmers' rights to save the seed and over the last five years it is the genuine opposition by the concerned people to the corporate take over of the Indian seed sector that has not allowed till now the passage of the said bill for enactment.

Fertilizers

Data on fertilizer use in West Bengal over 2001-02 to 2006-07 as shown in Economic Reviews (2005-06 and 2007-08, Statistical Appendix of each) and Statistical Handbook, 2007 as shown below in Table 11 have shown negative (statistically non-significant) correlations between fertilizer consumption per year and productivity as well as total production.

Table11: Total NPK fertilizer consumption data, index numbers of productivity and production of selected major crops during 2001-02 to 2006-07 and correlation coefficients between respective sets of variates

Crop years	Total NPK used (x) ('000 tonnes)	Productivity (y_1) (Index No.)	Production (y_2) (Index No.)
2001-02	1178.2	201.5	240.6
2002-03	1167.6	195.0	225.4
2003-04	1116.2	201.5	236.8
2004-05	1261.4	203.3	234.0
2005-06	1239.7	203.4	232.9
2006-07	1365.1	196.7	227.0

Correlation of NPK use and productivity/production:

Correlation coefficient (r) = -0.1507 -0.4518

Regression formula: y_1=207.7-0.0061x y_2=269.1-0.298x

Fertilizer use has steadily increased in the State and presently the consumption figure is above 130 kg/ha. A simple linear correlation (n=6) between fertilizer consumption in the State and productivity based on cumulative index numbers of yield rate of selected major crops (taking triennium ending in crop year 1981-82=100 as the base year), for years 2001-02 to 2006-07 falls much below the level of statistical significance at 0.05 P; the same is true of total production (duly converted to index numbers) clearly indicating the limitation of our present practice of farming. This also could be attributable to deficiency of secondary nutrients or microelements, the lack of which would be acting as limiting factors. A finding recently published by researchers in the Department of Agriculture (P. Sen *et al.* 2008, *Indian Agriculturist* **50** (1) p. 192) has identified widespread sulphur deficiency in 9 districts of West Bengal that includes Murshidabad, Nadia, Birbhum, Hooghly, 24-Parganas(N), Burdwan, Jalpaiguri, Midnapore (West) and Malda. This is in consonance with 90% samples in north-west India and eastern Bihar showing sulphur deficiency; further, 90, 70, 60 and 40 percent samples from major growing regions (based on rice-wheat cropping system) showed deficiencies of zinc, boron, manganese and copper respectively that would require site specific nutrient management (SSNM) (K. Majumdar, *Indian Agriculturist* **50**(1) p. 171, 2008). Most of these areas have been avoiding organic manures with the spread of green revolution technology. Site specific nutrient management through soil analysis in the laboratories is a Herculean task much beyond the infrastructural capacity for effective implementation. Colour charts (cropwise) for deficiency symptoms and quick tissue tests may be of some help but the immediate necessity would be to apply large quantities of organic manure to build up soil organic matter (SOM) and restore soil fertility.

Otherwise in such soils nitrogen use efficiency may be as low as 30% and most of the nitrogen from chemical fertilizers would be lost during the year of application. According to numerous ^{15}N-tracer investigations, the extent of over fertilization, which is the present trend in industrial agriculture, has been far more serious than under fertilization because grain nitrogen originates largely from the soil rather than fertilizer (Bijay-Singh, 2008; *Indian Agriculturist* **50**(1), p. 158).

Labour issues: Use of machines as labour saving input

One of the costly inputs in small holder farming is human labour despite the fact that in this country very often house-hold labour is not included in the cost of cultivation by the small and marginal farmers. In India wheat cultivation requires 180 man-days per hectare but in the USA for one hectare of wheat cultivation (from seed to seed) the human labour is about one man-day (7.5hours only) and machines do the rest. Of course with only 2 percent population in farming and average farm size hundreds of times bigger, there are few other options. The situation in India is totally different and more people are engaged in agriculture than in any other profession. Labour saving devices may displace such people from agriculture, who being unskilled in other activities, would simply shift over to manual jobs of any other kind. Even then, in intensively cultivated tracts of India labour shortage in peak periods of farming is a serious issue, and in many regions semi-medium, medium and large farmers are now using harvesting machines to overcome labour shortage. Basically the seasonal nature of monocultural farming practices is the root cause of the problem; lack of continuity of work discourages farm labour who would seek more regular and continuing work even on a daily wage basis in cities and towns.

Much of the farming job is now the responsibility of women in the villages as a significant number of their male counterparts have migrated to the urban areas, mainly working in the construction sector, returning sometimes for peak seasonal farming activities such as tillage, harvest or any other work requiring hard physical labour. This gradual feminization of third world agriculture is now a general trend. IAASTD has deliberated at length on issues covering 'Women in Agriculture' in its report specifically mentioning the necessary legal and social safeguards the women farmers would require as the main caretakers of families and farms.

The issue of broad distribution of farm work over the year at the level of small and marginal farms can be considerably resolved by shifting to livestock integrated farming systems. Women in particular have always proved themselves much more efficient caretakers of livestock including birds, bovines and small animals.

Coming back to the issue of use of machines, it is necessary to use simple implements and equipments that will reduce drudgery of work besides saving time and reducing physical hardship; for example rotary paddy weeder or the more sophisticated weeder developed for SRI, seed drills, more efficient threshing machines, etc. should be further improved to reduce drudgery. Much less emphasis should be given to fossil fuel dependent machines, particularly heavy machines, as the fossil fuel crisis would surely be a problem in future. Despite the recent drop in fuel prices due to general economic depression all over the world there would be a turn around sooner or later.

The short-term economic gains with machines may in the long run prove otherwise in view of the reported hardpan formation in the subsoil in many regions through continued use of heavy machines in the soil that restricts percolation of rain-water down below to recharge the aquifers.

It should also be clearly understood that too much dependence on machines using fossil fuels, besides dependence on various other external inputs (costly seeds, especially hybrids, agrochemicals, etc.) would be at the expense of long term sustainability of the rural economy with the villages becoming poorer and poorer over time.

Pesticides

Over 200 pesticides, that include insecticides, herbicides, fungicides, etc. are registered for agricultural use in India. The insecticides constitute the dominant class of pesticides with organophosphates, organochlorines, carbamates, synthetic pyrethroids, biopesticides, etc. As per WHO regulation the extremely hazardous pesticides class Ia (marked by a red coloured triangle) and highly hazardous, class 1b (yellow triangle), class II (moderately hazardous, blue triangle) constitute 2/3rd of the pesticides used in the country, the other insecticides, namely class III (slightly hazardous) and another, "not likely to be hazardous" group together constitute the rest 1/3rd of pesticides used in India.

Pesticides applied on crops would be expected to leave some residues depending on crop and various other factors and may show up their presence in products to be consumed such as grains, pulses, fruits and vegetables or in milk and other animal products. Although in our country pesticide application is less than in many other countries, the percentage of products showing residue level is higher in our country than the more chemical intensive agriculture in the industrialized countries of Europe. From 1965-66 to 1989-99, on an average 41% of our food had been free from pesticide compared to 63% in EU; and of the nearly 60% of pesticide contaminated foods 1/3rd had been above the respective maximum residue limits (MRLs). This is attributable to a lax regulatory system that fails to control indiscriminate application; often pesticides are used by farmers 2-3 days before fresh fruits and vegetables are brought to the market.

In response to a starred question in the Indian Parliament on August 8, 2005 the Agriculture Minister revealed the following facts on pesticide residues (samples above MRL values) for the period 1999-2003 (only annual mean values for the period are given).

(i) **Vegetables** (cabbage, cauliflower, brinjal, okra, potatoes, beans, gourds, tomato, chilli, spinach, carrot, cucumber, cowpea, etc.): 273 samples out of 3,043 were above MRL (9.0%).

(ii) **Fruits** (apple, banana, mango, grapes, oranges, pomegranate, guava, etc.): 15 samples out of 1,554 above MRL (1.0%).

(iii) **Milk**: 281 samples out of 1,199 above MRL (23.4%); (mean of only 3 years as no study was done for 2002 and 2003).

It needs to be pointed out that independent studies had shown much higher percentages of samples above MRL; in any case, the samples were taken from our domestic markets and it is sure that export of such items would have faced rejection by importing countries. Nevertheless, even 1% sample above MRL in the domestic market of the country means that the potential danger is quite high and must not be tolerated.

Pesticide exposure and health issues

There is unanimity in scientific circles on the potential dangers of pesticide exposures to consumers, bystanders and workers that exist at virtually all stages right from manufacturing, transport, storage and during and after application of pesticides. Both short term high level exposure (as during agricultural application without protective measures) or long-term low dose (chronic) exposures are differentially but highly detrimental to health; as such, the best alternative would be to adopt non-chemical interventions in pest control.

According to World Health Statistics Quarterly, as many as 25 million workers in the developing countries were reported to be suffering annually from mild pesticide poisoning. WHO and UNEP estimate a total of 3 million agricultural workers in developing countries to be experiencing severe pesticide poisoning ultimately causing death of about 18,000 persons every year. In a news report, D. Lawrence (International Herald Tribune, February 13, 2007) has given an estimate of half a million people in China being poisoned every year with 500 people ultimately dying per year. More recently, in April 2008, IAASTD has given a figure of 220,000 annual deaths and 2-5 million people suffering from pesticide toxicity every year (IAASTD website://www.agassessment.org/).

The preference for organophosphates (OP), because of their lesser persistence than the organchlorines (OC) and lower damage to the environment, has not reduced health problems of workers and short-term high exposure to OP would cause abdominal pain, dizziness, headaches, nausea, vomiting, skin and eye problems. Long-term health problems include chronic respiratory troubles, dermatological problems, cancer, memory disorders, depression, neurological problems, miscarriages and birth defects; the neurological outcomes and cancer are two of the more prevalent manifestations of OP exposure related health problems. According to the National Academy of Science, USA, pesticide residues in food in allowable amounts are responsible for 4,000 – 20,000 cases of cancer per year.

