Innovative Thought Forum

Indian Agriculture and Allied Sectors

Proceedings

24th July 2015

1st Floor, A-7, Safal Profitaire, Corporate Road, Near Prahladnagar Garden, Ahmedabad – 380 015.

Innovative Thought Forum

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PREFACE

INNOVATIVE THOUGHT FORUM (ITF) is an agnostic, nongovernmental organization established with an aim to work for the welfare of Indian People. The forum is built for the purpose of humanity without any discrimination of Individual(s), or sections of society on the basis of caste, doctrine, and religion or economics status. The forum has created a platform for organizing discussions in the form of either round table meetings or seminars and workshops on India Centric problems and tries to find appropriate technology solutions or policy level decisions.

The first discussion organized by the forum concentrated on the core issues of Land and Water. Closely associated with the land use and water is Agriculture, which is the back bone of India's food and social security. Besides food grains and oil seeds, the Indian agriculture has been growing in allied sectors of Livestock, Dairy and Fisheries, Forestry, Horticulture and other non-horticulture crops, soil heath, fertilizer and seeds, water and energy. The intention is to highlight the cross-sectoral and multidisciplinary inter linkages, equivalent to warp and weft in the India's socio-economic fabric.

Indian Agriculture sector supports 17% of world's population and exports rice, wheat, plantation horticulture and dairy products. India possesses only 2.4% of the world's geographical area and 4% of water resources. India's farm sector is dominated by small and medium land holdings; however Indian agriculture has kept pace with growing population and diversified demands. Secondly, it has also shown resilience to climate change and weather aberrations.

Farm mechanization and shift in food consumption behavior towards high value commodities are adding pressure on Indian agriculture system. There is a widespread feeling that the agriculture sector is not managed optimally because its contribution to the gross domestic product (GDP), of 14%, is not commensurate with resource allocations in terms of finance, water and human resource. The reasons that area assigned for the problem qualitatively are, irrational fertilizer and water use, lack of quality seeds, post harvest management and inadequacy of storage facilities. India's crop yield intensity measured in terms of tonne/ hectare is also low in comparison to the crop yield in developed countries and other BRIC nations namely China and Brazil. There is an urgent need to identify problems and find adequate solutions to further increase our food production. There is a raging debate on trials of GM food to enhance the food security of the nation has much divided opinion. There are many questions with respect to long term damages, non-sustainability and the danger of the multinationals monopolizing the GM food sector. In fact, the developed world is concentrating more on organic farming and it is essential to discuss the way forward in an objective way without losing on food security. The ITF organized a brainstorming on this subject on 24th July 2015, had brilliant presentations followed by meaningful discussions. The proceedings of this brainstorming are presented here for further discussions on this important topic.

S.B Dangayach.

N.K Bansal.

New Delhi.

Ramesh Jhamtani

Setting the Stage:

Bajrang Lal Gupt

It is my pleasure to be here for a "Manthan" on Indian Agriculture and Allied Sectors. I am not an expert in the field; however I am close to farmers and people who work in the villages. Having seen the conditions of the Indian farmers and farmer grown products, I would like to express my thoughts on three basic issues of Indian Agriculture:

1. Current Status of Indian Agriculture.
2. Low contribution of agriculture to the National GDP, though the agriculture workforce has more or less remained the same.
3. Decreased outlay for Indian Agriculture to only 17.3% in 12th Plan against 30% in the 11th Plan.

Before dealing with some of the details, I would like to emphasize that few very good things have happened in the Indian agriculture. Till the year 1967, we were relying on food imports to feed our population. In the year 1965, India had to go on war with Pakistan. We were importing PL 480 wheat from USA. There was a tremendous pressure on India to compromise. But the then, Prime Minister Late Lal Bahadur Shastri refused to bow to the pressure; as a result USA stopped a ship loaded with wheat in the middle of the ocean. This forced the late Prime Minister to enact a slogan " Jai Jawan Jai Kisan" and asked people to observe Monday as day of fasting to conserve food..

Today we are self reliant in terms of food, producing 260 MT of food grains. However, there is a problem of food security and food equity. Our per capita consumption of food grain is low because the poor does not have purchasing power. Also in terms of production there is serious non-uniformity. From the year 1950-51 to 2000-2001, share of cereal production has increased, but during the same time period, the production of pulses has decreased. Same is the case with oil seeds. Our per capita availability of food products is not impressive. For cereals, per capita net availability has increased from 395g-460g and that of pulses decreased from 608 to 39g. This essentially means that the protein content in the diet of poor people has decreased substantially.

Another major problem in our agriculture is the low productivity per hectare as well as per capita availability. Development of agriculture is regionally unbalanced. This is also true with respect to the variety. Benefits of new seed, use of chemical fertilizer and availability of unlimited water supply brought agriculture revolution in Haryana, Punjab and Western Uttar Pradesh. Farmers in these states became rich, whereas in other states the benefits of modern inputs were not quite visible. This has lead to social and political implications. In crop rich regions, food grain stocks increased. In the warehouses, however good quality food grain was illegally replaced by poor quality grain and sold in the market at high profits. Warehouse product was not even suitable for animals. The states for which the food grain was stored did not pick up the grain for public distribution system.

Another big problem in our food supply chain is the wastage. Wastage happens at all the levels, namely, the field level, storage level, market level and also at consumer level. What could be done to curb these losses?.

Another contemporary topic that is being debated presently is the GM crop. Some scientists argue that GM Food crop has to be allowed to feed the growing population and to cope up with increased food production. Other well meaning groups argue that GM crop is not suitable for a country like India. The arguments say that India has wonderful achievements at macro level, No. 1 country in milk production, No.2 in fruit and vegetable and so on. At micro level, however, the picture is dismally low per capita availability and qualities are the issues.

At this stage I would like to bring into discussion the use of technology. I am of the firm opinion that any new technology for India should be appropriate to its biodiversity and climatic conditions. Getting western technology and its adoption in India is the view of some experts. This is true of all the sectors. Prof. Swaminathan, father of green revolution made India self sufficient in food. However, he brought a new seed to Indian agriculture. The seed is hybrid. It needs chemical fertilizer, pesticides and large quantity of water. Vast use of these modern inputs has played havoc with ground water table, there is increased content of chemicals in the output and therefore in our body. Soil is polluted with chemicals and eroded due to large use of water.

Our traditional seed was rugged, needed less water and was based on natural fertilizer. Production was however low. Some farmers claim that it is a misconception. They argue that they are producing the same quantity using traditional seed. There is a gap of 1 to 2 years before soil regains its health and the productivity. Uncontrolled use of chemicals has spoiled the nature. We have wasted large quantity of water. We need India centric technology, which is environmental friendly and good for health. We may not be able to afford capital intensive technology. We need a technology that can generate employment. At one time we were producing 2500 varieties of rice. Nowadays, only one variety is being grown i.e "Basmati" and monoculture destroying biodiversity.

In the end, I would like to suggest an action plan. The action plan should be at two levels i.e Governmental Level, Non-governmental level.

At the governmental level we may contribute towards policy or policy changes, Institutional framework, structural changes and the support system.

At the Non-governmental level, lot of work can be done without any input from the government. Self reliant systems should not depend upon any governmental help. We need to create a self reliant agriculture system. We are associated with creation of self reliant group of villages. In these villages one needs to consider the socio-economic geological and agro-climactic conditions to develop a sustainable agriculture. Availability of drinking water and sufficient water for irrigation is always a problem. One needs to find appropriate solutions to tackle water problem. Gujarat is a example state that revived its ponds and lot of work was done on check dams. We need to use surface water and underground water conservatively. Our water pollution levels have increased. Much can be down by changing behavioral patterns.

Energy is another major issue demanding concrete work. Various renewable energy sources like solar energy, biomass utilization, bio-gas production should be prioritized and given a strong stimulus. Last issue that I will like to pose is the shrinking land holdings by Indian farmer. Small and marginal land holdings constitute 80% of our agriculture landscape. The productivity of these small farms is low. We need to address in our policy, the issue of these small farms. We need to make our small farms more productive and dovetail the agriculture produce with the allied sectors. Animal husbandry, aqua-culture, Gram Shilp, Gram Udyog with synthesis of modern and traditional technology may help the Indian farmer in an effective manner.

Let us create Self Reliant Group of Villages

A Perspective on Indian Agriculture

R. B Singh

1. Introduction

From the point of view of population, India is almost one sixth of the world. Whatever happens in India, its impacts are felt globally and if something happens in other parts of the world, its effects India as well? There was a fierce shortage of food in India in the 1960's. We grow today enough food for 1.2 billion people and have surplus for export.

In the context of global imperative, world population may increase by 33.7% by 2050, from 7.18 billion in 2014 to 9.6 billion. Share of urban areas will increase from 54% to 65% by 2020 (in India over 55%), and the middle class will grow from 50% to 70% (in India more than 80%). In order to meet the expected demand of food, feed, fiber and fuel, global agriculture input will have to double by 2050. This will put strain on water availability, when in the BAU scenario, 89% of the total water resource will have to be used in agriculture. Food production in the world has doubled during the last 25 years, reducing the number of hungry from 994 million in 1990-92 to 791 million in 2012-14, mostly in the developing countries. Despite this increased food production and visible economic growth, negative health consequences of micronutrient deficiencies continue to affect around 2 billion people. More than 100 million children under age of 5 are underweight and unable to realize their full socio-economic and human potential. Also Southern Asian region and sub-Saharan Africa have more hungry people today than in the nineties. Benefits of increased food production have not reached the poor all over the world (Table-1).

2. The Indian Green, White and Blue Revolutions

Agriculture is mix of the four major activities namely, farming, horticulture, livestock and fisheries. Indian achievements in all the monetary activities between 1951 and 2013, have been extraordinary. Our food grain production grew more than five times to 265 MT since 1951, horticulture production consisting of fruits and vegetable grew by seven times to 268 MT (India is the second largest producer of horticulture crop in the world), milk production grew nine times to the 136 MT (17 MT in 1951, India became no.1 milk producer) and fish production grew twelve times (from 0.75 to 10 MT). These are by no means small achievements. In spite of these major achievements, India has the largest number of poor and hungry people though by percentage it is reduced by more than halved. This is a contradiction that affects the social stability of the country

Table 1: Changing Distribution of Hungry

The Changing Distribution of Hungry

	Number (millions) 1990-92	Number (millions) 2012-14	Regional share (%) 1990-92	Regional share (%) 2012-14
A Developed regions	20	15	2.0	1.8
B Southern Asia	292	276	28.8	34.3
C Sub-Saharan Africa	176	214	17.3	26.6
D Eastern Asia	295	161	29.1	20.0
E South-Eastern Asia	138	64	13.6	7.9
F Latin America and the Caribbean	69	37	6.8	4.6
G Western Asia	8	19	0.8	2.3
H Northern Africa	6	13	0.6	1.6
I Caucasus and Central Asia	10	6	0.9	0.7
J Oceania	1	1	0.1	0.2
Total	1015	805	100	100

Till the year 1964, India had to import food grain. However, as a result of Technology, Services, Public Polices, Farmers enthusiasm and Political will, Indian farmer achieved a quantity of wheat production between 1964-1968, which we have not been able to produce in 4000 years. This is marked as Green Revolution Symphony (1968) of the Indian Republic. Assured and remunerative market has been the prime mover of India farmer's enthusiasm. The Indian enigma, however, is that India has the largest bulge of unemployed or poorly employed youth. This is very critical since India is a nation of youth, sixty five percent of country's population being below thirty five years of age. India may have to learn from Brazil, who has been able to eliminate hunger from the country through reforms and committed policies of the Brazilian government.

3. Indian Agriculture, Water stress and Nutrient Deficiency

In spite of stagnant farm area, the food grain production has been growing steadily over years (Fig.. 1) . Agriculture contribution to the GDP has matched the expectations of the Planning commission at 3.5% to 4%. This progress in agriculture is despite the fact that 70% of our farm holdings are very small, namely, less than 1 hectare. This pessimistic scenario is however likely to be balanced by the livestock activity, which can be seen as the future growth of Indian agriculture. Live stock ownership being highly egalitarian, it is therefore the way to break inequality and malnutrition. Livestock is a source of high protein, regular income (a sort of moving bank), gender empowerment and employment generation (18 million people directly employed). Livestock has the potential to become driver of congruence of food, nutrition, health, additional increase and livelihood security. Local breeds of Indian livestock and e better equipped to fight climate induced diseases. Kamdhenu, a local cow breed, carries high properties mega-anti bodies, which can be used to produce vaccines to counter Ebola and swine flue epidemics and therefore they can act as champion of Make in India campaign. Most farmers' families own a cow and buffalo; proper knowhow to use the potential of these animals can reduce poverty and hunger through better knowhow. India has a total population of 550 million livestock, out of which 270 million is bovine population. Only one third of population is milk producing and rest two third is a burden. We should reduce this population by 30% to 40% depending upon the livestock. This is going to be major challenge for Indian Agriculture.

Dr. Varghese Kurien, father of white revolution, proved the powers of market for small holders through co-operative movement. Today, county has 81000 co-operatives, 10 million small holders making India as the world's largest dairy producer. We have already talked about our progress in horticulture and fisheries ; the annual production has been illustrated in Fig. 2 to 4 respectively.