The USDA's Pesticide Data Programme that undertakes testing the pesticide residues on food sold in the US from samples collected close to the point of consumption is perhaps the biggest of its kind in the world. The results from the data for the year 2005, make alarming revealations. To cite a few examples, out of 774 samples of apples, 98% showed the presence of pesticide residues (parent substance and metabolites), for pears out of the 741 samples tested 87% showed presence of pesticides; in lettuce (743 samples tested) 88% were positive for pesticides residues. Even with processed orange juice (186 samples tested) half of the samples (50%) showed the presence of pesticide residues. For a very rich and advanced country like the USA, one would not expect so much of pesticide contamination (despite being below tolerance levels).

According to the Natural Resources Defense Council, higher instances of brain cancer, leukemia and birth defects have been found in children with early exposure to pesticides. In USA the neurotoxic effects of organophosphate pesticides have been noted at legally tolerable levels. Ascherio and coworkers (A. Ascherio *et al. Annals of Neurology* **6**, p. 197, 2006) estimated a 70% increase in the risk of developing Parkinson's disease for people exposed to even low levels of pesticides. Pesticide exposure may have negative effects on a fetus and manifested as growth and behavioral disorders or reduced resistance to pesticide toxicity later in life (BBC News, February 8, 2007).

All the aforesaid problems can be effectively controlled by switching over to organic farming or non-pesticidal management (NPM) in which use of synthetic chemical pesticides is strictly prohibited (see Non-Pesticidal Management in the Annexure Item 10).

Institutional services and related issues

Agricultural credit, cooperatives

Agriculture constitutes one of the important sectors of Indian economy, contributing about 18.5% in 2006-07 of the total Gross Domestic Product (GDP) (Source: RBI Annual Report, 2006-07) and 65% of the total work force. The production of food grains is also hovering around 212.4 to 217.3 million tonnes from 2001-02 to 2006-07. The share in real GDP in Agriculture has also gradually declined from 21.7% in 2003-04 to 18.5% in 2006-07.(Source: RBI Annual Report, 2007-08, p. 360, 358).

Agricultural credit: The relevance of agricultural credit and necessary support to the cooperatives can considerably help to meet the challenges of uneven competition posed by the new economic policy, considering the vast network, outreach and relationship with the rural people. Even after the emergence of commercial banks in the late sixties, the credit cooperatives today cover over three-fourth of the rural credit outlets. Nearly half of over 66 thousand branches of commercial banks in the country, are rural branches. On the other hand, in the year 2002-03, 1.123 lakh Primary Cooperative Credit Societies (rural outlets) purveyed credits to 6.38 crore members in the rural short term cooperative credit structure (STCCS). The findings of the National Sample Survey Organization (NSSO) 59th Round (2003) reveal that only 27 percent of the total households in the country received credit from formal sources while 22 percent received credit from informal sources. The remaining households (i.e. 51%) mainly small and marginal farmers, have virtually no access to credit. But it is a matter of concern that in West Bengal, the share of outstanding amount of small and marginal farmers from formal sources is 28% only whereas due to land reforms, proportion of small and marginal farmer to all farmer house holds in West Bengal is 78.69%

(marginal farmers 49.73% and small farmer 28.96%). (Source: Agricultural Census, Directorate of Agriculture, Govt. of West Bengal). This issue needs immediate resolution through effective dialogue between State and Union Governments and the formal banking sector.

Self help groups

Self help group is a newly started system in the State that has already reached the figure of 8 lakh approximately in number involving around 90 lakh beneficiaries, 90% of the members being women. Panchayat is the key facilitator and besides accumulation of micro-credit for 6 months by the SHG participants themselves, they are getting loans and funds from institutions like NABARD, State Co-operative Banks and projects like Swarnajayanti Gram Swarojgar Yojana (SGSY) and others. Through this system women are becoming economically self-dependent, learning to work together, applying collective wisdom to solve local social problems, improving local infrastructure and earning respectable position in the family and the village. Besides creation of an exclusive department of SHG, Government of West Bengal has issued circular indicating the responsibilities of Gram Panchayats towards SHG to help them progress further to participate in rural and agricultural development. Many more fields of activities around agriculture can be organized through SHG for all out development of agriculture. Besides agriculture the SHGs may be involved in non farm activities also like food processing, village agro-industries and handicrafts, garment making, etc. as far as practicable. There are opportunities for SHGs in emerging sectors also provided they are given training in these areas.

A brief report on the SHG movement in West Bengal (upto October, 2008) as received from Self-Help Groups and Self Employment Department of The Govt. of West Bengal is given below.

Brief report on SHG movement in West Bengal

a) Under the programme Swarnajayanti Gram Swarojgar Yojana (SGSY), there are at present (238,727) nos. of SHGs. The Programme is looked after by Panchayat and Rural Development Department of the State Government in the rural areas only.
b) Besides Government, NABARD is a major organization which has been responsible in promoting SHG movement in the State.
   So far 365,805 nos. of SHGs have been formed by NABARD in the rural areas only.
c) The Co-operation Department of the State Government has so far formed more than 132,292 SHGs through Primary Agricultural Co-operative Societies. Funding is made by West Bengal State Cooperative Bank under the financial assistance of NABARD. Therefore, this figure is included in the figure of NABARD in para (a) above.
d) There is a programme named Swarnajayanti Sahari Rojgar Yojana which is being looked after by Municipal Affairs Department of the State Government.

Under this programme 45,000 Neighbourhood groups, 27,044 nos. of Thrift and Credit Groups and 1,450 nos. of DWCUA groups have been formed. The programme is restricted in Urban Areas only.

Major achievements of SHGs are as follows:

i) More than 90 lakh of beneficiaries have been covered under SHG movement; 90% of the members are women.
ii) The savings of the SHG under SGSY is approximately Rs.217 crore.
iii) The savings of the SHG under NABARD approximately Rs.190 crore.
iv) The SHGs under SGSY who have passed Grade-I are 183,307 in number; out of these groups the number of SHGs passed Grade-II is 44,484.
v) The SHGs under SGSY who have got cash credit loan is 142,384.
vi) The amount of Cash Credit is Rs. 358 crore approximately.
vii) The number SHGs under NABARD who have got 1st input of loan is 237,517.
viii) The amount of Cash Credit for NABARD SHGs is Rs. 584 crore approximately.
ix) The SHGs under NABARD who had repaid the 1st input of loans got refinance amounting to Rs. 151 crore approximately.
x) The number of SHGs under the Co-operation Deparement getting loan is 70,000 approximately and the amount of loan is Rs. 115 crore approximately.

Growth in agriculture has a direct bearing on poverty and livelihood of farmers. Credits including other inputs play an important role in strengthening agriculture in general and farmers in particular. It is a means of poverty alleviation, but not an end. However, credit is not a panacea for all the problems of the farm sector and providing credit to the farm sector without considering its absorptive capacity will push the farmers in to the vortex of irretrievable indebtedness and distress.

Agricultural trade and market related issues

As discussed earlier in the present discourse a serious setback in the agricultural sector of the developing countries has taken place in the post-WTO phase during 1996-97 to 2001-2002 half-a-decade phase (relative to the 1990-91 to 1995-96 pre-WTO half-a-decade period). The declining agricultural growth rate in most of the developing countries, including India, needs critical consideration. The dumping of heavily subsidized agricultural products from USA and EU has already worked havoc in some countries. A report by the Institute of Science in Society last year (ISIS Press Release dated 15.7.08 on "Rising food prices reinforce need for food security policies" by Martin Khor, website:http://www.i-sis.org.uk/index.php) is a timely reminder of what may happen through well designed strategies to make poor nations dependent on large scale food imports.

The case story of destruction of Ghana's agriculture by the IMF and World Bank illustrates how a developing African nation that achieved near self sufficiency in agriculture through the country's policies, that have been instrumental in its adequate production of rice, tomato and poultry, was subjugated. As per conditionalities of IMF, World Bank funds, Ghana was forced to withdraw fertilizer subsidy and phase out prevailing market systems along with abolition of minimum guaranteed prices for rice and wheat, winding up of agricultural trading enterprises and seed distribution systems and simultaneously reducing applied tariffs on imports to the present 20% limit. Ghana now imports 64% of its rice (in 2003 , 111 thousand tonnes of US rice was imported, that year US subsidy to rice growers was $1.3 billion and while the production and milling cost in the USA was $415 per tonne, the same was sold at $ 274 per tonne, 34% below the cost of production). The tomato sector was ruined; and along with farmers those employed in the processing industries were effectively displaced because of highly subsidized tomato paste exports from the EU. Between 1996-2002, heavily subsidized EU frozen chicken exports to West Africa rose 8-fold and domestic farmers who supplied 95% of Ghana's market earlier, shared a paltry 11% in 2001. WTO has not been able to do anything fruitful to control the trade-distorting subsidies.

The aforesaid trade and marketing scenario is truly reflective of what is happening in import dependent countries. As such, the policies of the developing countries now should be centered on high priority to expanding local food production to achieve greater self sufficiency instead of reliance on cheaper imports.

It needs to be understood that climate changes, input costs, energy crisis, population growth, etc. are not the only major barriers to food security but the IMF/World Bank/WTO polices favouring structural overproduction in the developed countries, the USA and EU in particular, are formidable barriers to the food security of the developing countries including India. West Bengal being a constituent part of the federal structure would be a subscriber to overall national policies on the issue. However, less external input and energy dependent agriculture with integrated and localized marketing and distribution channel can effectively ensure food security and food sovereignty at the micro-level as well collectively at a broader macro-level.

In tune with the rest of the country, the weakest link in the chain of agricultural production system in West Bengal, that is of utmost concern to the small and marginal farmers, is the prevailing agricultural marketing system in the State. In case of perishables the farmer may get on an average 20-30% of what the consumer would pay (or sometimes even less) implying that 70-80% of the final price would be shared by intermediaries. With the investment mostly through non-institutional loans, hard labour and considerable risk bearing, the primary producer should logically get at least 50% of the price of the produce. How the same can be assured should be the primary objective of a true reform in the marketing system.

Market access also includes infrastructure in terms of 'auction platforms', drying sheds, godowns, cold storage and facilities for training whereas roads and transport facilities are the necessary prerequisites in establishing proper market environment. The National Commission on Agriculture 1976 also noted that post-harvest loss was much higher in India than many other developing countries. We may add here that over the years not much change has taken place in the country in this regard and West Bengal is no exception.

Regarding marketing of nutritionally superior products from organic and near-organic from localized systems, the recent Government of India's support to PGS (participatory guarantee system) is a significant step forward for assurance of more remunerative prices to the growers (as yet uncertified). A number of studies have now confirmed that net income from organic practices are more than that from chemical intensive conventional farming practices even without taking into account the huge external costs (ecology, environment and health degradation costs, that incidentally needs effective quantification for due addition to the cost of production). Involving SHGs in the marketing of such products would be mutually beneficial and cut down operational costs.

The laying of the foundation stone of the Netaji Subhas Training Institute of Agricultural Marketing (NSTIAM) under the auspices of the West Bengal State Marketing Board on November 21, 2008 at the Principal Market Yard of Sheoraphully Regulated Market Committee, - the first such institute opened in this part of the country, is a commendable endeavour (the Commission is particularly happy that the same was duly recommended in its interim report). The institute includes in its curricula most issues that are of considerable importance and focus thrust areas such as WTO, Food Safety Quality Certification and Standardization, Organic Farming which are integrally linked with marketing endeavours tuned to general well-being and consumer satisfaction.

Specific problems of small holders

A critical appraisal of the data (for 2003-04) on percentage distribution of operational holdings, ownership households and area owned over five broad classes of holdings (namely, marginal, small, semi-medium and large) in West Bengal as well as several other selected states (also all India average) would clearly bring about certain special features of land holding related issues in the State.

West Bengal in terms of percentage distribution of operational holding is very close to Kerala as far as 'marginal' operational holdings (less than 1 ha) are concerned (88.8% in West Bengal against 91.8% in Kerala, that is the highest in the country). The trend of distribution in respect of 'small' and other classes is similar in the two states albeit a bit more squeezed in Kerala than in West Bengal; these two are the only states where the 'large' class (over 10 ha) is altogether absent. Regarding the Punjab situation, contrary to West Bengal where the percentage of farmers in the 'marginal' class increased from 61% in 1971-72 and rose to the present nearly 89%, Punjab showed a rise from 11.7% in 1970-71 to 66.3% in 2002-03; Punjab as well as Haryana (both irrigated and well mechanized), however, have a much larger number of operational holdings in the semi-medium and medium classes almost comparable to those in Andhra Pradesh, Madhya Pradesh and Gujarat which have vast arid and semiarid unirrigated areas that are usually associated with larger operational holdings.

Table 12: Percentage distributions of operational holdings, ownership households and area owned over five broad classes of holdings in India, West Bengal and some selected states

All India	**Marginal** (less than 1 ha)	**Small** (1.01-2 ha)	**Semi-medium** (2.01- 4 ha)	**Medium** (4.01-10 ha)	**Large** (over 10 ha)
Operational holdings (%)	69.8	16.2	9.0	4.2	0.8
Ownership households (%)	79.6	10.80	6.00	3.0	0.60
Area owned (%)	23.05	20.38	21.98	23.08	0.0
West Bengal					
Operational holdings (%)	88.8	8.9	2.1	0.20	0.0
Ownership Households (%)	92.06	5.70	1.40	0.20	0.0
Area owned (%)	58.23	25.71	1.88	4.02	0.0
Punjab					
Operational holdings (%)	66.3	11.2	12.9	7.8	1.9
Ownership households (%)	76.30	9.50	7.90	5.10	1.00
Area owned (%)	9.16	15.63	25.30	34.50	15.31
Kerala					
Operational holdings (%)	91,8	6.2	1.5	0.5	0.0
Ownership households (%)	95.30	3.50	0.90	0.30	0.00
Area owned (%)	60.72	21.30	10.78	7.16	0.00
Gujarat					
Operational holdings (%)	60.0	17.3	11.1	9.8	1.8
Ownership households (%)	73.30	11.9	7.20	6.50	1.00
Area owned (%)	13.60	16.50	18.96	39.12	12.28
Andhra Pradesh					
Operational holdings (%)	60.7	20.7	12.00	5.5	1.1
Ownership households (%)	82.70	9.10	5.30	2.60	0.50
Area owned (%)	18.6	21.1	22.8	22.1	15.5

Source: Bureau of Applied Economics and Statistics, Govt. of West Bengal, 2007

What is equally significant is the percentage distribution of area owned over the five broad categories (marginal, small, semi-medium, medium and large) in the State. West Bengal marginal farmers who are 89% in terms of occupational holdings, own 58% of the cultivated land that is less than a hectare in holding size (that may be sub-divided into several parcels) but the rest nearly 42% area under small, semi-medium, medium sizes are obviously more than one hectare and in such holdings a wide range of cropping systems, mixed farming with crop-livestock integration using cattle, small animals like sheep , goat, pisciculture, apiary, etc., even fodder crops and fuel trees may be effectively integrated. This does not mean that integrated farming system (IFS) would require larger holding size as even with 1.5 bigha (=0.2 ha) of land hundreds of very remunerative IFS have been developed but what is important for all small and medium land holders is to design and develop most efficient water harvest method. The present phase of global climate change and associated weather extremes with the possibility of abrupt torrential rains over a short period causing floods and run-offs, then a failed monsoon and prolonged droughts would require almost year round water storage and most preferably surface water structures for agricultural as well as domestic needs of the farmers.

Ground water tapping through bore wells should be discouraged because of insufficient recharging of aquifers. Even medium level mechanization for tillage has resulted in hardpan formation that has the potential to restrict the movement of rain water down below for recharging of aquifers. Consequently, low percolation of water would promote run-offs and soil erosion. The need for surface water use for agriculture is discussed in more details under irrigation potential and water management.

Contextual Issues

Agriculture all over the world is at the crossroads and Indian agriculture is more so because of its huge population of over 1,120 million (with one fifth of the people living below the poverty line) and growing at the rate of around 2% per year in the backdrop of plateauing of agricultural growth, global climate change and increasing degradation of natural resources – land, air, water and biodiversity along with significant decline in the ecosystem services resulting in the deceleration of net productivity.

The year 2008 was designated by the United Nations as "The Year of Global Food Crisis" in the context of agricultural production falling below consumption level for seven out of the past eight years, and grain reserves touching the lowest level since the 1970s, in the past one year from middle of 2007 to mid 2008. The global food prices went up by 40% and nearly 75 million people (not even 10% of the 850 million hungry people!) in 78 countries have been covered by the World Food Programme with 36 countries declaring food crisis by December 2007 amid food riots and protests over rising food prices in many countries around the world: Mexico, Yemen, Morocco, Mauritania, Senegal, Uzbekistan, Egypt, Burkina Faso, etc. Even in developed countries such as Italy, UK, etc. there have been protests by livestock farmers who found it extremely difficult to make a living because of increased feed prices.

According to many analysts, this could be a long term trend reflecting a failure of the industrial "Green Revolution" agriculture clearing the way to promote genetically modified crops (GMCs) as the new "doubly green revolution" (Mae-Wan Ho, 2008), a term synonymous with the "Second Green Revolution" of India (courtesy

Indo-US Knowledge Initiative in Agriculture, 2005, see Annexure Items 16 and 17). The so called Knowledge Initiative is nothing but a carefully designed strategy by the US-based TNCs to take over the control of India's food and agriculture sector. Instead of serving the farmers and saving the farming systems as contemplated by the National Commission on Farmers (NCF), the Second Green Revolution presumably based on GMCs and chemical intensive industrial agriculture, has the potential to destroy the socio-economic base of the farming community and ruin our traditional farming systems. The GMCs incidentally have been given an all round negative treatment (along with another controversial issue namely, biofuels from food crops) by the world's largest ever agricultural assessment, the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) more about which are given below.

International Assessment of Agricultural Knowledge, Science and Technology for Development (IAAKSTD/IAASTD)

The ground-breaking report of the IAASTD dealing with the past, present and future of global agriculture was formally launched on April 15, 2008 simultaneously from London, Paris, Washington, Nairobi, New Delhi and several other world cities with the conclusion that the currently followed agricultural practices need radical changes, "Business as usual is not an option". The IAASTD was initiated by the World Bank and FAO in 2002 and subsequently sponsored by the UN with many of its constituent and sister organizations like UNEP, GEF, WHO, UNESCO, UNDP, etc., besides the FAO, taking active part in the assessment along with biotech companies, civil societies, etc. as well as representatives of many world governments.

The 2500-page IAASTD report prepared by over four hundred experts and nearly one thousand researchers and reviewers is an outstanding document of the global agricultural scenario in the backdrop of the current environmental crisis, exacerbated by climate change and global warming with dire consequences on global and regional agriculture in the ongoing and coming decades; climate change and industrial agriculture adversely affecting each other more and more intensely with the passage of time.

IAASTD has deliberated on virtually all issues directly or indirectly connected or related to agriculture globally as well as regionally with particular emphasis on the multifunctionality of agriculture involving production of not only various commodities but also undertaking a range of noncommodity services of which the ecosystem services are of paramount importance. Some of the important findings brought out by the assessment are very briefly mentioned hereunder.