Fig.2 India's Horticulture Production vs. Rest of the World

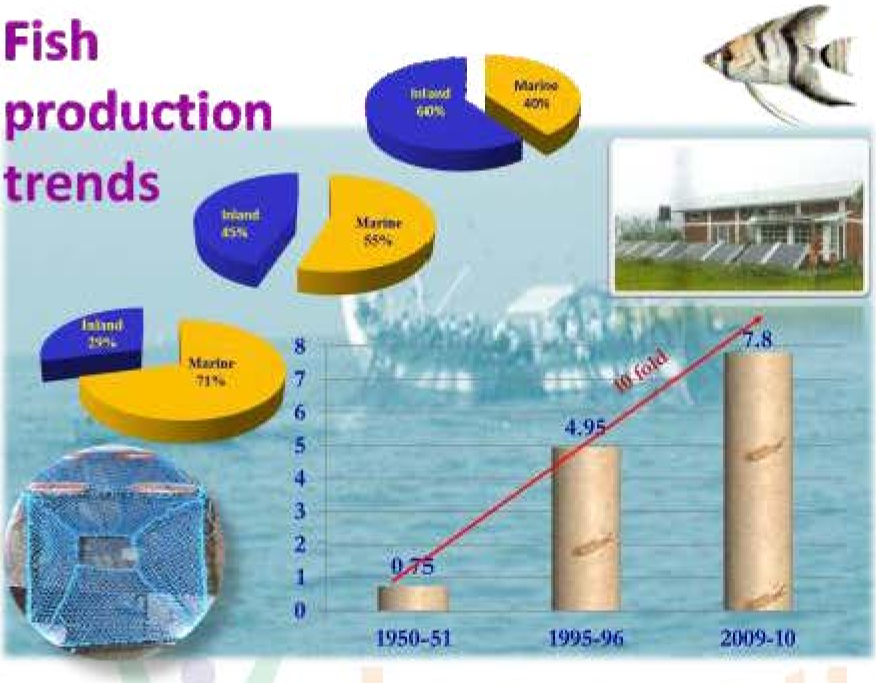

Fig.3; Trends in Fishery Production in India

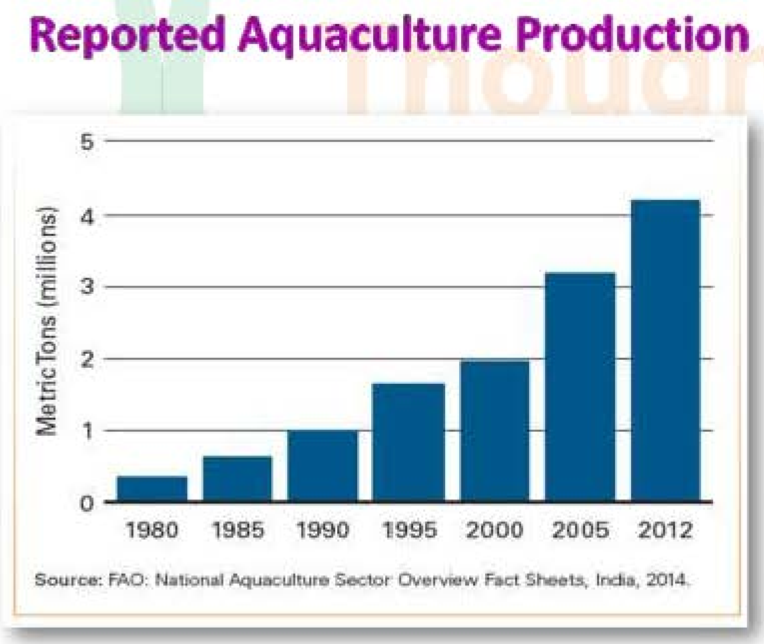

Fig.4 ; Progress of Aquaculture production in India

All these notable achievements of India agriculture have stressed the basic resource input, namely the water. Per capita water availability has reduced leading to water scarcity situation as shown in Fig. 5. Main reason for this is large use of ground and surface water for irrigation (Fig. 6) ; amount water per kilogram of various agriculture products is shown in Fig. 7. This is also true for fertilizer application that has reduced fertilizer use efficiency for nitrogen and for cereals in India. Also the nutrients have been progressively deficient for agri-fertilizer since 1950 (Fig. 8).

Per capita water availability in India

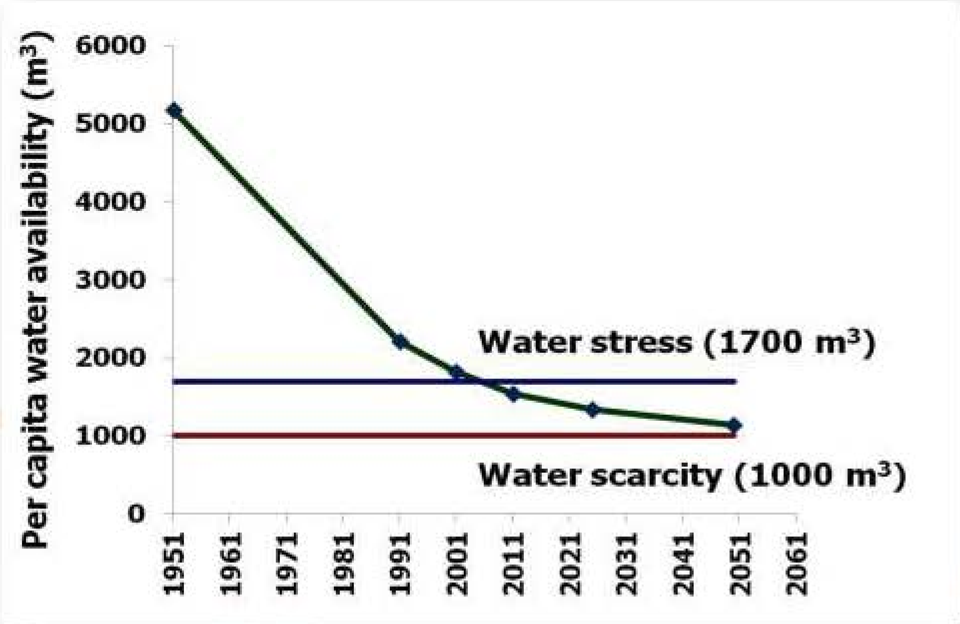

Fig.6: Trends in per Capita Availability in India

Surface Water and Groundwater Irrigation

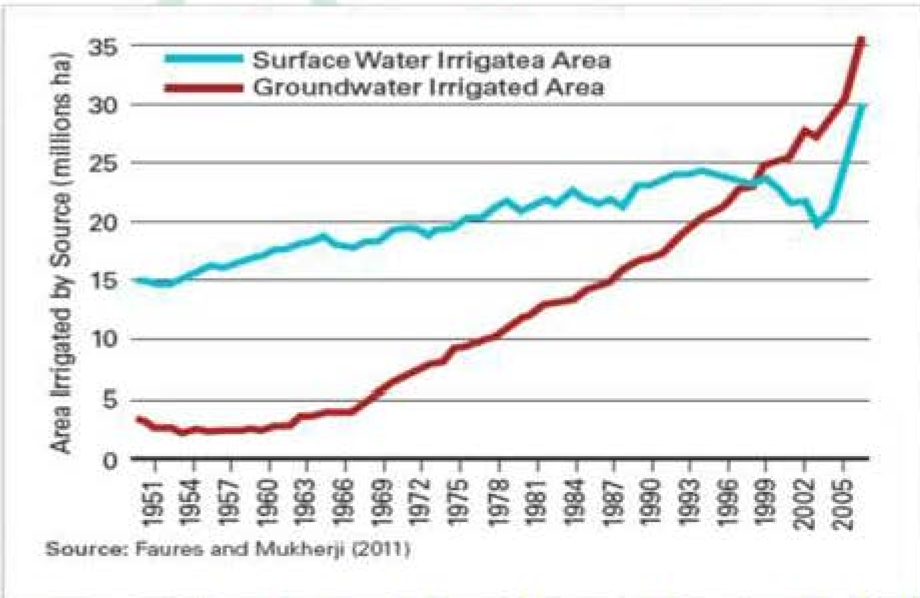

Fig.7: Patterns of Surface and Ground Water Irrigation

Water for agricultural products

Liters of water per kilogram of product

- Every Drop Counts
- Choose Your Food with Water in Mind
- Increase Water Use Efficiency

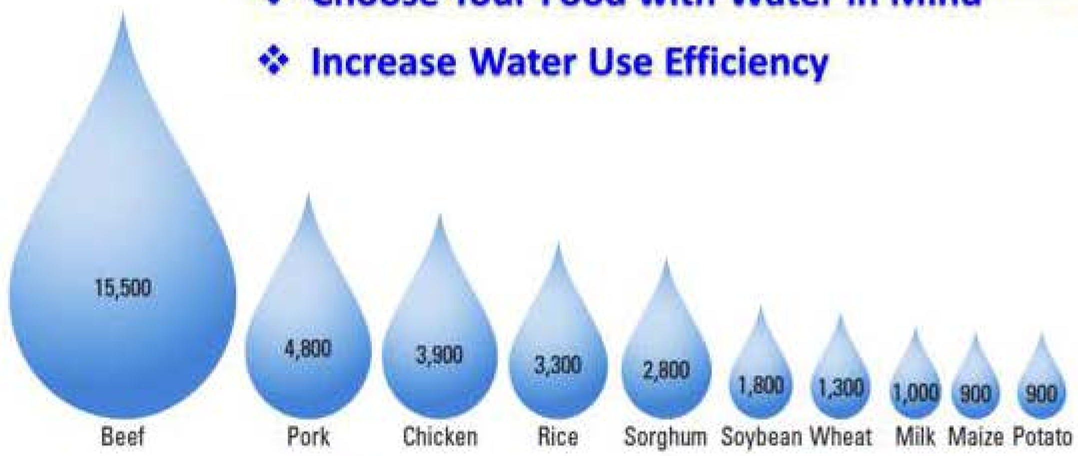

Fig.8: Water Requirements for Different Crops

Progressive expansion in the occurrence of nutrient deficiencies

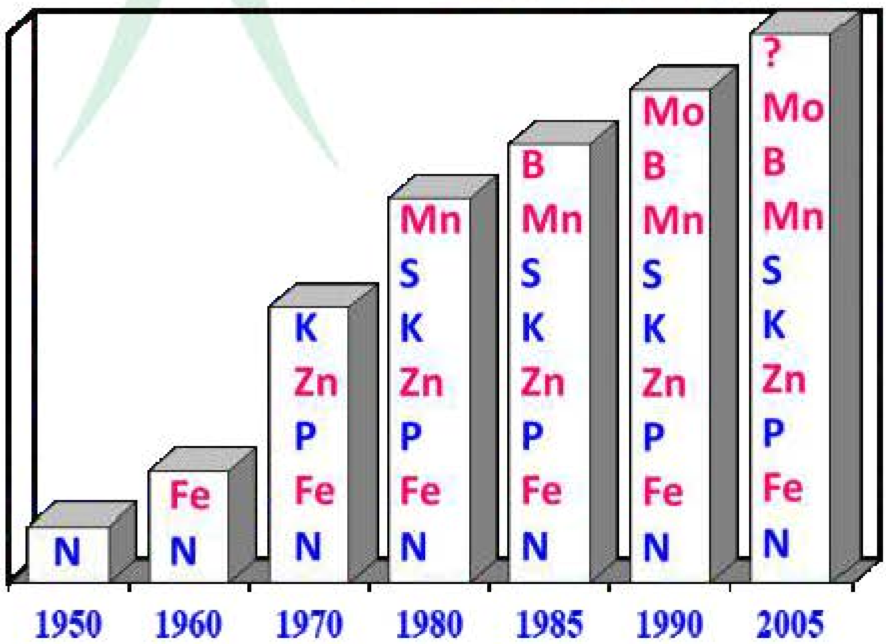

Fig.9: Nutrient Deficiencies sin Indian Crop Fertilizer

4. Way Ahead

The Indian agriculture has shown tremendous progress; however it has also stressed the resources like water and eroded the soil and worsened the plight of farmers, particularly of small and marginal holdings. We need a policy to use our resources judiciously and to create farmer friendly technology base that provides enough space to farmer. India is the centre of magical biodiversity in terms of crop variety, wild animals and micro-bacteria. This is our treasure and this must be protected. Science must ensure judicious harnessing of this treasure for multiple means.

The next important point is the judicious use of energy. Fig.10, shows the patterns of energy source uses in agriculture. The contribution of manual and animal contribution has declined sharply, where as that of electricity and diesel has increased sharply. In Bihar 90% of pumps are diesel operated. This is distracted use of energy sources because diesel has to be imported and its large scale use pollutes the environment. Solar and other renewable energy sources should be used along with energy conservation and energy recycling.