World agricultural production has considerably increased during the last five decades, but the sharing of benefits has not at all been equitable and the increased production has been attained with very high social and environmental costs. Global pesticide poisoning deaths are estimated at 220,000 annually with 20-50 lakh people suffering from pesticide toxicity each year (besides 170,000 occupational deaths every year); chemical pesticide residues and anthropogenic green house gas (GHG) emissions from conventional farming practices have greatly damaged ecosystem services. The currently followed industrial farming practices have depleted the fertility of the soil and 35% of the earth's severely degraded lands have been damaged by the highly mechanized chemical intensive agricultural activities. Globally agriculture and land use now contribute to over 30% of the global warming potential (GWP) that, if continued as such, would seriously jeopardize farming and food security. The chemical intensive farming has exhausted and polluted water resources raising serious public health concerns and has greatly reduced biodiversity through promotion of monoculture leaving the poor people vulnerable to food shortage and resultant high food prices. The lack of diversity in foods and faulty processing are responsible for widespread malnutrition (that includes over nutrition and obesity).

The report considers major issues such as GMOs and specifically GM crops as controversial, and according to IAASTD, "Assessment of the technology lags behind its development, information is anecdotal and contradictory, and uncertainty about possible benefits and damage is unavoidable." As such, the consequences are uncertain and for the developing countries GM is surely not an answer to hunger and poverty. The report recommends a ban on growing GMCs in countries that are centres of origin of such crops in order to prevent inevitable genetic contamination and preserve biodiversity essential for the future of agriculture.

The report has highlighted the importance of conventional plant breeding employing marker assisted breeding and selection (MAB and MAS) for crop improvement and has expressed concern over the slowing down of conventional plant improvement work, relative to transgenic research, that may eventually adversely affect crop breeding programmes due to IPR and paucity of breeders in public research institutions in the developing countries.

The first generation biofuels from starchy cereals or oilseeds would not be an acceptable proposition and would increase food crisis; further, there are lingering doubts about their environment friendliness in the long run. The second generation biofuels from cellulosic biomass may possibly be more promising.

The report emphasizes the need for greater public investment in agricultural research globally, particularly in the developing countries. In North America and Europe, the funding of agricultural research by the corporate private sector has greatly increased in the last two decades but the direction of that research is IPR centred and business oriented which would act as barriers to progress of agriculture in the developing countries. As such, public domain research with adequate funding for sustainable agriculture is urgently necessary in developing countries.

International trade in agricultural commodities, traditionally dominated by USA and EU, has in the recent times adversely affected the developing countries through opening up of domestic markets via WTO imposed obligations, without any safety nets thereby allowing highly subsidized imports from the developed countries so much so that farming by small and marginal farmers in many developing countries has become non-remunerative. The plight of farmers engaged in cash crop farming, in particular, has been unbearable in the face of escalating price of all inputs such as high-yielding seeds, petrochemical based fertilizers and pesticides, etc.

The report has pointed out that low input ecologically sustainable farming based primarily on the judicious use of renewable natural resources only (avoiding to the maximum possible extent, the use of nonrenewable resources) are the best possible options for small holder farmers of the developing countries because that would not only cut the operating costs as local resources would provide the major inputs but would also minimize dependence on costly fossil fuel for transport. If there is a surplus the first choice should be to sell the perishables, in particular, in local markets specially reorganized for the purpose.

The primary and top beneficiary in agriculture should be the farmers not the processors, intermediaries and corporate agricommodity traders and retailers. IAASTD looks upon farmers as the future custodians and managers of environment and ecosystems services besides their involvement in developing sustainable agricultural practices through judicious amalgamation of traditional and valuable observation-based knowledge with scientifically updated ecologically sustainable farming practices to foster a desirable dynamic equilibrium between agriculture and environment.

IAASTD options are characterized by the ‘bottom-up’ approach rather than the conventional ‘top-down’ approach in most forms of industrial agriculture related policies. It also seeks legal empowerment of women farmers in developing countries whose escalating numbers in the recent times relative to men require special safeguards.

[The Executive Summary of the Synthesis Report of the IAASTD is given in the Annexure Item 9]

The sagacity in the deliberations of the IAASTD has been really admirable. Within less than a year of release of the report, the observations on the safety issues of the GM food crops have been vindicated by independent studies. A long-term feeding study commissioned by the Austrian Federal Ministry of Health has recently confirmed that GM corn seriously affects reproductive health in mice. Within a week, the Italian Government’s National Institute of Research on Food and Nutrition has published a report in the *Journal of Agricultural and Food Chemistry* (online, November 14, 2008) documenting significant disturbances in the immune system of young and old mice fed with the GM maize MON 810. Transgenes from GM maize have been convincingly demonstrated in traditional "landrace" maize in Mexico, a centre of origin of the crop. In India, Bt gene of genetically modified rice under field trial has contaminated local rice germplasm in Jharkhand. Regarding another controversial issue, biofuels from food crops, a recent report in the Financial Times, UK (Oct. 22, 2008) shows that the share market in the USA which was so upbeat with corn bioethanol in the beginning, has been a mute spectator to the rapid downfall of corn ethanol share prices in the US much ahead of the general economic depression.

The West Bengal State Agriculture Commission is particularly happy that its interim report submitted to the Government of West Bengal in January, 2008 (the report incidentally was finalized in the Commission meeting held in the first week of October, 2007) thematically reflects almost fully the findings and options proposed in the IAASTD report. This is especially heartening to the Commission in view of the fact that our small state-level body was totally unaware of IAASTD and its ground-breaking report produced through voluntary efforts of thousands of leading international experts headed by the former Chairman of the IPCC, Professor Robert Watson, Nobel Laureate, Chief Scientist of the World Bank and independently Chief Scientist of the Department for Environment, Food and Rural Affairs, U.K.

Global warming effects: The fourth assessment of Intergovernmental Panel on Climate Change (IPCC IV, 2007, website: http://ipcc.ch/) clearly shows that climate change is hitting us much faster and harder than expected; glaciers are melting much quicker, weather extremes are increasingly frequent with potential big impacts on food production for which the prevailing system itself is self-defeating. The biggest rivers in China and India, depend in the dry season on melt water of the Himalayan glaciers. The Gangotri Glacier which alone supplies 70% of the water in the Ganga in the dry season will dry up by 2035 according to IPCC; that would indeed be a disaster for Indian agriculture.

Over 15,000 glaciers in the Himalayas are melting at a faster rate than usual and excessive accumulation of melt water has made many of them vulnerable to outburst, a phenomenon known as glacial lake outburst flood (GLOF) causing enormous destruction of everything obstructing the onrush of water (see Annexure Item 15).

Climatic aberrations and weather extremes, which are important manifestations of global climate changes, are already proving highly detrimental to agriculture, Australia for example has suffered a 60 per cent drop in wheat harvest last year due to drought. India has been fortunate in that in 2008 there has not been any major climatic disaster.

Natural resource management: Another resource management related issue deserves especial mentioning in this connection. Over the last four decades of the so-called green revolution, natural resource management has been deplorable with the consequence that in large intensively cultivated tracts micronutrient deficiency has surfaced as recycling of nutrients (as has been the case with the use of composts and animal manures) are not routinely practiced. Unfortunately, not only micronutrients, global shortage of a key macroelement, phosphorus, is just round the corner. Economically recoverable fertilizer-grade phosphatic ores in the world may last upto 2030 (T. L. Roberts and W. M. Stewart, in their paper on P and K reserves in *Better Crops*, **86**(2) p.7, 2002, gave about 25 years as the cost effective limit for US phosphorus reserves). We are almost totally dependent on imports for phosphorus, that went up last year to 97% of the requirement (incidentally we are also importing 40% of N and 100% of K). A fertilizer subsidy of Rs. 1.20 lakh crore was given by the Union Government in 2008 to enable the farmers to pay about only 15% of the actual cost of chemical fertilizers to keep the food prices down. How long that may go on is anybody's guess. It would be an utter disaster if total recycling of nutrients and stoppage of leachings and run-offs are not fully ensured. The pity is that we prefer to wake up only at the last moment on most burning issues – almost acquiring a new national character of sheer insensitiveness to our surroundings.

Organic agriculture as the most suitable option

Indian agriculture has been totally organic till about two decades after independence. Since 1966 onwards with the introduction of the green revolution technology, high yielding varieties of crops, inorganic fertilizers and synthetic chemical pesticides started to dominate the farming of mainly irrigated lands of the country and predictably there was a boost in agricultural production both due to higher productivity per unit land and large area expansion that enabled food production to keep pace with population growth. Unfortunately but quite expectedly, the agricultural growth over the years slowed down considerably because of significant decline of natural soil fertility primarily attributable to lack of soil organic matter and beneficial soil biota essential for long term sustenance of soil fertility and crop productivity. Further, contamination of water bodies with fertilizer and toxic pesticide residues resulted in serious environmental pollution and health hazards and also caused significant disruption of the normal functioning of the delicately balanced ecosystems.

Ecologically sustainable organic farming system is currently looked upon as the most suitable alternative to the conventional chemical intensive farming practices. But, West Bengal, some how is lagging far behind.

Current scenario of organic agriculture in the world and in India: According to the recent global survey of organic farming, organic agriculture is practiced in 120 countries covering a total of 31 million hectares and the trade in organic food crossed

35 billion US dollars ($40 billion by December 2007) and growing about $5 billion per year. Even in the USA, the home land of GM crops, during the last two years there has been an unprecedented 30% annual growth of organic farming. According to a Financial Express news on December 8, 2008 the US has emerged as the largest consumer of organic products in 2007 at $21.2 billion including $20 billion alone on organic food and drinks. According to Organic Trade Association (OTA), sales of organic products in the US are likely to increase to $ 25 billion in 2008. Germany emerged as the second largest market for organic products at 5.3 billion euro in 2007. The UK market in 2006 was 3 billion euro and the average British spent 49 euro per head per year on organic food. The French organic market in 2007 has been 2 billion euro, 77% of the French prefer organic food and would spend 43 euro per head for the purpose.