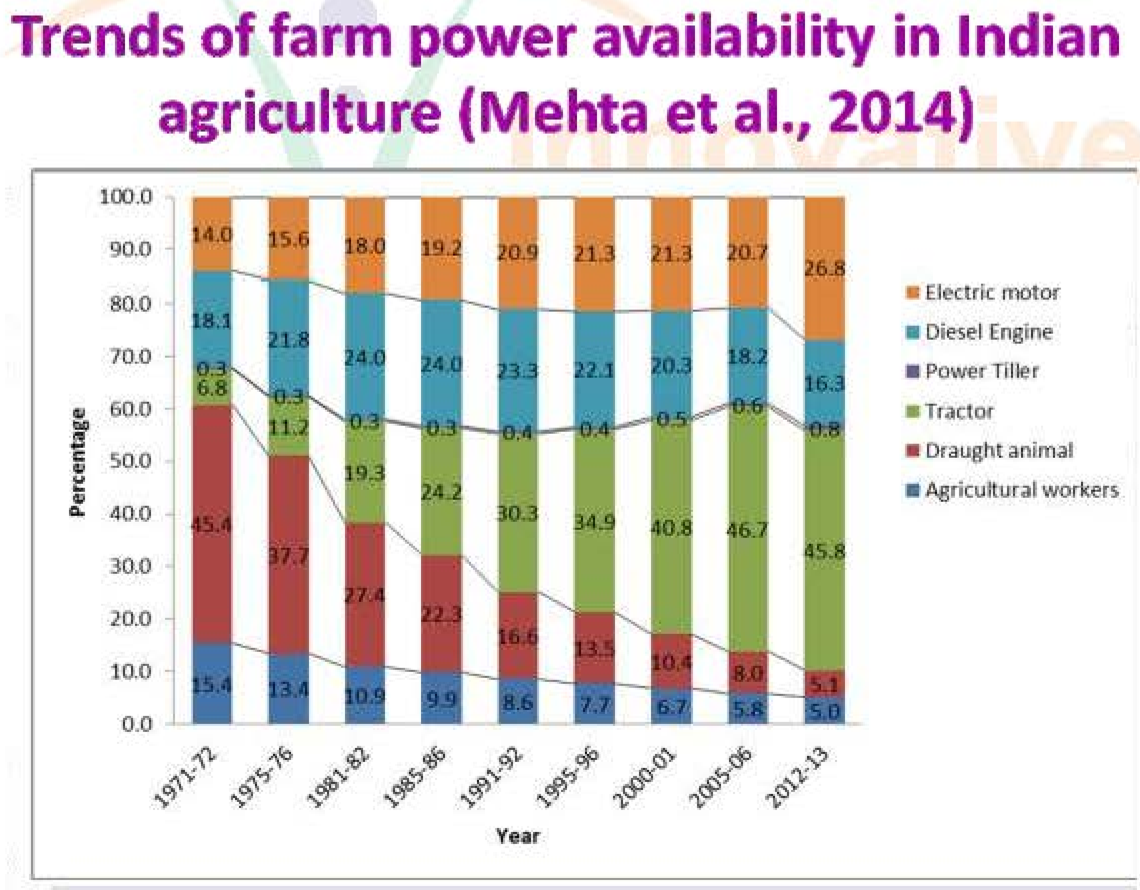

Fig.10: Patterns of Energy Resource Use in Indian Agriculture

We need to develop a zero hunger program for our country men. The dilemma is that people who grow food for us are themselves hungry. We need a very strong political will to eliminate hunger and poverty. The United Nations is concerned about it. The successive UN conferences on sustainable development, in 1972 Copenhagen, 1992 Earth Summit in Rio, and Rio +20 in were all attended by then Prime Ministers of India.

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At Rio +20, 2012, Secretary General Ban Ki-Moon said " We must build a future in which all people enjoy their fundamental right to food, in which their livelihoods and food systems are resilient and able to withstand the pressure induced by climate change and other resource and environmental challenges" . Sustainable agriculture development is the best hope to achieve zero hunger following five pillars:

-100% access to adequate food all around.

-Zero stunted children less than 2 years.

-All food systems are sustainable.

-100% increase in small holder productively and income.

-Zero loss or waste of food.

India will ultimately be fed by small holder farmer owing less than 2 hectare land. Pro-poor innovations in agriculture science and technology should be the highest priority as growth in agriculture is 2-3 times more effective in alleviating hunger & poverty than those in other sectors. India should learn from Brazil's Zero Hunger Program with political commitment at the highest level. On her first day in the office, President Lula placed hunger eradication and poverty reduction at the very centre of Brazil's development policy. They created a ministry for food security and appointed an Extra-ordinary Minister for zero hunger, Prof. Jose Graziano da Silva, presently DG of FAO. The result is the achievement of 100 percent availability of food, with no-one hungry.

India must adopt scientifically proven agriculture findings. As an example Pusa Basmati 150g has the advantage of reduced height early maturity, non-lodging and non-shattering. This allows sawing of Moong between wheat crop harvesting and paddy sawing allowing at least three crop production in a year. However adoption of this variety by some farmers resulted in Sharp losses to farmers, when basmati rice's prices dropped to Rs. 1500 per quintal from Rs. 4500 per quintal in 2013. India needs to have a policy to get ensured price for basmati by fixing a basic procurement price as for other varieties or start a Basmati Trading corporation to increase Basmati market world under. India needs to have revolution in other crops by having adequate inputs from biotechnology. Hybrid cotton revolution is an example with India ranking first in cotton production and an increase of to 71% in the income of small and marginal farmers.

Our vision to agriculture economy and eradication of hunger and poverty needs to be dictated by the following profound words of the Father of Nation to judiciously blend.

KNOWLEDGE WITH CHARACTER.

COMMERCE WITH MORALITY.

SCIENCE WITH HUMANITY.

POLITICS WITH PRINCIPLE.

We should build on the principles of a Green Economy by increasing the productivity by 40% , reduce rural poverty by 30%, eliminating hunger and reduce emission by 20%.

Agriculture & Allied Sectors: Livestock, Dairy & Fisheries.

Anup Kalra

1. Introduction:

I will like to start my presentations by posing problems of Indian Agriculture today. Some of the hard facts are:

Farmer is ready to leave agriculture and livestock because he does not find it profitable. This includes dairy farming as well because of social & political constraints. In Haryana and Maharashtra, cow slaughter is banned. When a farmer takes his cow to a veterinary hospital, he is stopped by the activists & harassed. He therefore does not want to do cow farming and prefers a buffalo. Culturally many farmers hence suffered because of business tag to agriculture. Many villages do or had a barter system of exchanging seed or milk or whatever they produce in exchange of required items.

Therefore, all is not well with agriculture in India. Agriculture is never considered to be an option for graduates from the IITs or IIMs and the contribution to R & D in Indian agriculture is dismally low (Fig. 1).

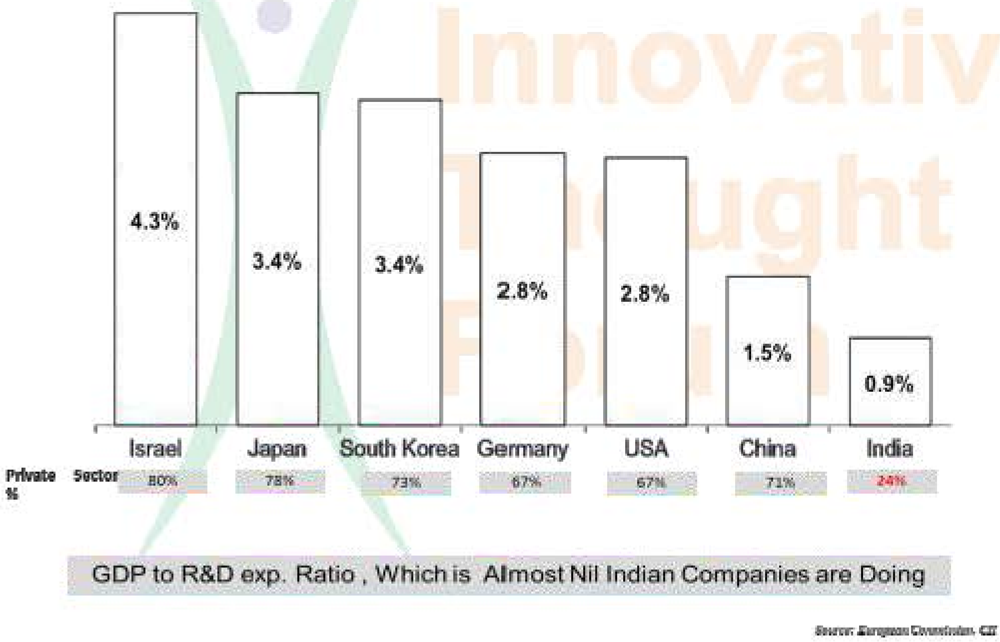


Figure. 1: Percentage of R&D Budget w.r.t. GDP in Various Countries

In table 1, I have illustrated the GDP value of livestock and agriculture with budget of the ICAR, that also ignores the animal science.

Table 1: ICAR Budget Allocation for R&D in Agriculture

Rs crore (Current Prices)	Sector GDP FY2009-10	ICAR Budget FY2011-12
Livestock	170,237	533
Total Agriculture	767,119	4611
Livestock as % of Total	22.2%	11.6%

2. Indian Achievements:

As far as the overall statistics is concerned, India has performed very well in all sectors of agriculture, namely, first in milk production, second in fresh water aquaculture, third in egg production, fourth in broiler production, self sufficient in most feed ingredients. All the sectors are growing at an annual growth rate of 5 to 10%. Table 2 also shows the total feed production and availability of protein to the Indian consumer.

Table – 2: Protein Availability from the Feed Industry in India

feed industry is the guardian of India's protein

	Market Size (Volume)	Nutritional	Protein (MT)	
Dairy Production	132 million MT of milk	3.5%	46.2 lakh MT	64.85 lakh MT of animal protein!
Inland Aquaculture	4.9 million MT of fish/shrimp	20.0%	9.8 lakh MT	
Meat Production	5.1 million MT of meat	21.0%	10.7 lakh MT	
Egg Production	69 billion eggs	14.0%	4.85 lakh MT	

However, in spite of excellent cereal, milk, livestock and fisheries production, India has to import pulses that are responsible to provide 15% of proteins (41.8 lakh MT) , the rest 64.85 lakh MT is produced domestically. Current price of various livestock & poultry products is given in Table-3.

Table -3; Value of Various Dairy Products

Rs crore (Current Prices)	FY2013-14	% of Total
Dairy	3360000	67.2%
Eggs	**18500**	**3.7%**
Poultry Meat	**36500**	**7.3%**
Mutton	32000	6.4%
Other Meat	25500	5.1%
Other Products	51500	10.3%
Total Livestock Output	**500,000**	**100.0%**

Broiler market in India is likely to grow four times by 2020, to 100 million per week by 2020 from 54 million per week presently. Weekly broiler placements from various states are given in Table – 4.

Table 4: Weekly Broiler placements from Various States in India

Weekly Broiler Placements: 2013-14		
Sl No	Region	Avg. Placement in millions
1	Tamil Nadu	7.05
2	Kerala	1.21
3	Karnataka	5.24
4	Andhra Pradesh	7.59
5	Maharashtra	7.32
6	Gujrat	1.21
7	West Bengal	6.69
8	Odisha	1.62
9	Assam	1.37
10	Punjab and Haryana	5.27
11	Rajsthan	0.98
12	Uttar Pradesh	3.77
13	Bihar & Jharkhand	3.41
14	Madhya Pradesh	1.16
15	J & K	0.55
16	Chattisgarh	1.19
17	Himachal Pradesh	0.72
18	Uttrakhand	1.07
19	Others	1.65
	Total	59.07

There is overall increase in India's food basket as provided in Fig.2. Quantity of global milk production is given in Fig. 3 showing India as leader. However, our bovine population producing milk is 100 milling in contrast to 9 million of USA, but USA cow gives ten times more milk than our Indian cow. Milk production from various breeds of cows in India is given in Fig. 4

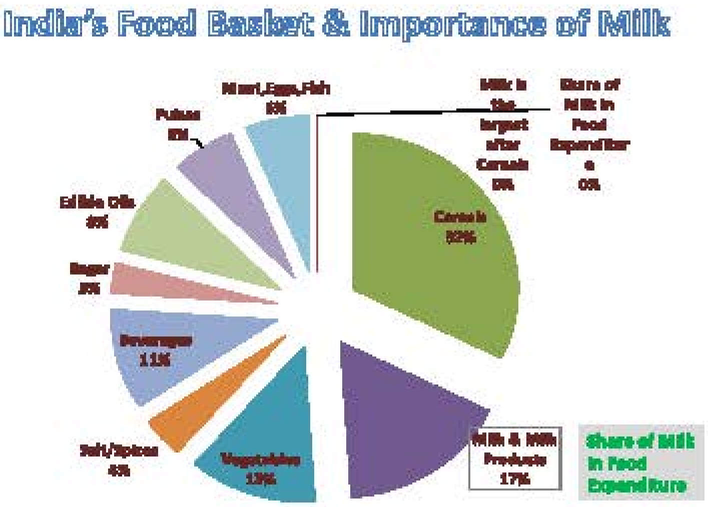


Fig. 4: India's Food Basket

3. Changing Scenario of Indian Dairy Sector.

Indian dairy sector has six major achievements. These are:

Current milk production – 130 million tons/a (highest in the world).

Per capita consumption 310 g/day.

Milk processing by organized section 25%.

Milk production growing @ 4% and should reach 180MT by 2020-21.

More than 90% milk comes from rural areas providing income.

High social equity – 80% milk from small marginal farmers and landless laborers.

The face of Indian dairy sector has been changing rapidly. National dairy plans to increase the milk production to double by 2020 with 55% contribution from buffalo. They plan to increase the population of the cross-breed cow and take steps to increase awareness about compound feed and scientific feeding. Projected changes in livestock population are provided in table 5.

Table- 5: Projected Changes in Livestock Population

Projected Changes In Livestock Population (Million)

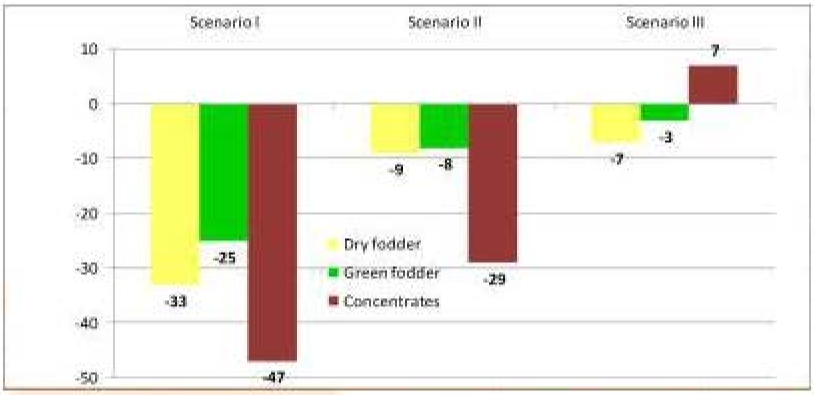
Category	2007	2020
CB cattle	33.06	65.30
Indigenous cattle	166.02	161.37
Buffalo	105.33	115.60
Sheep	71.56	74.78
Goat	140.53	142.23
Pigs	11.13	11.91
Poultry	648.83	1062.69
Fish**	7.13	12.38

Crossbreds double, poultry 1.6 times, fish 1.7 times

4. Deficit Feed Availability

India's plan to increase dairy products may be hampered by the availability of feed. For different scenarios, status of feed availability is given in fig. 3, showing deficit in all the three scenarios, except for Concentrates in scenario III. Table 6, provides exact figures about the requirements and availability of feed resources to the animals.

Status of Feed Availability (% Deficit / Surplus) Under Different Scenario - 2011



Scenario I – 100% each to productive & non productive animals
Scenario II – 90% to productive animals & 80% to non productive animals
Scenario III – 90% to productive animals & 60% to non productive animals

Fig.3: Feed Deficit in Various Scenarios

Table- 6: Requirements and Availability of Feed Resources by 2020

Estimated Requirement & Availability of Feed Resources By 2020

Category	Requirements * (million tons)	Availability * (million tons)	% Deficit *
Dry fodder	530	404	24
Green fodder	880	590	33
Concentrate	96	61	37

NIANP Estimates

The major concerns are the availability of proper feed to the livestock otherwise the plans of National Dairy Sector may be hampered; the major concerns that need to be addressed are as follows:

- Feeding largely dependent on crop residues & byproducts.
- Annual compounded feed requirements are 43 MT/a against an availability of 7 MT/a.
- Contribution by private sector to feed is 108 MT/a, dairy co-operative 2-5 MT/a and unorganized sector 3 MT/a.
- For green fodder land availability is less than 5%.
- Homemade concentrate mixture of cake, bran and grass husk is insufficient.

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5. Conclusion

In spite of big achievements in all sectors of Indian agriculture, there are still major problems that need to be resolved. Plight of small and marginal farmers, lack of education, uncontrolled use of water and fertilizer are major concerns that need our attention. Our livestock and dairy sector needs urgent intervention to use the bovine population not only for milk production but also to use them for medicinal value addition. Problem of adequate feed and its availability is a more problem with shrinking areas for fodder production. Animal feed requires as much attention as the agriculture production for optimal use of animal population for supplying protein, milk and other useful derivable products.

ENERGY IN INDIAN AGRICULTURE

N.K BANSAL

1. Introduction:

Agriculture input survey of the Directorate of Economics and Statistics (DES) clearly indicated rapid increase in the use of modern inputs(fertilizer, pesticides and insecticides and farm mechanization in majority of farms including small and marginal farms, who form four fifth of the total operational holdings of the country. Modern inputs and farm mechanization require more commercial energy. Along with energy and material inputs on agriculture farms, there has been considerable increase of commercial energy in the management of perishable commodities such as milk, vegetables, fruits, fish etc. Increasing energy inputs in the agriculture and the price increase in commercial energy in the last two decades have resulted in higher costs for farm inputs, thus reducing profitability in agriculture. Financial condition of farmers has therefore deteriorated and this requires immediate intervention at the policy level to either reduce farm input cost or upward revision of the crop produce.

This paper provides source wise energy use patterns in the agriculture sector, cost of energy input in crop production, analysis of energy input and agriculture output relationship and presents some solutions for renewable energy use in irrigation and post harvest processing.

2. Energy Use Patterns:

Primary energy use in the agriculture sector has increased from 2% in 1980-81 to 4% in 2008-09. The contribution of commercial energy, namely diesel and electricity, has shown a rapid rise, where as animal and human labour have declined sharply. At present, the contribution of electricity and fossil energy together has gone up to 86% and of agriculture workers and draught animals has come down to 6% and 8% respectively. Energy use in agriculture is direct as well as indirect. Direct energy is essentially for irrigation (diesel or electricity), & mechanization (Tractor, power tiller etc.), and indirect energy is in the form of chemical fertilizer, pesticides and insecticides. Fertilizers and other chemical inputs to agriculture have been responsible for increased food production in all regions of the world. Mineral fertilizers, chemical pesticides, fungicides and herbicides all require energy for their production, distribution and transport process. Fertilizers form he largest of these energy inputs, while the pesticides are most energy intensive of all these inputs. Energy contents of various agriculture inputs are listed in Table -1, which shows the energy required for manufacturing these products.

Table-1: Energy content of agriculture input (FAO, www.fav.org/docrop/

Input		Typical rate of application (kg/ha)	Sequestered energy (MJ/kg)	Energy content of crop produce (MJ/ha)
Fertilizer	Nitrogen	150	65	9,750
	Phosphate	60	9	540
	Potash	60	6	360
Insecticide		0.14	200	28
Herbicide		5	240	1,200
Fungicide		3	92	276
Seed		120	14	1,680

Consumption of different sources of energy, from the year 1980-81 to 2009-10, is shown in Table -2. It is noted that consumption of electricity increased sharply between 1980-81 and 2000-01 owing to rapid expansion of tube well irrigation in Indo-Gangetic plains. After 2001, the increase has been increasing steadily between 1990 & 2000. Fertilizers and pesticides have been increasing relatively slowly, but the consumption of diesel increased steeply between 1990-2000. Source wise consumption of various energy inputs shows that total commercial energy input to Indian agriculture has increased from 425.4 x 109 MJ in 1980-81 to 3222.5 x 109 MJ in 2009-10. Consumption of energy per hectare of net sown area has increased from 3000 MJ to 22.8 thousand MJ during this period. Energy consumption for gross cropped area increased from 2.5 thousand MJ/ha to 16.5 thousand MJ/ha during the same period. This clearly indicates manifold increase in the energy intensity of Indian farms.

Table-2: Commercial Energy use Patterns in Indian Agriculture.

Year	Diesel ('000 tonnes)	Electricity (GWh)	Nitrogen ('000 tonnes)	Phosphorous & Potassium ('000 tonnes)	Pesticides ('000 tonnes)	Total Energy (10'MJ)	Energy input (10'MJ/ha)	
							Net Sown Area	Gross Cropped Area
198-81	101 (6,579)	14,489 (1,72,853)	3,678 (2,22,892)	1,836 (17,650)	45 (5,400)	425.38	3.04	2.46
1990-91	318 (2,082)	50,321 (6,00,329)	7,997 (4,84,630)	4,549 (38,459)	75 (9,000)	1,159.43	8.11	6.24
2000-01	7,497 (4,90,883)	84,729 (10,10,816)	10,920 (6,61,764)	5,781 (57,284)	44 (5,229)	2,225.98	15.74	12.01
2009-10	11,212 (7,34,131)	1,20,209 (14,34,093)	15,580 (9,44,148)	10,906 (1,05,075)	42 (5,018)	3,222.46	22.85	16.52

*Figures in parenthesis indicate a common energy unit of MJ.

3. Energy Input and Value of Agriculture Output.

Increase in the energy input in Indian agriculture has significantly impacted the input cost of farming sector. Figure-1 depicts the relationship between commercial energy use and gross value of agriculture output in real terms (2004-05 prices), which increased from Rs.385.4 thousand crores in1980-81 to Rs.856.7 thousand crores in 2008-09. In the same period, total energy use increased from 425.38 x 109 MJ to 3222.46 x 109 MJ. Gross value of agriculture output per thousand MJ of energy declined from Rs.9060 in 1980-81 to Rs.2788 in 1997-98 and thereafter remain stagnant with marginal fluctuations. In view of the declining ground water table and increasing nutrient deficiencies in soil, the direct and indirect energy requirements for sustaining current yields may increase further.

Crop Output and Energy Consumption in Agriculture

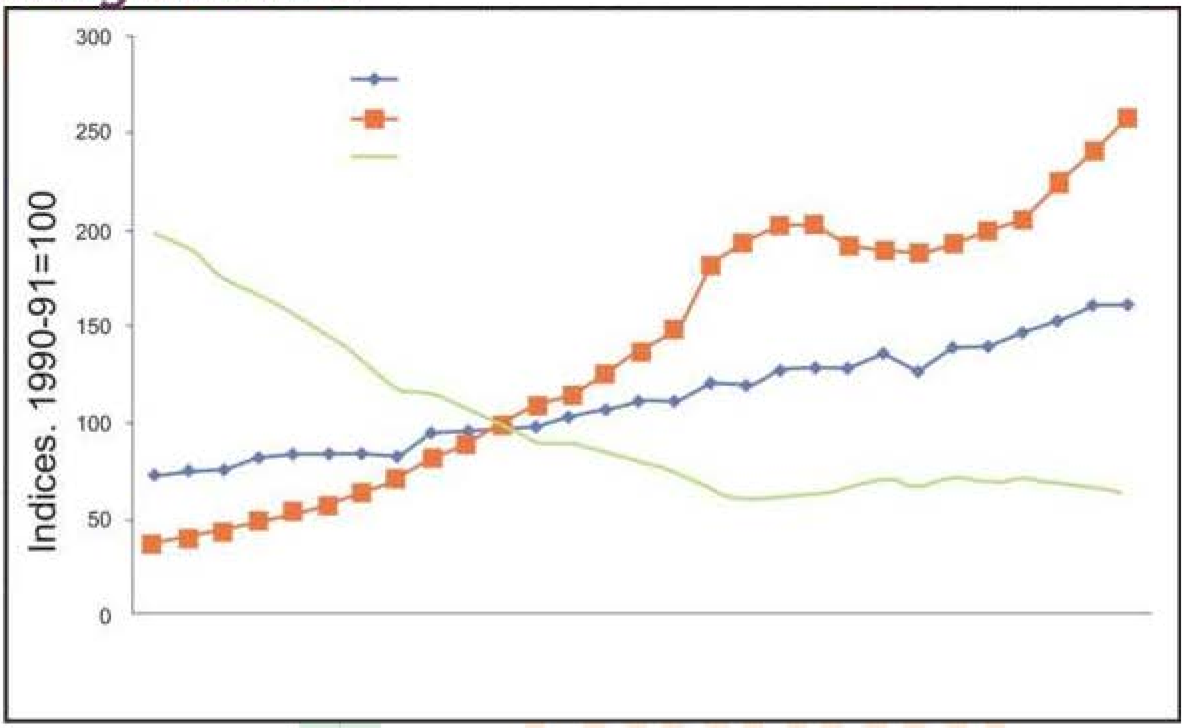


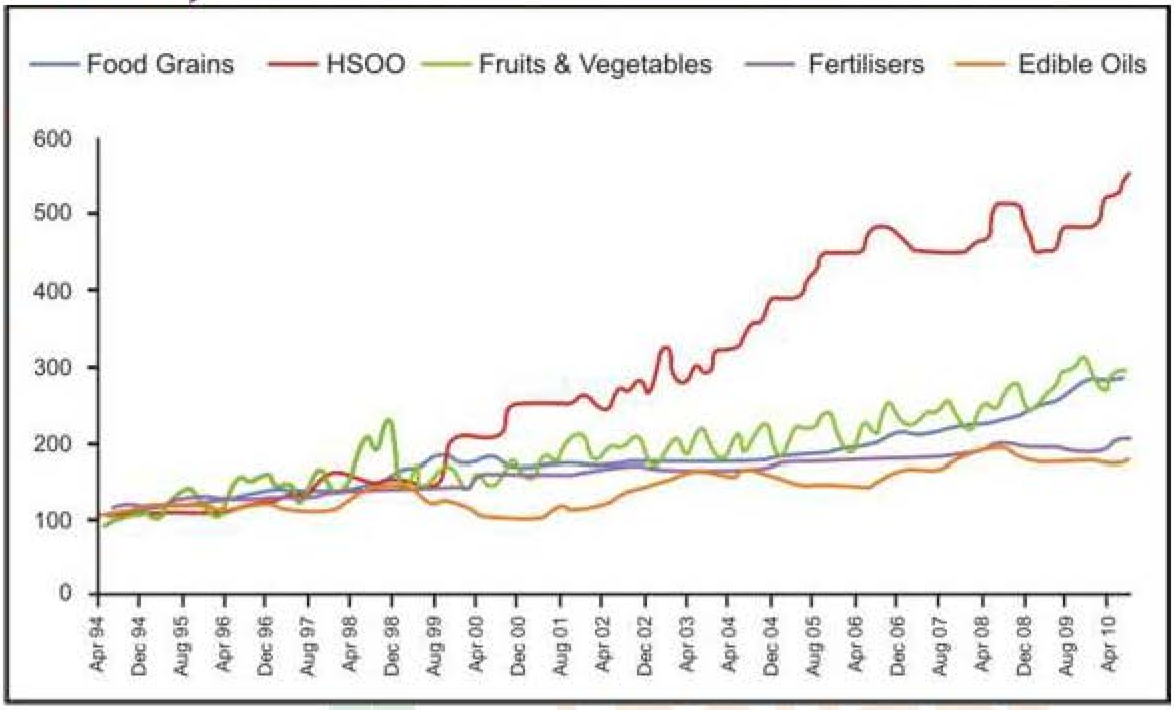
Fig. 1: Trends in energy use and value of agricultural output.

Amongst various states of the country, there is a wide variability in terms of energy intensity. Fig. 2 gives the agriculture GDP as a function of commercial energy consumption for various states in the country. In states like Punjab, Haryana, Tamil Nadu, Andhra Pradesh and Gujarat, the agriculture GDP is almost linearly proportional to the energy consumption. In larger states like Madhya Pradesh and Maharashtra have low productivity as well as low energy consumption? States like Bihar, Uttar Pradesh and Uttrarakhad are still dominantly dependent upon traditional energy. State like Kerala, J & K and Himachal Pradesh, though use low energy, but they produce value added products like spices, saphron, cotton etc and hence their agriculture GDP is higher for an equivalent energy consumption per hectare of the farm land.

4. Energy Prices and Farm Profitability

The cost of cultivation data shows that the expenses on farm inputs have increased significantly during the post reform period. This in a way has led to agrarian crisis in Indian agriculture. As an example, machine labour charge which was less than 4% of the operation cost of wheat crop in 1970-71, rose to 24% in 2008-09. This increase is due to upward revision of fuel prices and increased cost of the other farm inputs. Fig. 3 represents the changes in price index of food grains and commercial energy sources between 1994 and 2010. During this period, diesel price index increased by 407% while food grains price increased by on 162%. Indian farmer cannot easily pass on the increased cost in the inputs to the consumer because of the fixation of price by the government or other marketing chains. In any case this increased cost in the farm inputs has reduced profitability in the Indian farm sector.