The total certified area under organic farming in India cultivated upto March 2008 has gone up to 865,323 hectares with an annual 100% growth rate during the preceding two years. Madhya Pradesh is the leading state with 214,088 ha under certified organic production followed by Maharashtra with 125,098 hectares (NCOF/DAC,2008). Among the states Uttarakhand, Sikkim, Mizoram and Nagaland have declared their intention to go for organic farming. Incidentally, India produced a total of nearly 5 lakh metric tonnes of organic produce including 142,714 metric tonnes of organic cotton during 2006-07 and is on the verge of replacing Turkey as the largest producer of organic cotton in the world. The annual consumption (accessible potential) of organic products in eight metropolitan cities of India is presently Rs 562 crore; the total market potential is, however, Rs 1,452 crore (M. K. Menon, *Organic Farming News Letter,* **3**(2), June 2007).

West Bengal has a certified organic area of 9,880 ha mostly for organic tea production. Recently, under the auspices of the State Horticulture Mission another 4,000 ha are being covered in 10 districts of West Bengal.

Superiority of organic food in terms of nutritional quality

In January 2005, the Organic Center of the Organic Trade Association of the USA produced a report entitled, "Elevating Antioxidant Levels in Food through Organic Farming and Food Processing", concluding that organic farming methods had the potential to elevate average antioxidant levels by about 30%, especially in fresh produce. It further highlighted the considerable potential to increase the retention of antioxidants in organic processed foods through non-chemical, low temperature, low pressure processing methods. In another report released in September 2005 organic agricultural practices were found to have reduced the risk of serious fungal infections and hence mycotoxin risks especially in grain based food or feed by promoting the diversity in microorganisms colonizing plant tissues and cutting down the supply of readily available nitrogen that would support pathogen growth.

Researchers of the University of California, Davis and University of Minnesota USA, reported in 2007 a 79% higher quercetin (a flavonoid aglycone) content in tomatoes grown organically (115.5 mg per gram of dry matter against 64.6 mg per gm in conventionally grown tomatoes), another flavonoid aglycone kaempferol was nearly double in amount (97% higher) under organic management compared to the conventional produce (63.3 mg per gram). The study by Alyson Mitchell *et al.* (in *Journal of Agricultural and Food Chemistry,* **55**, p. 6154, 2007) is considered most convincing because the mean values are based on analysis of dried samples that had been archived for ten years over 1994-2004 from the Long-Term Research on Agricultural Systems (LTRAS) project at the University of California, Davis which began in 1993 (see Figure 3). Interestingly, the levels of flavonoids increased over time in organic samples whereas in the conventional treatments flavonoid contents did not vary significantly over the time period.

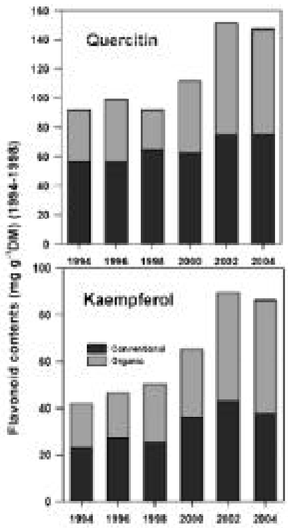


Figure 3. Changes in the levels of two flavonoids, querecitin and kaempferol, averaged over 10 years of the LTRAS trial, (1994-2004); full lengths of the bars represent flavonoid contents under organic management with the darkened portions indicating the flavonoid contents in the conventional system.
Source: Alyson Mitchell *et al. Journal of Agricultural and Food Chemistry,* **55**, p 6154, 2007

Epidemiological studies suggest the protective role of flavonoids against cardiovascular diseases including strokes and also to a lesser extent, against cancer and other age-related diseases such as dementia. The antioxidative role of flavonoids that encompass a large group of phenolic secondary metabolites has been demonstrated in *in vitro* studies in the laboratory. The free radicals which are believed to be the primary reasons of a host of age-related diseases and other ailments have been found to be scavenged by flavonoids. Therefore, the emphasis given on flavonoids showing much higher concentrations in organically grown tomatoes are based on sound scientific principles and therefore fully justified.

The fact that comparisons of the quality of conventional and organic produces have been made using samples of long-term research plots that have been managed consistently over enabled the researchers to overcome many of the confounding factors associated with farm-based sampling. Such confounding effects perhaps vitiated effective comparison of nutritional quality of conventionally and organically produced vegetables demonstrating in earlier studies inconsistent differences with the exception of higher levels of vitamin C and less nitrates in organic products. Furthermore, conclusions based on a continuously generated data over a period of ten years are bound to be much more reliable.

Countering pesticide residue induced health problems by organic food

As in organic farming synthetic chemical inputs are strictly prohibited, the pesticide residues would be naturally absent. Not only that, environmental health scientists of the University of Washington, Emory University and the Centers for Disease Control and Prevention in the USA in an elegant study with 23 children (selected on the basis of certain specific criteria) aged between 3-11 years showed immediate beneficial effect of organic food consumption. The children originally habituated to conventional food when switched over to eating organic foods demonstrated dramatic and immediate reversal of the occurrence of metabolites of malathion (malathion dicarboxylic acid, MDA, as the major metabolite) and chloropyriphos, two organophosphorus (OP) insecticides in their urine samples to almost nondetectable levels; however, on reintroduction of conventional food, the pesticide residues reappeared in the urine samples (Lu *et al.*, *Environmental Health Perspective,* **114**(2) p 260, 2006). It appears that even intermittent consumption of organic food would have a cleansing effect on the body with significant beneficial effects on neurological development of the children.

Organic agricultural practices reduce the prevalence of serious fungal infections and hence mycotxin risks in the food and livestock feed supply by promoting diversity in the microorganisms living in the soil and colonizing plant tissues, and also by reducing the supply of nitrogen that in conventional farming becomes readily available to support growth of pathogenic microorganisms. Convincing evidences are now available on the superior nutritive value of organic food in terms of occurrence of beneficial mineral elements, absence of heavy metals, more vitamin C, better protein quality (amount of essential amino acids higher), and despite some reservations in certain quarters, better taste and flavour.

Comparisons of organic and conventional farming systems

The findings of a number of studies on comparisons of sustainable organic agriculture and conventional chemical intensive agriculture with the view to validate the need to adopt organic agricultural practices for alleviating the plethora of adverse ecological and environmental effects of conventional agriculture (Christos Vasilikiotis, 2005; Website: http://www.cnr.berkeley.edu/~christos/articles/cv_organic_farming.html) are outlined below.

(a) **Sustainable farming systems at the University of California, Davis**: During the first eight years of the project, the organic and low input systems have given yields comparable to the conventional system for all crops which were tested (tomato, safflower, corn and bean); in some instances yields were more than the conventional system. Studies on soil characteristics showed that both organic and low input systems resulted in increases in organic carbon content of soil and larger pools of stored nutrients each of which are critical for long term fertility maintenance. The organic system relied mainly on cover crops and composted poultry manures for fertilization. One possible explanation for a lower availability of N in the organic system is that high carbon inputs associated with organic farming need nitrogen to build soil organic matter, thus reducing nitrogen availability for the organic crops. However, during the latter two years of experiment, soil organic matter levels were stabilized resulting in more nitrogen availability. This was in agreement with the higher yields of organic crops observed in the last two years.

(b) **Farming systems trials at the Rodale Institute:** The organic systems employed were a traditional integrated system with manures of cattle fed with leguminous cover crops as the main source of nitrogen, and the other in which leguminous cover crops were incorporated into the soil as the source of nitrogen before planting corn or soybean. In all the three cropping systems, corn yields were comparable (less than 1% difference). A comparison of the soil characteristics during a 15-year period showed that soil fertility was enhanced in the organic systems while it decreased in the conventional system. N content and organic matter levels in the soil increased remarkably in the manure-fertilized organic systems but declined in the conventional system. In the conventional system, there was adverse environmental impact and 60% more nitrate leached into the ground water over a 5-year period in the conventional system than in the organic system. In soybean, productivity in drought year in particular was 2.5 times higher in the organic systems compared to the conventional. It was concluded that over time organic practices would encourage the soil to hold moisture more efficiently than in conventionally managed soil; in the former the soil was less compact thereby allowing greater penetration of roots into the soil in search of moisture.

(c) **Broadbalk experiment at Rothamsted, UK**: The longest running experiments (over 150 years) on the comparison of manure based (not certified organic) and chemical fertilizer based farming practices have given an average of 3.45 tonnes per hectare of wheat in the former against 3.4 tonnes in the latter. Soil fertility as measured by soil organic matter (SOM) content and nitrogen levels increased by 120 per cent in organic plots against only 20% in the chemically fertilized plots.

(d) **Midwestern USA**: The data obtained from six universities of Midwestern United States also confirmed that organic production was equivalent to and in many cases better than conventional farming. In South Dakota the average yield of soybeans were 29.6 bushels/acre in organic and 28.6 bushels/acre in the conventional; for spring wheat the yields were 41.5 and 39.5 bushels/acre for organic and conventional systems respectively.

(e) **California commercial farms**: The yields of tomato in 20 commercial farms in the central valley of California were shown to be quite similar in organic and conventional farms; damage due to insect pests was also similar. Nitrogen mineralization potential and microbial abundance and diversity were, however, higher in the organic farms which also showed 28% more organic matter. The better soil health coincided with noticeable reduction in the prevalence of disease in the organic farms.