Commodity wholesale price indices (1993-94=100)



Achnowledgement:G.Jha, S.Pal and Alka Singh, Research Brief ICAR

Fig. 3: Commodity wholesale rice indices (1993-94=100)

5. Reducing Farm Input Costs and Increase Yield

Crop yield per hectare of farm in India is low as compared to the crop yield in developed countries and other BRIC countries like China and Brazil. Table 3, compares the crop yield of India and other countries.

Table 3: Cereal yield per hectare of agriculture land in few countries

Country	Cereal yield tones/hectare
Austria	6.073
Belgium	9.213
Brazil	4.826
Canada	4.17
China	5.891
France	7.074
Germany	7.318
India	2.962
Netherlands	8.653
USA	7.34

There are six top reasons that lead to poor agriculture in India:

Degrading Soil Quality:Over use of irrigation and chemical fertilizers (Punjab, Haryana, Western Maharashtra) have led to increased soil salinity of soil.

Poor irrigation & Water Management: Most of agriculture is rain fed as only 34% agriculture land is irrigated due to irrational underground water pumping, the water table has been going down and this is also leading to increased cost of irrigation.

Small land holdings: Over 70% of farmers in India hold agriculture land of area less than 1 hectare. This results in inadequate technology application that are possible in large agriculture farms.

Inadequate Knowledge: Most framers have poor access to knowledge of agriculture techniques. Agriculture extension services are in poor conditions. A small farmer is guided by large farmers and agriculture input dealer on what to plant & how.

Poor access to fair markets: This leads to low income for the farmers. Since the input costs are increasing, he has to spend more and unable to invest in buying better seed or fertilizer.

Farming high yielding varieties: Though a number of high yielding varieties have been released for general cultivation, but most varieties are for irrigated eco-system and very few improved varieties are available for rain bed eco-system, which constitutes almost 60% of cultural areas in the country. In addition to above mentioned reasons for low crop yield in India, other reasons is very high post harvest losses due to post harvest processing deficiencies and storage system. Cheap storage and solar drying techniques at farm lever could be beneficial for reducing crop loss after harvest.

6. Solar Energy in Agriculture

Solar energy is a natural necessary input in agriculture due to photosynthesis process necessary for plant growth. Production of agriculture crop can be quantitatively understood by the following equation:

$$H_2O + b.NO_3 + CO_2 + (8\text{-}10)\,h \xrightarrow{\text{(Chlorophyl)}} C_KH_mO_n + H_2O + O_2 + \text{other material products} \qquad (12.1)$$
$$+c\,SO_4$$
$$+d\,PO_4$$

From soil Of water (H_2O, $b.NO_3$, $+c\,SO_4$, $+d\,PO_4$); From air (CO_2); From sun ($(8\text{-}10)\,h$); Biomass ($C_KH_mO_n$); Water vapor (H_2O)

Where,

b,c,d = various small quantities (ppm)

h = Planck's constant = 6.625×10^{-34} JS

b,c,d = various small quantities (ppm)

h = Planck's constant = 6.625 X 10-34 JS

v = frequency = c/λ (s-1)

c = speed of light = 2.99 X 108 m/s

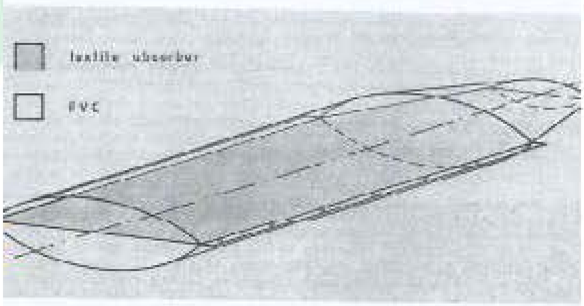
It is evident that the most important inputs to plant growth are water and N, P and K. Solar photovoltaic pump is a mature technology, which can be profitably used at the farm level. When the pump is not used, solar panels from a cluster of farms can form an electric supply system connected to the grid with provision of net metering. A concept of forming "Solar Pump Irrigators' co-operative Enterprises" (SPICE) will be presented by Mr. Tushar Shah establishing the economic viability of such a concept.

For reducing post harvest losses, two things are important. One, providing adequate storage and second reduce moisture content of the produce to be able to store the product for longer periods. Normally, storage systems are large silos employing large steel vessels. However, simplified ventilated grain houses build near the farm can reduce losses due to sudden change of weather conditions. A solar heater, made from plastic films, can provide heated air to regulate humidity and also drying the product to required level of moisture content. A simple concept of solar air heater is shown in Fig. 4. The absorber in this air heater is a black textile cloth with a designable texture (4b) so that heat transfer from the absorber to the air takes place in a turbulent fashion achieving higher temperatures. Full fledged operating solar air heater of this kind is shown in Fig. 5. This kind of solar plastic collector is capable of achieving air outlet temperature of 50oC or more depending upon the inlet air temperature (Table 4) and the air mass flow rate. The rate of the heat delivered by the system is 22.9 kW, meaning that it can dry 1 ton of maize or wheat in about 10 hours.

Table 4. Thermal performance of Solar Air Heater of Fig. 5.

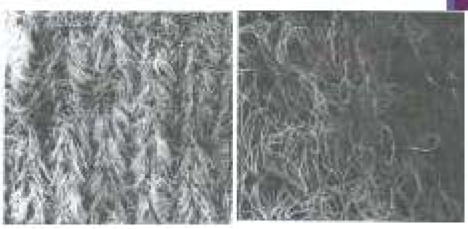
Serial No.	Mass Flow Rate (Kg/h)	Solar Radiation W/m^2	Ti Deg. C	To Deg. C
1	730	900	20.3	36.6
2	700	900	20.4	37.3
3	660	900	20.8	38.2
4	610	900	21.2	39.4
5	520	900	21.8	41.2
6	410	900	21.7	45.9
7	270	900	20.1	50.6

Solar Air Heater



(a)

Texture of Cloth Absorber



(b)

Fig. 4(a): Plastic solar air heater employing transparent UV stabilized films and a black textile cloth in the centre. Fig. 4(b): Shows the texture of two cloths that were used to make solar plastic air heaters.

7. Biomass utilization:

Biomass in the terms of wood, agro residues cattle dung and kitchen waste are available in a village, that can be used to provide clean cooking fuel in the form of biogas and provide electricity by using IC engines,(with adequate modifications) that work both on biogas or producer gas obtained by thermo-chemical of biomass. It is estimated that the total wood availability in the country is 307.4 MT (138 MT social forestry, 169.4 MT waste land and road side plantation). For energy conversion, the total wood availability is estimated as 176 MT. Total agro-residue availability is estimated to be 150 MT, out of which 70 MT is available for energy conversion. Depending upon livestock population the dung availability is conservatively estimated as 500 MT, which can be used to produce 54 million cu.m biogas daily. Apart from this, the total food and kitchen waste availability is 200 MT (Maithani and Gupta 2015). For a particular village or a cluster of village, one has to adequately estimate these resources for rational use for electricity generation and manure production.

8. Conclusions:

Indian agriculture has become much more energy intensive reducing profitability in agriculture. Besides there are large discrepancies in the inter state energy use and crop production. In some of the states like Maharashtra, Madhya Pradesh and Uttar Pradesh the energy consumption as well as the agriculture yield is low, indicating very hopeless condition of the farmers. Current trends in Indian agriculture revealed that energy requirements in Indian agriculture will increase further. Therefore there is a need of introducing technology change involving energy efficient farm machinery and irrigation systems. Solar photovoltaic pumps given to a cluster of farms can provide required water for irrigation purposes as well as produce electricity for grid export resulting in more revenue to the farmers. A model of Solar Pump Irrigation Co-operative Enterprise has been proposed by Mr. Tushar Shah. Solar and other forms of renewable energy like biomass can be used for reducing post harvest losses as well as farm manure production. Action is required on two fronts. First on utilization of available energy sources more efficiently addressing supply constraints. The second approach should be on promotion use of alternate renewal energy sources and appropriate technologies.

Acknowledgements:

Sections 1 to 4 are based on a report " Energy requirements for Indian Agriculture by Girish Kumar Jha, Suresh Pal and Alka Singh of the Indian Agriculture Research Institute, New Delhi.

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Approach for Energy Efficiency and Renewable Energy in Small Enterprises.

Vishal Sardeshpande
Adjunct Associate Professor, CTARA, IIT Bombay.

1. Introduction

Medium and small enterprises, which are agriculture based include, livestock processing and products (hides and skins, small artisanal tanneries, cheese making etc), fish processing and marketing (dried smoked or salted), processing (milling, jams, pickles, syrups, hency, beer making, oil extraction), agriculture marketing enterprises (association/groups)input sales (chemical and non-chemicals), agriculture equipments manufacturing (carts, agriculture tools etc) and non-timber first products. Small enterprises may be small scale households, microenterprises and small enterprises. The examples are families running the enterprise, with low capital flow, higher level of skill and capital intensity family enterprise with structured growth orientated business that serves relatively large markets..

Performance of these small scale, micro and small enterprises can be affected by a number of parameters like inadequate cash flow, lack of supply chain sufficient market and equipment and management problems. In this presentation, we emphasize the role of energy efficiency and use of renewable energy for reducing the input costs.

2. Reducing Input Energy Cost through Renewable Energy.

In order to demonstrate the use of renewable energy in agriculture based industry, we consider the process flow diagram of Jaggery making (Fig. 1)

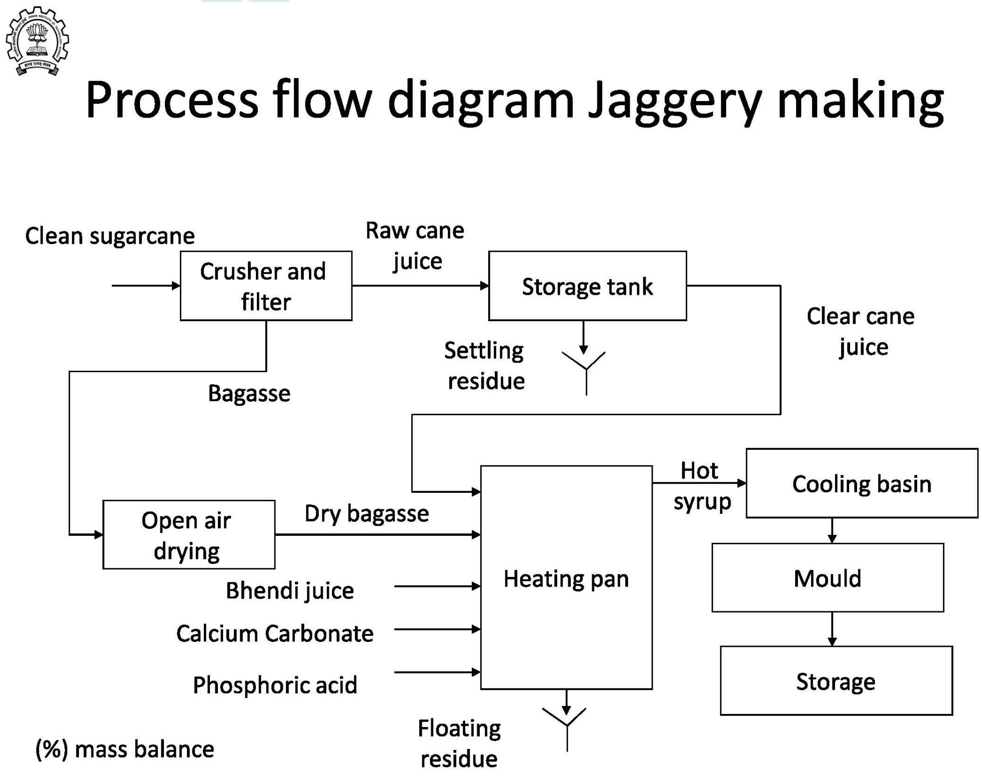


Fig. 1: Process Flow Diagram of Jaggery Making

Equipment required for unit operations in the process flow is a follows:

Equipment and operation

- Major equipment
  - Crusher
    - Driven by motor / engine
  - Pump
    - Driven motor / engine
  - Furnace and pans
    - Fired with bagasse
  - Stirrer and cooling basin
    - Manual stirring
  - Molds
    - Manual pouring
- Unit operation
  - Extraction
    - Mechanical process
  - Evaporation
    - Heat and mass transfer
  - Drying
    - Heat and mass transfer
  - Cooling basin and molds
    - Heat transfer

Fig. 2 shows the mass balance of Jaggery making:

Mass balance of Jaggery making

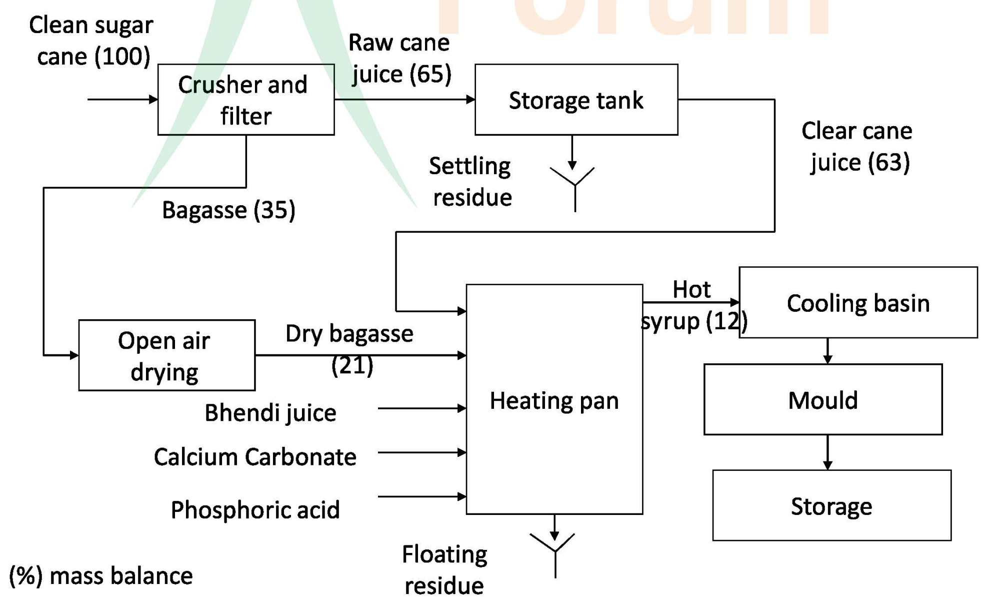


Fig. 2: Mass Balance of Jaggery Making

For 12 tons of sugar cane per day, typical operating numbers are

-20 batches / day.

-600 kg sugarcane / batch

-390 kg sugarcane juice / batch (65%)

-210 kg baggass (35%)

-75 kg Jaggery (12%)

Main energy inputs in the process are through baggasse, diesel or electricity. Cost of estimations of various inputs in jiggery production of this kind are given in Table 1.

Table 1: Input Costs to Jaggery making

Cost estimation for jaggery production

Particular	Unit	Value	Remark
Cane cost	Rs. / ton	2600	Minimum support price (MSP) for last year
Labor cost	Rs. / day	5000	RS. 250/batch, about 20 Batches
Cost of chemical	Rs./ kg jaggery	0.5	Estimated based on inputs
Jaggery recovery	%	12%	Based on cane maturity
Cane cutting and transport	Rs. /trip	5400	Rs. 200 / ton cutting and Rs. 250 /ton for transport
Cane carried	ton/trip	12	Two trollies of 6 ton each capacity
Cost of cane	Rs. / ton	2600	
Cost of transportation and cutting	Rs. /ton	450	
Cost of diesel	Rs. /ton	165	Diesel required 36 lit for 120 ton crushing
Cost of labor	Rs./ ton	417	12 tpd crushing
Cost of chemical	Rs./ ton	60	120 kg jaggery per ton
Total cost	Rs. / ton	3692	
Jaggery produced	kg jaggery /ton	120	
Total cost production	Rs./ kg	30.8	

It is inferred that the total cost of energy input is about 17% consisting of diesel and human labour.

3. Areas for Intervention for Increased Profitability.

The two major cost heads in jaggery making are :

Energy (the cost is proportional to the quality of energy). For evaporation process, one needs some more heat besides that s provided by baggasse. For crushing one need either diesel or electricity to operate a motor.

Labour : the cost of labour is proportional to the criticality and complexity of work, which includes drying, crushing, firing and processing.

Solar concentrators can be used for providing heat besides baggasse

Summary and way forward

- Cost of energy and labor is area of concern for agriculture and allied sector
- Use of technology to reduce energy cost and improve labor productivity
- Energy cost reduction through first energy efficiency and then renewable energy
- Need for good application engineering in this sector

Perspectives and Prospects in Horticulture.

Pankaj Khandewal
CMD, International Farms Pvt. Ltd.,
Mumbai-400072.

Introduction:

India has made tremendous growth in horticulture products ranking second in the world in terms of fruits and vegetable production. Fig. 1 shows the patterns of horticulture production alongwith the land area used for horticulture production.

Fig. 1 Production View of India's Horticulture Product

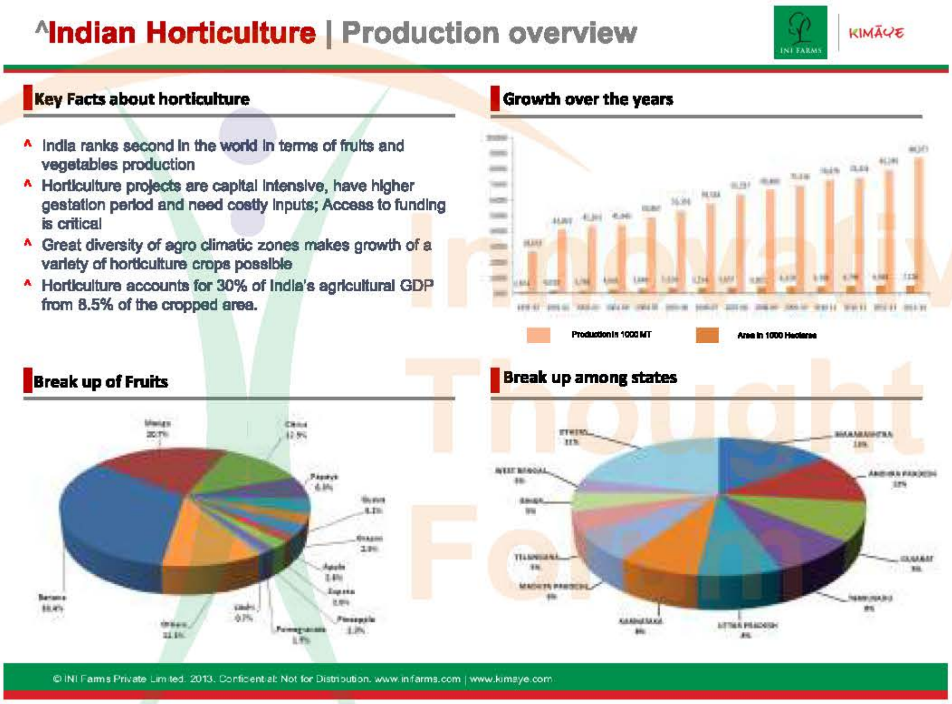


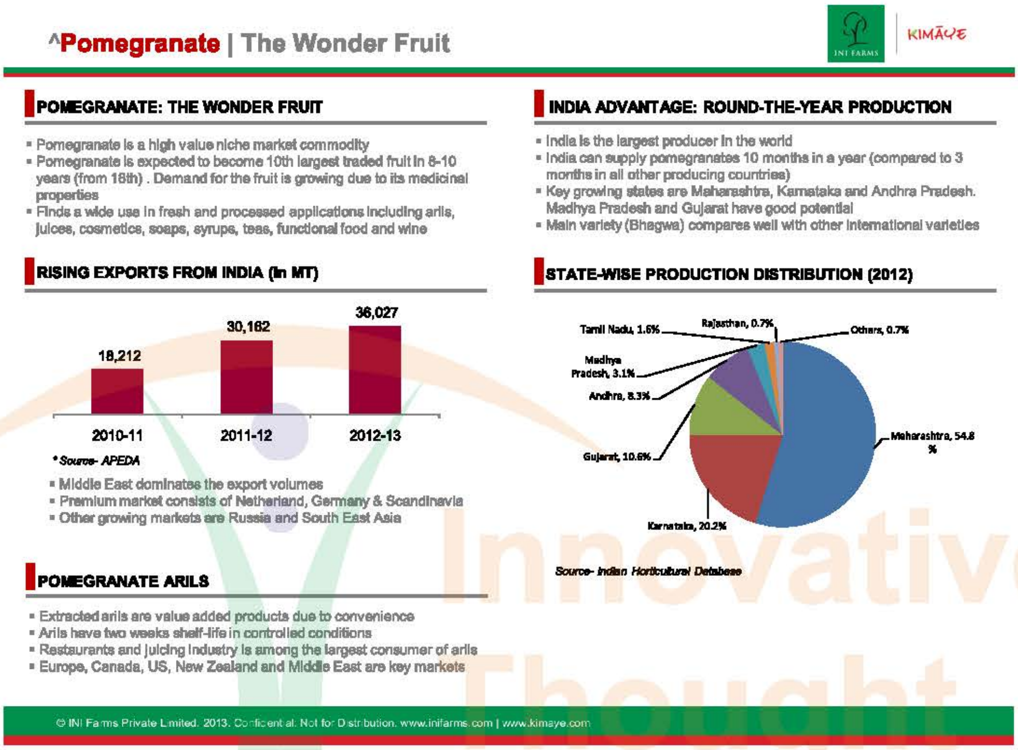
Figure1 also gives the breakup of various fruits and production amongst various states of the Indian Republic. Banana and Mango are the dominant fruit crops in India; Maharashtra and Andhra Pradesh being the leaders amongst States. Looking at the growth patterns of horticulture crop in India, it is noted that it is almost 9%. The reason is the great diversity of India's agro climatic zones making growth of a variety of horticulture crops possible. Horticulture accounts for 30%

of India's agriculture GDP from 8.5% of cropped area. However, horticulture projects are capital intensive, have higher gestation periods and need costly inputs. One of the major barriers to horticulture growth is access to funding at critical times. I will like to demonstrate the success of horticulture by taking the case study of two products, namely, Pomegranate and Banana.

2. Pomegranate: The Wonder Fruit

Pomegranate is a high value niche market commodity. This is likely to become tenth largest traded fruit in eight to ten years (presently eighteenth), because its demand is growing because of the medicinal properties it possesses. It is finding increasing applications in arils, juices, cosmetics, soaps , syrup, tea and wine. India is the largest producer of pomegranate in the world. Pomegranate in India grows ten months in a year (compared to three months in all other producing countries). State wise production of pomegranate is shown in Fig. 2 with Maharashtra being the largest producer.

Fig. 3 : State wise Production of Pomegranate in india



Pomegranate exports from India have been rising , Middle East dominating the export volumes. Netherland, Germany and Scandinavia are also premium markets; other growing markets being Russia and South East Asia. Prices of pomegranate have been rising constantly because the supply is constraints. Indian pomegranate orchards produce 4-5 MT per acre as compared to 10-12 MT/acre globally. India therefore needs to improve its productivity. Demand in the internal market has widened the scope for earning high dividends from this crop. Profits up to Rupees ten lacs per acre per annum have been demonstrated by some growers. It is therefore a remunerative crop to replace subsistence farming in comparison to other fruit crops. Table 1 gives the price and production of pomegranate and other main fruits in India.

Table -1 : Ex-Farm Prices and Productivity of Indian Fruits.

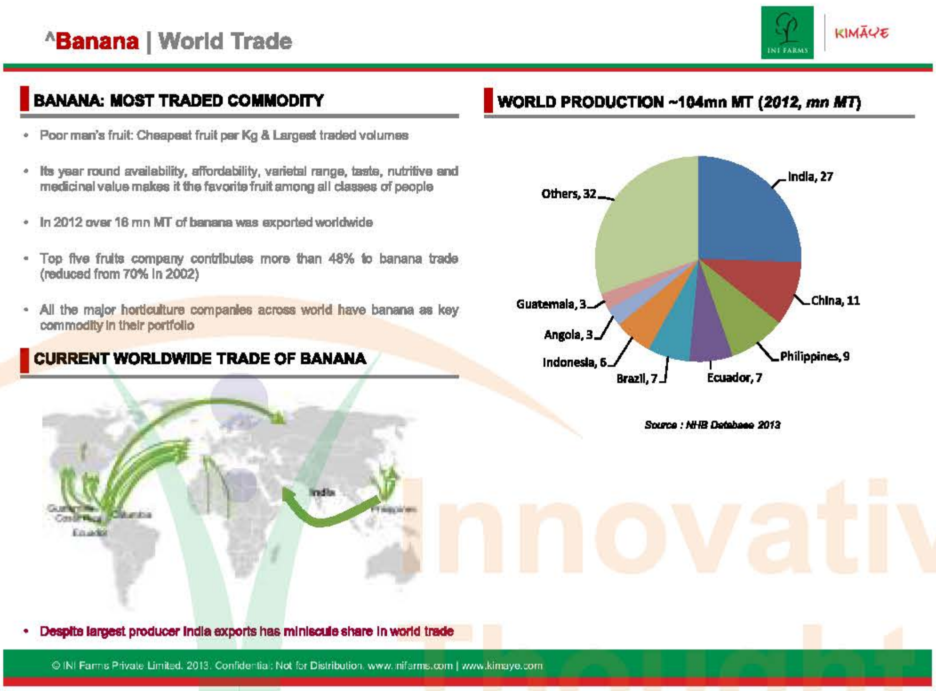
Fruit	Average price /Kg	Production/acre	Shelf life	Season
Pomegranate	Exports.Rs.80-120 Domestic Rs.50-80	4-5 tons	60-90 days	10 months
Apple	Export: N.A Domestic: Rs. 60-70	3-4 tons	60-240 days	3-4 months
Mango	Export: Rs.30 Domestic: Rs. 20	4-5 tons	21 days	4-5 months.
Banana	Export: Rs.8-14 Domestic: Rs.5-11	20-25 tons	30 days	Round the year

4. Banana: Most Traded Commodity

Banana is known as poor man's fruit with lowest prices per kg and has largest traded volumes.

Its year round availability, affordability, varietal range, taste, nutritive and medicinal value makes it favorite fruit among all classes of people. Worldwide production of banana was 104 MT in 2012 with India being the dominant producer (Fig.3).

Fig. 3: Worldwide trade of Banana and Indian Contribution



All major horticulture companies across world have banana as key commodity in their portfolio. Over the last 7 years, lot of development has taken place in Indian Banana Industry. Production and export quantities are given in Fig. 4.