We cannot ignore the aforesaid evidences and when we add the overwhelming global evidences on productivity as well as health and nutrition related effects (direct effects as well indirect effects via synthetic chemical pesticide elimination) and the positive role of organic agriculture on mitigation of climate change and reduction in fossil fuel energy used in farming and enhancement of ecosystem services one would readily agree that organic agriculture is not only the most logical option to achieve all round sustainability in agriculture but also the most pragmatic solution for the social, economical and cultural uplift of the farming community.

Recent study in the University of Michigan: Researchers of the University of Michigan have compared yields of organic versus conventional or low intensive food production for a global dataset of 293 examples and estimated the average yield ratio (organic: non-organic) of different food categories for the developed and developing world. For most food categories, the average yield ratio was slightly less than 1.0 for studies in the developed world and more than 1.0 for studies in the developing world.

Using the average yield ratios, the authors modeled the global food supply that could be grown organically on the current agricultural land base. Model estimates indicate that organic methods could produce enough food on a global per capita basis to sustain the current human population and potentially an even larger population, without increasing the land base. The authors evaluated the amount of nitrogen potentially available from fixation by leguminous cover crops used as fertilizer. Data from temperate and tropical agroecosystems suggest that leguminous cover crops could fix enough nitrogen to replace the amount of synthetic fertilizer currently in use. These results indicated that organic agriculture has the potential to contribute quite substantially to the global food supply, while reducing the detrimental environmental impacts of conventional agriculture.

Table 13: Yield ratios of organic versus conventional agriculture

Food Category	**World**			**Developed countries**			**Developing countries**		
	N	Av.	S.E.	N	Av.	S.E.	N	Av.	S.E.
Grain products	171	1.312	0.06	69	0.928	0.02	102	1.573	0.09
Starchy roots	25	1.686	0.27	14	0.891	0.04	11	2.697	0.46
Sugars and sweeteners	2	1.005	0.02	2	1.005	0.02	-	-	-
Legumes (pulses)	9	1.522	0.55	7	0.816	0.07	2	3.995	1.68
Oil crops and Veg oils	15	1.078	0.07	13	0.991	0.05	2	1.645	0.00
Vegetables	37	1.064	0.10	31	0.876	0.03	6	2.038	0.44
Fruits excl. wine	7	2.080	0.43	2	0.955	0.04	5	2.530	0.46
All plant foods	266	1.325	0.05	138	0.914	0.02	128	1.736	0.09
Meat and offal	8	0.988	0.03	8	0.988	0.03	-	-	-
Milk, excl. butter	18	1.434	0.24	13	0.949	0.04	5	2.694	0.57
Eggs	1	1.060	-	1	1.060	-	-	-	-
All animal foods	27	1.288	0.16	22	0.968	0.02	5	2.694	0.57
All plant and animal foods	293	1.321	0.05	160	0.922	0.01	133	1.802	0.09

Abbreviations: N = number of studies, Av= average yield ratio (organic : conventional), S.E.= standard error

***Note*:** Out of 293 cases, 160 compared organic with conventional methods and in 133 cases organic was compared with low-intensive methods; most studies are from peer-reviewed literature.

Source: C. Badgley *et al. Renewable Agriculture and Food Systems,* **22**: p 86, 2007.

On September 25, 2008 the President of the General Assembly of the United Nations produced a report stating that: "The essential purpose of food, which is to nourish people, has been subordinated to the economic aims of a handful of multinational corporations that monopolize all aspects of food production, from seeds to major distribution chains, and they have been the prime beneficiaries of the world crisis. Research conducted by the UN Environment Programme suggests that organic, small-scale farming can deliver the increased yields which were thought to be the preserve of industrial farming, without the environmental and social damage which that form of agriculture brings with it. An analysis of 114 projects in 24 African countries found that yields had more than doubled where organic, or near-organic practices had been used. That increase in yield jumped to 128 per cent in east Africa." (ISIS Press Release dated 5.11.2008).

Mitigation of climate change and reduction of fossil fuel energy by organic farming

The IAASTD gives an estimate of about 31% of total greenhouse gas (GHG) emission annually that would be attributable to all agricultural practices including crop and livestock husbandries, land use, and deforestation related land use activities, etc. Such a high global warming potential (GWP) would be eventually suicidal for agriculture itself. The GHGs originate from burning of fossil fuels for agricultural activities, production of fertilizers, transport, processing and packaging, storage, distribution and food preparation (*i.e.* most activities from ploughing to food finally reaching the consumer's plate). Additionally, methane (CH_4, GWP 23) production in livestock rearing and rice cultivation, rotting vegetation, etc., nitrous oxide (N_2O, GWP 289) from nitrogenous fertilizers, etc. significantly contribute to GHG emissions that may total up along with CO_2 and other gases to as high as 34% of the global GHG emissions.

According to David Pimental of Cornell University, USA, 19% of total fossil fuel energy in the USA is used in agriculture and US farms on an average invest 2 (two) units of fossil fuel energy to harvest one unit of energy in the crop (values ranging from 0.26 in tomato to nearly 6.0 in maize), in case of maize, which is a very energy efficient crop, the values may range from 3-6. However, energy input: output ratio in organic maize production system was 1: 5.79 against 1: 3.99 in conventional corn production system, showing 45% more efficiency in the organic system alongwith a 31% reduction in fossil fuel energy input. In case of organic soybean, the energy input : output ratio has been 1 : 3.84 against 1 : 3.19 in the conventional system showing a 20% higher efficiency in the organic system. The drought year productivity of organic soybeans was 68% higher than in conventional system (for corn the same was 30% higher), thereby showing the great resilience of the organic production systems (D. Pimental, 2006, website: http://www.organic-center.org/reportfiles /ENERGY-SSR.pdf).

In case of beef production, the fossil fuel energy input was 40 k cal per k cal beef protein produced in the conventional feed-lot system compared to only 20 k cal per k cal beef protein in organic grass-fed beef production (*i.e.* 100% greater efficiency).

According to a revised calculation of Mae-Wan Ho (2008, website: http://www.i-sis.org.uk/index.php), organic sustainable agriculture and localized food systems would mitigate 32.1% of global greenhouse emission and 17.3% of energy use with the largest contributions attributable to carbon sequestration by organically managed soils and reduced transport through localization of food systems.

Crop-livestock integrated farming systems (IFS)

Traditionally most Indian farming systems have been based on some form of integration of crop husbandry and livestock keeping. But for the milch cow, the huge population of vegetarians in the country would possibly have suffered from perpetual nutritional deficiency. Introduction of small animals such as, sheep, goat, poultry, etc. and aquaculture as components of agricultural systems has also been profitable to the small holders.

E. R. Orskov, an agroecologist of Macaulay Institute, Aberdeen, UK and a proponent of crop-livestock integrated farming systems, substantiated his arguments in support of integrated farming systems with data from many studies in South and Southeast Asia (European Parliament Briefings, October 20, 2004). The notable example of rice-cum-duck-cum-fish culture in Vietnam (T. N. Minh *et al.* 2003, see Table 14 for details) would amply demonstrate the large benefits of polycultural agriculture; ducks and fish very efficiently removed weeds and gave much higher net economic returns over what could be achieved by rice monoculture alone (Table 14).

The ducks not only ate the weeds and insects but also produced enough organic manure that served as nutrients to the rice paddy and helped phyto- and zooplankton growth serving as necessary food for the rapidly growing fish. As a result of the multiple synergistic effects, the total income of the farm (in Vietnam Dong per hectare) went up from 8.56 million for rice monoculture to 126.38 million in the layer duck-fish-rice integrated system.

A few more examples of ecologically sustainable farming with highly remunerative income generation from livestock integrated farming for our resource poor small and marginal farmers as effective alternatives, which are superior in all respects to the antinature technology of the conventional agricultural system perpetuated by agribusiness lobby, are given hereunder.

Livestock incorporated sustainable farming with land shaping (LS)

The Ramakrishna Mission Loka-Siksha Parishad (RKMLSP), Narendrapur in the outskirts of Kolkata has so far completed around 1,600 LS projects in small and marginal farmers' fields in the Sundarbans area in which the low-lying flood-prone land (plots of 1 to 4 bighas) has been raised by excavating a pond, covering 20-25% area of the plot, at an appropriate position for rain water harvesting and using the excavated soil for making bunds and uplands and lifting the said pond water for irrigating the rabi crops (Figure 3). The pond is used besides irrigation for fish and duck rearing. A small part of the raised land would also accommodate a cattle shed for 3-4 cows and a small poultry-cum-duck house near the farmer's house for about 15-20 poultry birds and 10-15 ducks. The cattle dung and bird excreta are used for compost making along with crop residues and farm wastes; also most farmers produce vermicomposts for raising vegetables and other high value crops. The integration of crop farming with livestock usually cattle, duckery and poultry has resulted in a high level of synergy giving the farmers a 3-4 fold increase in income.

Table 14: Integrated system of rice, rice plus duck, rice plus fish and rice plus fish plus duck on the net benefit of the farmer (million Vietnam Dong/ha)

Million Vietnam Dong/hectare

Input/output costs in different systems	Rice	Rice - Duck	Rice - Fish	Rice - Duck-Fish	Rice - Layer duck- Fish
Total input cost	6.62	12.62	22.94	26.52	70.74
Outputs					
From rice	8.56	8.03	9.23	9.58	10.44
From duck	-	14.50	-	14.50	68.02
From fish	-	-	22.22	46.39	47.92
Total output	8.56	22.53	31.45	70.74	126.38
Net benefit	+1.94	+9.91	+8.51	+44.22	+55.64
Extent of benefit	Rice x 1	Rice x 5.1	Rice x 4.4	Rice x 22.8	Rice x 28.7

[1 million Vietnam Dong = approximately 60 US dollars]

Last row shows how many times the income in different integrated systems increased over rice cultivation alone.