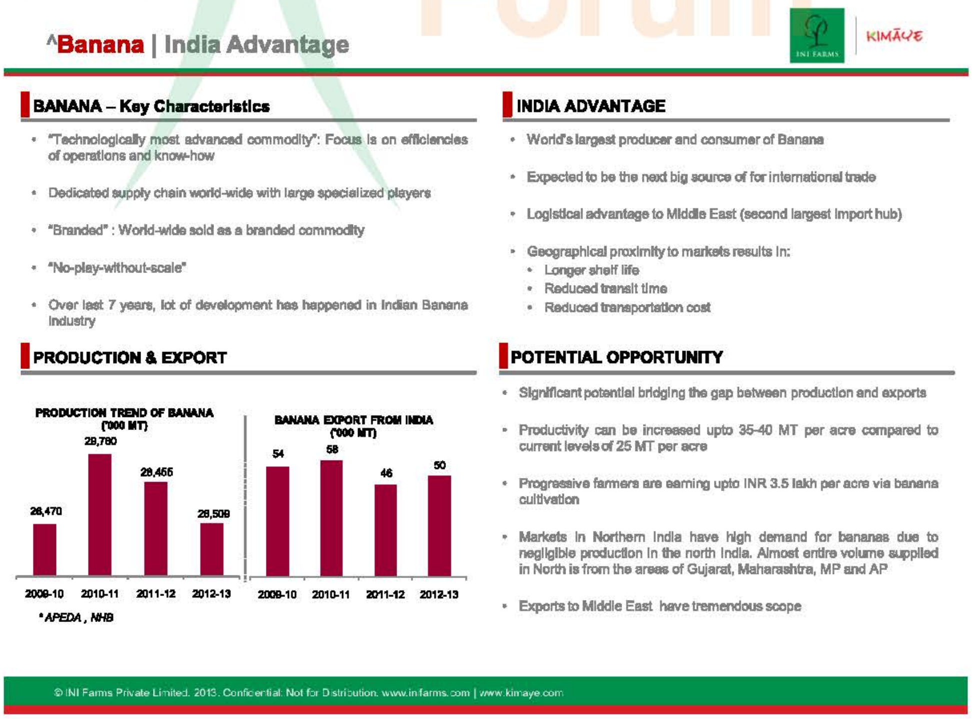


Fig. 5: Production and Export of Banana from India

There are potential opportunity for India to bridge the gap between production and exports & to increase the productivity to 35-40 MT/acre from its present value of 25 MT/acre.

5. Social Impact and Risks

Horticulture crop business has significant social impact in creating rural jobs, empowerment of local farmers, farm education, infrastructure development, demonstration benefits and environmental friendliness. This business can create jobs for unskilled and woman labour and enables market access to farmers through management support and carrying building capacity activities. It is possible to use water conservatively by drip irrigation reducing water consumption by 70% .

Success of horticulture farming business depends upon several external factors. It needs a sound infrastructure in road, transport and communication. Luckily lot of progress has been made in these sectors in the last few years. However, availability of electricity still remains a problem. This business needs right cash flows at right time making it a high risky business. One needs to invest the year round and make profits at the end of the year. Weather may also spoil your chances of earning profits. Farming therefore needs to be considered as an enterprise with the availability of cash flow and risk coverage.

Solar Power as Remunerative Crop (SPaRc).

Tushaar Shah
Senior Fellow, International Water Management Institute,
Anand-388001.

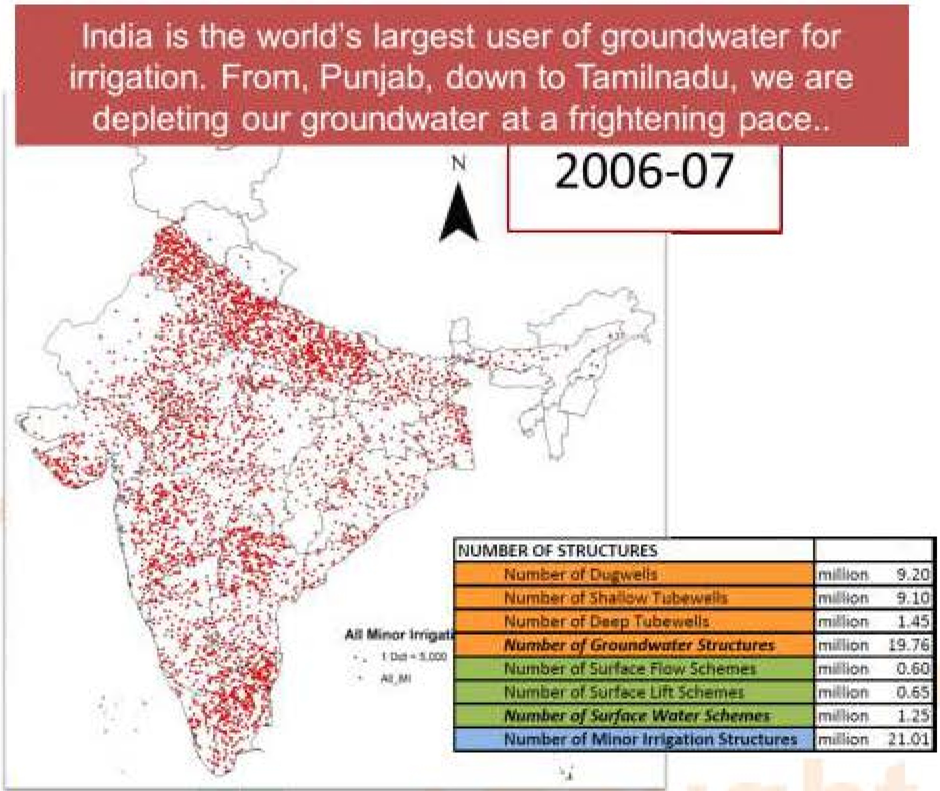
1. Introduction

The government of India's ambitious 100 GW solar capacity target for 2022 has provided a fillip to India's nascent solar economy. There are different ways of achieving this target and the path that India chooses will determine who benefits most from this growth. The conventional way is to commission MW-scale solar power plants by offering them lucrative power purchase agreements. Another alternative is to promote solar-rooftop installations for households. A third option is to provide solar irrigation pumps to farmers at a subsidy of 90 percent or more as many state governments are now doing. However, in our view, the most beneficial route for enhancing India's solar capacity is by providing solar pumps in lieu of grid-connected pumps and connecting solar-powered irrigation pumps to the grid and incentivizing farmers to evacuate surplus solar power. This option offers multiple benefits: [1] It creates an additional, climate-proof income source for millions of farmers, amounting to Rs. 40-50 thousand per year net; [2] By converting farmers from power consumers to net power sellers, it will reduce the power subsidy burden on the state; [3] By offering an opportunity cost for power, it will incentivize farmers to use power and groundwater efficiently; [4] It will reduce transmission and distribution (T&D) losses incurred by power utilities and release grid capacity to service growing domestic and industrial demand; and [5] reduce the carbon footprint of Indian agriculture. In this presentation we show that a solar pump farm cooperative leads to profitable business for farmers and saving subsidy money to the government.

2. Ground Water Situation

India is the largest user of ground water for irrigation resulting in fast depletion of water table from Punjab down to Tamilnadu. There are twenty six million irrigation wells of different depth all over the country with huge concentration in the Indo-Gangetic plains (Fig. 1). There are many pockets of ground water depletion in the north west and southern region with varying degree of overexploited to safe (Fig. 2). There is serious inequitable distribution of water and energy in the eastern and western part of the country. Eastern Indian has abundant ground water but no energy, while in western India power subsidies has resulted in overuse of ground water (Fig. 3).

Fig. 1. Water Utilization in India



NUMBER OF STRUCTURES		
Number of Dugwells	million	9.20
Number of Shallow Tubewells	million	9.10
Number of Deep Tubewells	million	1.45
Number of Groundwater Structures	million	19.76
Number of Surface Flow Schemes	million	0.60
Number of Surface Lift Schemes	million	0.65
Number of Surface Water Schemes	million	1.25
Number of Minor Irrigation Structures	million	21.01

Fig. 2: Pockets of Ground Water Depletion in India

Planning Commission of India, 20007
http://cdn.iopscience.com/images/1748-9326/4/3/035005/Full/9925403.jpg

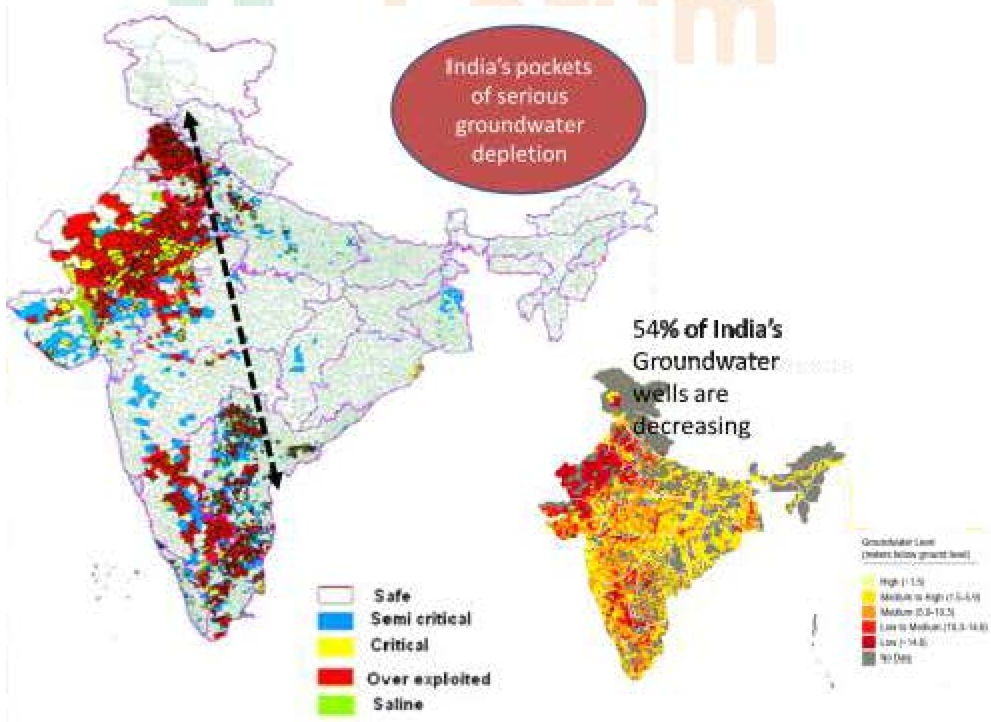
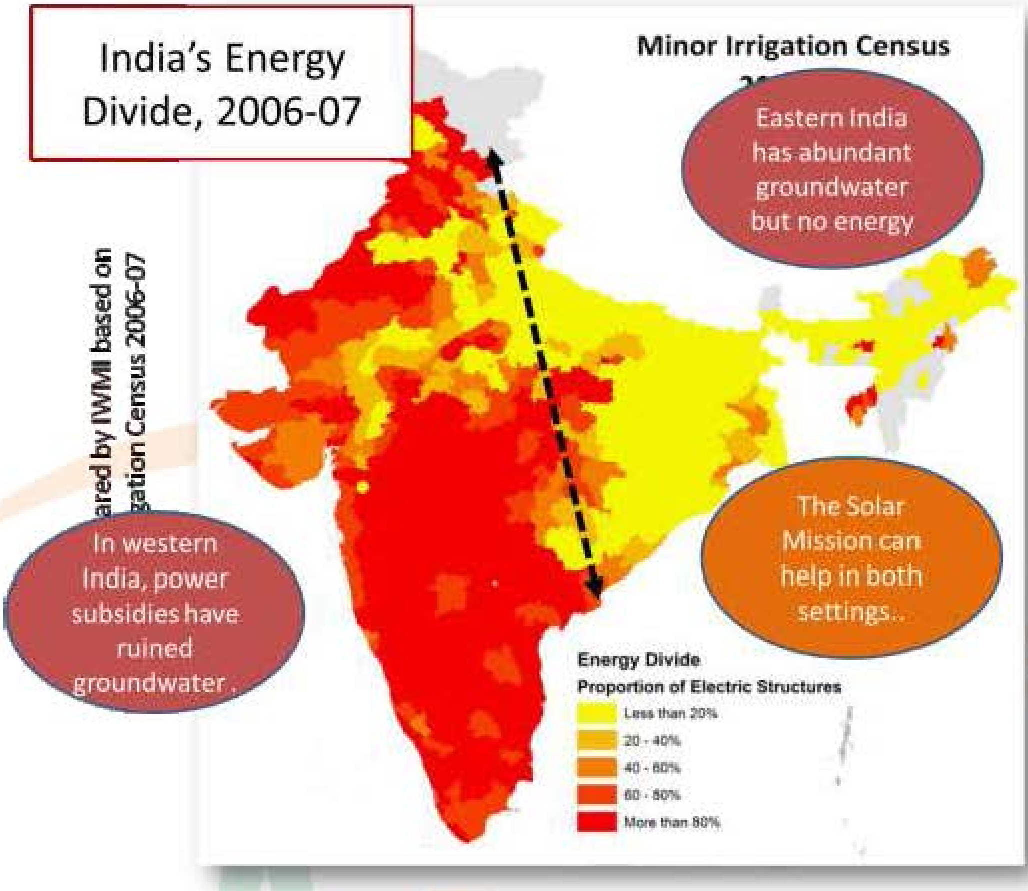


Fig. 3: India's energy Divide



3. Solar Energy for Electricity & Water Pumping.

India is blessed with abundant solar radiation with most parts receiving 50-70% more isolation compared to Europe which has gone heavily solar. 100 GW solar electricity program can be integrated with solar water pumps to promote solar irrigation economy and at the same time provide grid electricity yielding multiple social-economic and environmental dividends.