Source: Minh, Ly and Orskov, SARC International Meeting, Hue, Vietnam, March, 2003

Land shaping as a boost to adoption of SRI

Land shaping in areas with negligible soil salinity, with the newly raised land at different elevations and easier water control facilities, offers an excellent opportunity, particularly in the rabi season, for a switch over to fully organic SRI (System of Rice Intensification, developed by farmers in Madagascar under the supervision of Father Henri de Laulanie, a Jesuit priest, in the late 1980s and now being practised in many countries) method of rice cultivation that, if properly done, would give the farmers at least one tonne of additional rice per hectare with the added benefit of a 40 percent saving on water use and a big saving on seed for sowing to the tune of 75 - 85 percent. SRI is being practised by farmers in Tripura on a moderately large scale; Tamil Nadu and Andhra Pradesh farmers are also enthusiastically taking up SRI. A reputed NGO working in the arid western part of West Bengal has been working with farmers in Purulia and adjacent areas popularizing SRI method of rice cultivation over the past several years with highly promising results.

The qualitative and quantitative changes in the farming system are summarized in a tabular form to evaluate the benefits of land shaping (Table 15).

Figure 4:

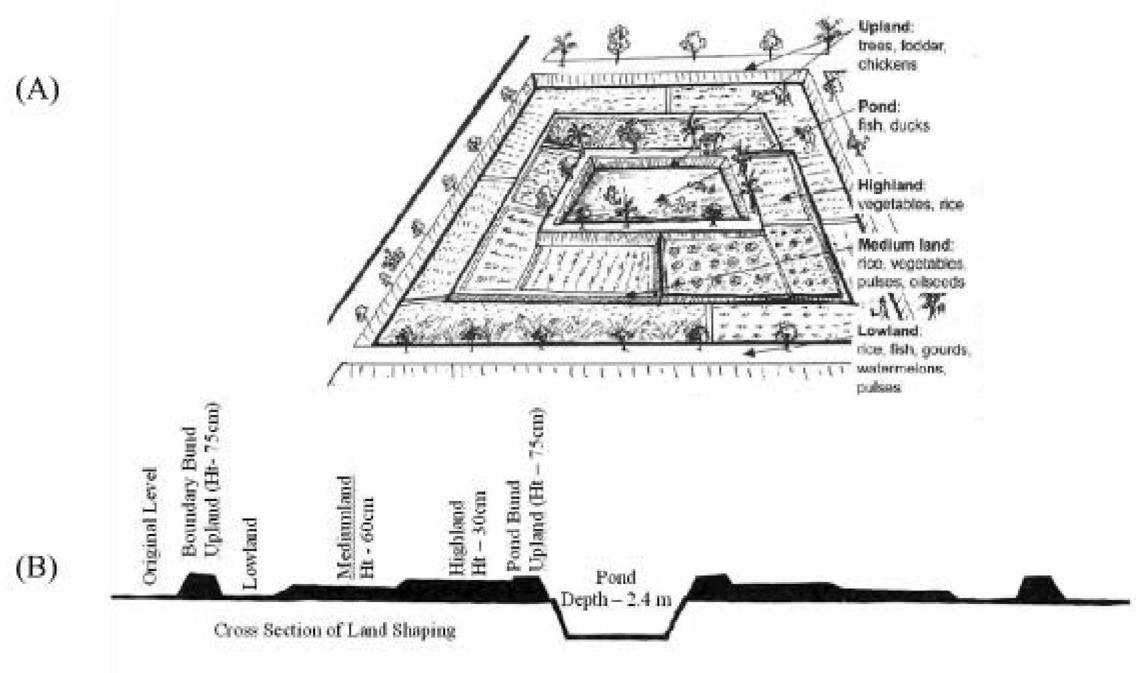


Figure 4: (A) Diagram of a farmer's plot after land shaping showing a diverse range of crops growing in the plot which was previously a predominantly monocultual land growing traditional low-land rice.
(B) Cross sectional diagram of a plot showing the levels of land across the plot after land shaping. Diagrams (A) and (B), with the centrally located pond (2.4 m depth), are from RKMLSP, Narendrapur (M. Ghosh, in Deutsche Gesellschaft für Technische Zusammenarbeit, Eschborn. p. 94, 2006).

A set of data provided by a senior researcher of RKMLSP from a number of randomly selected farmers (n=16), with an average land area of 2.66 ± 0.65 bigha (0.35 ± 0.09 ha) that shows a 3.2 times increase in net income (from Rs. 9,730 to Rs. 30,922 per year) due to land shaping. The average contribution from the crop sector has gone up from Rs 7,056 to Rs. 24,969 (including betel vine cultivation after land shaping) showing a 254% rise, and for livestock and fishery from Rs 356 before land shaping to Rs 5,514 after land shaping recording a 1,449% rise in the farmer's income from that sector. Not unexpectedly, the income from labour wages that was Rs. 2,318 originally went down to Rs 438, a decrease of 429% implying a considerable improvement of the socioeconomic status of the farmers.

Table 15: Change to a typical small farm after land shaping in the Sundarbans (farm size, 1.5 bigha = 0.2 ha)

	Before land shaping	After land shaping
Crops grown	Long duration traditional rice, some vegetables. Low yields (eg., 1000 kg/ha of rice)	High-yielding rice, traditional rice, rainy season vegetables, summer vegetables, fruit trees, timber trees, pulses, oilseeds. Higher yields (eg., 2,500 kg/ha of rice)
Cows	2	3-4
Chickens	3-4 local chickens, free range	15-20 Rhode Island Red,etc. birds (small poultry house)
Ducks	None	10-15 ducks
Fish	Fish from river	Fish from pond throughout the year
Irrigation water	From roadside ditch	From pond throughout the year
Compost	Very little	Vermicompost pit
Farm income Rs/year (from 1.5 bigha = 0.2 ha)	Rs.9,000	Rs. 39,000 (4.3 times increase)
Estimated income from one ha per year	Rs. 45,000	Rs.195,000

Source: Ramakrishna Mission Loka Shiksha Parishad, Narendrapur (M. Ghosh, 2006, op. cit)

The West Bengal State Agriculture Commission is strongly recommending the setting up of a small biogas (gobar gas) plant at a convenient place on the raised land not only to supply kitchen fuel for the farm family but also to ensure recycling of nutrients in the animal excreta and crop residues back to the field; in the process the green house gas methane is ultimately converted to the much less potent carbon dioxide (GWP 1). A diagram showing the possible recycling pattern in a typical integrated farming system (IFS) is presented diagram in Figure 5.

Similar findings on the great advantages and benefits of land shaping have been reported from Sri Ramakrishna Ashrama in Nimpith. The data as presented by Swami Sadananda (2005) would show an unbelievable but validated increase in the net income of the very poor marginal farmers to the tune of 10-19 times over their incomes prior to land shaping (Table 16). The National Bank for Agriculture and Rural Development (NABARD) has come forward with credit facilities for the farmers and propagating the idea through publication of booklets in the vernacular language to popularize the innovation.

An article from the Central Agricultural Research Institute, Port Blair published in late 2007 in *Indian Farming* reports an income of over Rs.3 lakh per hectare per year through livestock integrated cropping system in the Andaman and Nicobar Islands (Table17), in which virtually nothing has been brought from outside and use-recyclereuse and so on in an efficient manner enabled an optimum harvesting of the sun's almost unlimited energy resource.

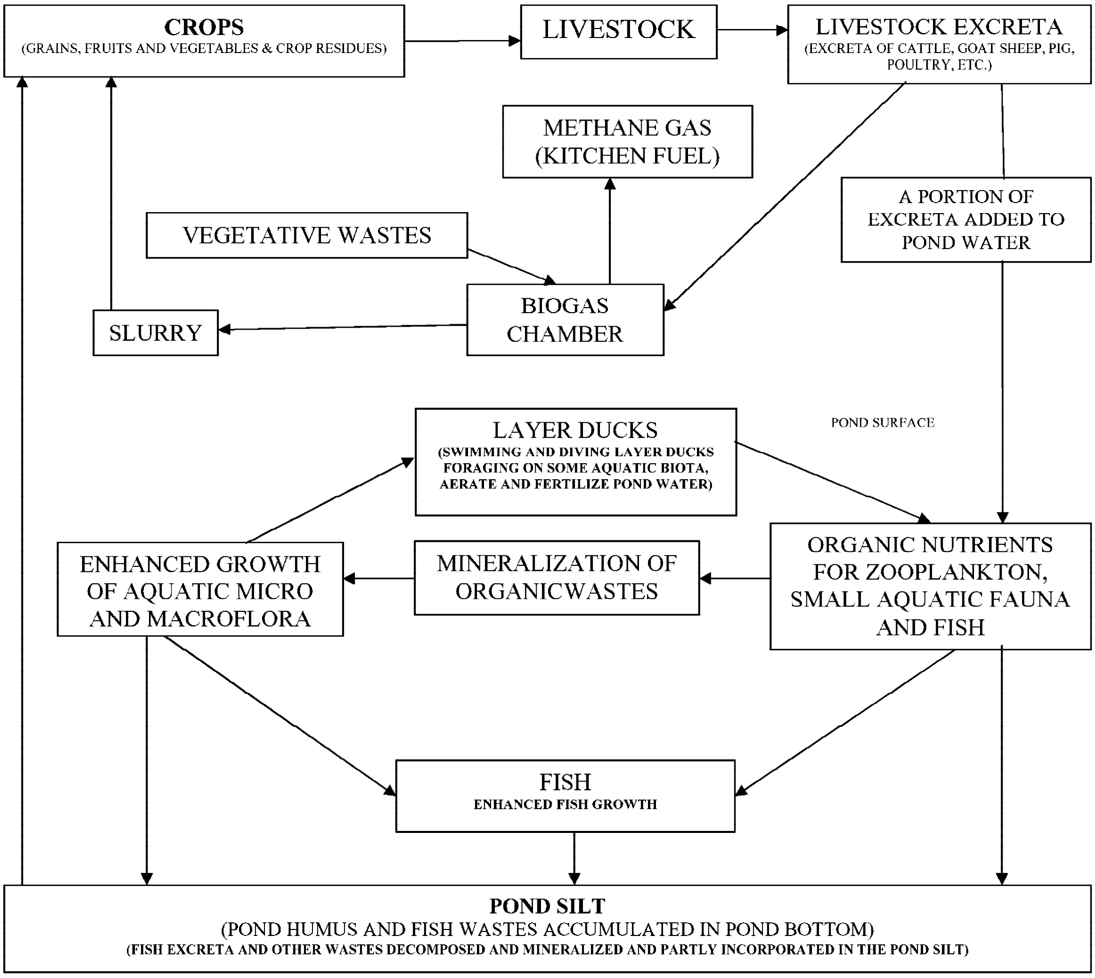


Figure 5: Schematic diagram of a typical crop-livestock-fish integrated farming system showing the interconnectedness of the components with mutual benefits giving greater income and employment generation to the small and marginal farmers besides ecological sustainability and minimal dependence of external inputs.

Employment generation: Properly planned integrated farming systems should provide full employment to the farm family all the year round. In the Sundarban region, the land shaping programme has proved to be a very good source of employment generation for marginal farmers and landless labourers. In the relatively dry months (January to June), there is usually a scarcity of farm jobs but with land shaping the situation has changed. From 75 units of LS projects of average 0.26 ha plot size, and another 75 units of average 0.2 ha plot size, a total of 50,382 man-days of farm work could be generated (Swami Sadananda, 2005, op cit.), that was much higher than pre-LS period. Obviously, the scope of such employment generation is very much there in all crop-livestock integrated systems anywhere in the State. The migration of unemployed rural farm workers would go down considerably because of employment generation within the village.

Table 16: Annual income from 0.2 ha raised land, 0.05 ha pond and 0.01 ha pond embankment and the resulting increase of income after land shaping programme in comparison with the annual net income from 0.26 ha low-land before the land shaping programme (figures in Rs.)

Name of the village / island	Av. net income from 0.2 ha raised land in kharif season	Av. net income from 0.2 ha raised land in rabi season	Av. net income from 0.05 ha pond area	Av. net income from 0.01 ha pond embankment	Total annual income on the average after land shaping programme	Annual net income before land shaping programme	Resultant increase in income after land shaping programme
Banghari	2,987	3,012	1,800	250	8,040	690	12 times
Kaikhali 8	3,502	4,205	1,790	210	9,707	720	13 times
Kaikhali 4	3,609	4,303	1,500	260	9,672	860	11 times
Gopalgange	3,808	4,506	1,410	400	10,124	780	13 times
Garankhati	3,220	3,910	1,705	310	9,145	903	10 times
Nolgora	4,506	10,600	1,508	410	17,024	980	17 times
Chuprijhara	4,500	12,300	1,605	315	18,720	920	20 times
Kantamari	3,907	10,320	1,809	210	10,246	870	19 times
Ghotiharani	3,620	11,605	1,410	250	16,885	900	19 times
Subhasnagar	3,675	8,405	1,206	405	13,691	870	16 times

LSP implemented during 1991-1992

Source: Swami Sadananda (2005),Sri Ramkrishna Ashrama, Nimpith (SRAN) In: *Best Practices in Water Management* Case Studies from Rural India. German Agro Action (India), p.65, 2005.

Table 17: Integrated farming system in Andaman and Nicobar Islands Sectorwise income generation in crop-cattle-poultry-fish integrated farming system

Sectors	Land (area in hectare)/ number of animals	Gross income (Rs)	Net income (Rs)	Relative contribution (%)
Crop	0.9 ha, 8 cropping systems	326,944	259,985	84.2
Cattle	3 cows, 2 bullocks	62,307	29,343	9.5
Poultry	23 layers, several guinea fowls	20,150	17,464	5.7
Fish	0.036 ha mixed fish	3,760	1,840	0.6
Total income from the Integrated System			Rs. 309,632	100

Source: N. Ravisankar, and S.C. Pramanik, (2007). *Indian Farming*, Nov. 2007 p 11.

Non-pesticidal management of pests (NPM): Lastly an important farmer's innovation is the development of non-pesticidal management (NPM) in Andhra Pradesh, recently very successfully scaled up by the Society for Elimination of Rural Poverty (SERP) with the collaboration of the Centre for Sustainable Agriculture (CSA), Hyderabad and other NGOs that needs especial mentioning in view of the serious global pesticide menace perpetuated by indiscriminate use of synthetic chemical pesticides. Over 10 lakh acres in Andhra Pradesh have been covered by NPM that works through non-chemical interventions such as setting up bird perches, use of light and pheromone traps, trap crops, fermented cow urine and dung (spraying done after adequate dilutions), diluted neem seed kernel extracts, etc. giving highly satisfactory control of insect pests at much lower costs. The success has been so spectacular that the central government has sanctioned Rs.180 crore for the financial year 2008-09. It is expected that by the end of the 11th plan period, the whole of Andhra Pradesh would be covered by NPM (G. V. Ramanjaneyulu *et al.,* 2008, in: *Organic Farming in Rainfed Agriculture*: Opportunities and Constraints,CRIDA, Hyderabad, p.157, 2008; also see Annexure Item 10b).

Only such innovations are required to improve the socioeconomic conditions of our 750 million people dependent on farming in the country and definitely not the chemical intensive ecologically unsustainable conventional farming practices just to satisfy the greed of the corporate sector. No branded seed of any kind, hybrids or genetically modified seeds are necessary for the purpose. Well preserved seeds of locally adapted varieties of crops and breeds of animals would elegantly serve the purpose.

We may mention here that the West Bengal State Agriculture Commission while recommending a ban on field trials and commercial cultivation of genetically modified crops, as indicated at the outset, has strongly recommended a shift from conventional agriculture to ecologically sustainable organic farming in the State.

Options for small and marginal farmers

Only pronature policies and practices can enable us to face the impending challenges to long term sustainability of agriculture in general and rural livelihood in particular as the country cannot prosper keeping the majority of its people deprived of basic necessities of life. Their food and nutritional security are being increasingly impacted adversely by serious degradation of natural resources, – land, air, water and biodiversity primarily due to wrong agricultural policies, deliberately pursued by global corporates with the active support of people involved in vital decision making processes. They basically follow a top-down approach to suit their economic interests, sacrificing in the process all vital norms of ecology and environment. It is high time to immediately turn to much more ecofriendly systems of agriculture that will make the farmers free from the clutches of the agribusiness lobby and enable them to make their own decisions on all aspects of agriculture right from choice of inputs, cultural practices and subsequent processes. What the agricultural scientists, sociologists, economists and others, specifically the agricultural field level scientists can do is to suggest the most suitable options depending on the circumstances and perspectives. It has to be a total welfare oriented partnership, with the state providing the much needed financial help and necessary infrastructural framework.

In view of the degradation and shortage of natural resources the underlying motto of all activities would be resource conservation that includes all abiotic and biotic resources. Ensuring availability of adequate quantity of water and preservation of its quality, conservation of soil and its nutrients, conservation of all forms of biodiversity, – the unique creations of nature that once lost would be absolutely irreplaceable, and most efficient recycling of wastes through innovative technologies, and researching economically viable renewable energy sources that would be readily available to the rural people.

The options for our predominantly small and marginal farmers could be as follows : (i) rain water harvesting through all possible ways such as building surface storage structures, tanks, dugwells, etc., contour bunding, gully plugging in case of undulated terrains, in particular, (ii) land shaping for rainwater harvesting in ponds and elevation of low lands to different levels with the excavated soil for growing different types of crops, bunds on all sides of plots to prevent run-offs, etc. checking ingression of salt water in coastal regions, (iii) cultural and biological control of pests and diseases, (iv) developing area-specific crop-livestock integrated farming systems using multiple crops and maximizing the synergy between the different components of the integrated system, (v) development of most efficient systems of recycling of wastes, implying in the long run zero waste generation, (vi) encouraging localized food systems through a cluster, group or cooperative approach to cut down energy costs in long distance transport, distribution and marketing, (vii) involving at all levels appropriate self help groups preferably women self help groups, in making vermicomposts, botanical preparations for pest control, and in processing, post-harvest value addition and all such activities that would economically benefit women, in particular.

Even at the level of the average small holder, food security, – the assured year-round availability of nutritious food in adequate quantity, and food sovereignty, – the full freedom and authority in all decision-making processes in agriculture, are ensured in the biodiversity based built-in safety mechanisms of the integrated organic farming systems.

The West Bengal State Agriculture Commission fully subscribes to IAASTD's view,

"**Business as usual is not an option**".

On February 21, 2009 the UN Secretary-General Ban Ki-moon and former Vice-President of the USA, Al Gore, a joint winner of 2007 Nobel Prize with IPCC, have made a fervent appeal, "**Let's go green**", to all nations that needs urgent implementation. Excerpts from the same are quoted below.

"………. we need 'pro-poor' policies now ………… Last year, food riots and unrest swept more than 30 countries. Ominously, this was even before September's financial implosion, which sparked the global recession that has driven a further 100 million people deeper into poverty. We must act now to prevent further suffering and potential widespread political instability. This means increasing overseas development assistance this year. It means strengthening social safety nets. It means investing in agriculture in developing countries by getting seeds, tools, sustainable agricultural practices and credit to smallholder farmers so they can produce more food and get it to local and regional markets. Pro-poor policy also means increasing investments in better land use, water conservation and drought-resistant crops to help farmers adapt to a changing climate, which if not addressed could usher in chronic hunger and malnutrition across large swathes of the developing world."

Source: http://timesofindia.indiatimes.com/Opinion/Editorial/TOP-ARTICLE--Lets-Go-Green/articleshow/4162513.cms
(see Annexure Item 21for full text of the appeal)