Power distribution companies in Gujarat – MGVCL, UGVCL, PGVCL and DGVCL – at present have a policy of offering solar irrigation pumps to farmers who have applied for new farm connections on the electricity grid. Under this policy, the farmer has to pay just Rs. 5000 per HP (roughly 5 per cent of the capital cost) while the distribution company (DISCOM) bears the remainder. Once a farmer is given a solar irrigation pumping system, the farmer is off the waiting list for grid connections. This saves the utility future energy subsidies that they would have to incur if the farmer was connected to the grid. The average pooled power purchase cost (APPC) in Gujarat is Rs. 3.57/kWh; of this, farmers pay less than Re. 1 and for each unit (kWh) consumed, farmers receive subsidy. By keeping a farmer off the grid, the utility saves thousands of rupees in reduced subsidy. Further, the power that the farmer does not need now can be sold to domestic and industrial consumers **SPaRC Model**

Solar power as remunerative crop model (SPaRC) is based on providing solar pump to grid connected farmers and from a co-operative of 30-40 member farmers who will agree to give up—after a two year trial period, their existing farm power connections in lieu of solar irrigation pumps; the member farmers will be connected through a mini-solar-grid through which they will pool their surplus solar power and evacuate to the Jyotigram feeder in the electricity grid at a single point metered by the DISCOM. The DISCOMs will net-meter the cooperative at that single point and offer the cooperative a feed-in-tariff of Rs. 5/kWh(lower than the tariff offered to MW-scale solar plants) for the solar power they feed into the grid. The cooperative will net meter all its members and will distribute the earnings among the member farmers based on surplus solar power evacuated by each member based on individual meters. Our contention is that farmers will turn out to be more 'efficient' solar power producers than MW-scale plants: there will be minimal T&D losses and the cooperative will have zero land footprint since farmers will use land under solar panels also for cultivating shade-loving crops. The opportunity to sell surplus solar power to the grid will encourage farmers to adopt technologies and practices that minimize groundwater pumping to maximize income. A farmer with a 10 kWp solar pump will generate around 16200 units of power; if he sells half of it to the DISCOM, he will earn a steady net income of over Rs. 40,000/year that is free from the risk of floods and droughts; requires very little labor; and needs no investments in seed, fertilizer and pesticide. A comparision of present solar pump policy and the suggested SPaRC model is given in Table 1.

Table-1: Present Solar Pump Policy vs. Solar Pump Policy

Contrasting Two Models of Solar Pump Promotion Policy

Current Solar Pump Strategy	Solar Power as Remunerative Crop (SPaRC)
capital cost subsidy of 90%+	Capital cost subsidy pegged at around Rs 40,000/kW
SIP owners will use 2500 hours/year of free day-time quality power to deplete aquifers	Solar farmers' cooperatives are grid connected, net-metered & have power purchase guarantee at ~ Rs 5/kWh
Solar pumps add to grid connected irrigation pumps	An incentive price of Rs 7/kWh to solar farmers who surrender their grid power connection.
Farmer remains net buyer of grid power	Solar coops become net sellers of power to the grid

Extending 100 GW solar electricity program through solar irrigation pumps (SIP), with a feed in tariff (FIT) OF Rs.7.5 per kwh will allow, each SIP owner an income of Rs.49680/annum and save discoms Rs.60,000 crores in power subsidies besides reducing CO_2 emissions and reducing ground water use (Fig.3).

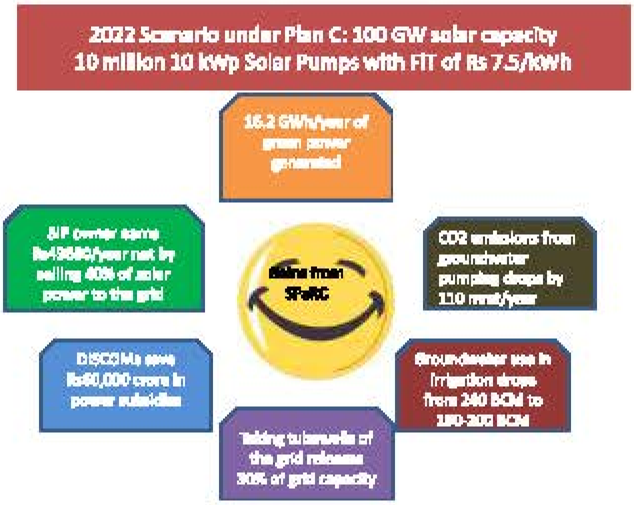
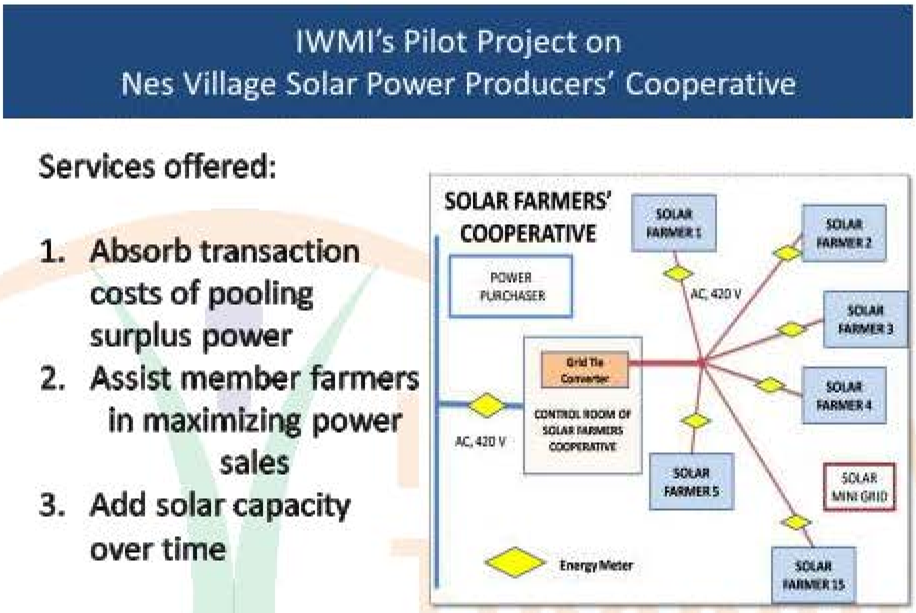


Fig.3: 2022 Scenario under JNNSM with 100 GW solar installed through Solar Pump

4. Spa RC model at Anand.

SPaRC is an initiative of the IWMI – India water policy program and Anand objective of this initiative is to develop business model for farmers to adopt solar powered irrigation systems. A pilot project of 8 kwp grid tied solar system allows the farmer to run 7.5hp irrigation pump and evacuate power to the grid at a rate of Rs.5 per kwh, when irrigation pump is not in use. IWHI has created a solar co-operative based on the following services.



Annexure: Calculations and Assumptions

1st Floor, A-7, Safal Profitaire, Corporate Road, Near Prahladnagar Garden, Ahmedabad – 380 015.

	Present Grid Power Based GW Economy	Maharashtra Model for Solarization[i] [? 6 Crore/MW]	IWMI-Tata recommended model for Gujarat [? 7 Crore/MW][ii]
Capital Subsidy per KW / kWp	? 15,000	? 30,000[iii]	? 30,000
Capital Subsidy for 1 lakh pumps or 1 GW (? Cr.)	1,500	3,000	3,000
Annual Farm Power Subsidy[iv] (? Cr.)	257	--	--
T & D losses (20%) & Maintenance (10%) (? Cr.)	118	--	--
Power Tariff for buying/selling power (? /kWh)	? 3.57 Cost of Power(APPC)	--	? 5.00 (Guaranteed buyback tariff offered to farmers)
Farmers Income & Expenditure (for a farmer with 10kWp[v] pump)			
Capital Expenditure(?)	? 1,50,000	--	? 1,00,000
	(Tatkalconnection rate; irrespective of pump size)		*(? 10,000/kWp)*
Income from Agriculture[vi]	? 95,112	? 95,112[vii]	? 95,112
Gross Income from Energy Sales	? 0	? 0	? 51,000[viii]
Gross Income	? 95,112	? 95,112	? 1,46,112
Loan payment towards Solar Pump		? 38,626	? 38,626[ix]
Net Farm Income	? 95,112	? 56,486	? 1,07,486
Groundwater Situation			
Annual groundwater withdrawal by a 7.5 HP electric pump or 10 kWp solar irrigation pump (m^3)	50,000[x]	81,000	30,000
	Aquifer depletion checked by rationing and nightly power supply	No rationing possible; aquifer depletion worsens	Farmers incentivized to conserve power (and water); aquifers improve

PLASTICULTURE

K.S Iyengar
Executive Director,
National Committee on Plasticulture, Applications in Horticulture(NCPAH),
Ministry of Agriculture, Gov. of India, New Delhi.

1. Introduction

We have been hearing about problems of agriculture in India since mooring. I will like to summarize these problems before deliberating on the subject of plasticulture. Agriculture land availability has been coming down slowly, water quantity and quality has been declining, productivity, pesticides and low yield are the problems that came into discussions. Along with these technical problems, there are problems of low education level of farmers, odd working hours and male dominating activity. Plasticultre offers solution to all these problems.

In plasticultre, large land areas are not required. In fact a farm are of 0.5 ha is ideal. Quantity of water required is very less as compared to flood irrigation and quality of water is not a big issue because one can use saline or grey water. Since one uses less water, the electricity requirement is also less and the other inputs are also used in controlled fashion keeping the cost of overall inputs on a lower side.

The main problem in its large scale adoptability is the mind set of people. It is more acceptable by people of age less than thirty five years. Since these people use latest gadgets, we have been able to link agriculture with gadgets, where the use of sensors and laptop indicates the water level in the plants. Plasticulture is well accepted in Gujarat, Rajasthan, Tamilnadu and other southern regions, but the main problem comes in its adoptability in the Eastern Indo-Gangetic plains.

2. Agriculture and Water Availability

An overview of agriculture in India, with respect to land use in provided in Table-1.

Table-1 : Agriculture Land Use In India

Item	Area
Total Geographical Area	328.7 Mha
No. of Agroclimatic Zones	15
Net Irrigated Area	65.3 Mha
Net sown Area	140.8 Mha
Gross cropped Area	195.2 Mha
Av. Operational Land Holdings	< 1 ha.

In the pre-green revolution era before 1964, the focus was on enhanced productivity of coarse grain and pulses. In the green revolution era, the agriculture area under wheat and rice was expended with the introduction of high yield varieties. In the post green revolution, the inputs of chemical fertilizer was intensified and the cultivated area for sugarcane and oilseeds etc increased. The next revolution should see commercialization through change of cropping patters towards high value crop. The critical issues with our agriculture are

-Low crop productivity (40-60%) of world average.

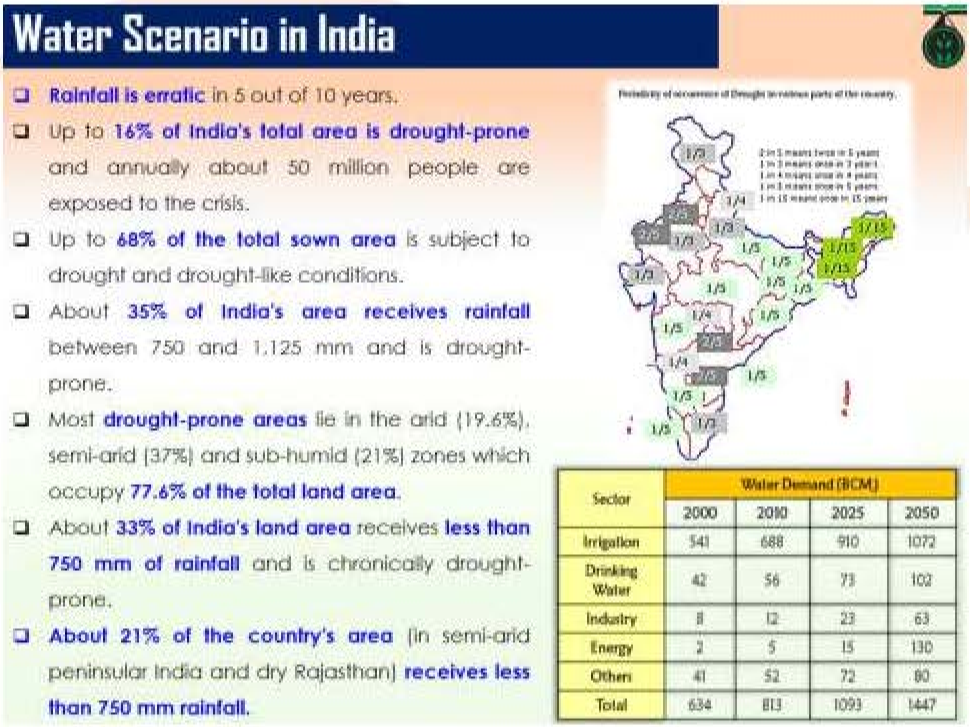
-Conventional irrigation for only 40% of the cropped area.

-High pre-and post harvest losses.

-Un-organized market network.

Due to heavy dependence on rains, agriculture in India suffers because of erratic rain fall that happens in five out ten years. 16% of our land area is drought prone and annually fifty million people are exposed to the crisis. Our most draught prone areas lie in the arid (19.6%), semi-arid (37%) and sub humid (21%) zones which occupy77.6% of the total land area. The draught in India have been periodical as shown in Fig. 1

Fig. 1 Drought probability in India



Sector	Water Demand (BCM)			
	2000	2010	2025	2050
Irrigation	541	688	910	1072
Drinking Water	42	56	73	102
Industry	8	12	23	63
Energy	2	5	15	130
Others	41	52	72	80
Total	634	813	1093	1447

In contrast to our depleting water availability, water demand in India for various purposes has been rising as shown in the table of Fig.1. Increasing population needs more food ; present consumption of 334 MT may increase to 444 MT in 2025 and to 463 MT by 2050. This may put severe constraints on water availability, which in turn put our agriculture under strain.

3. Plasticultre

Plasticulture may be termed as the most indirect input to agriculture, which is passed to transform Indian agriculture for an evergreen revolution. Major plasticulture applications are :

-Water management.

-Surface cover cultivation

-Protected cultivation

-Plant protection nets.

-Nursery management

-Organic farming

In the water management, plasticultre allows drip irrigation or sprinkler irrigation to stimulate rains. Wide ranges of mini - and micro – sprinkling systems have been developed to suit various crop types and crop patters. A water gun capable of throwing water from 50 ft height has been developed for sugar care irrigation. General advantages of plasticulture in agriculture are summarized in Table 2.

Table 2 : Advantages of Plasticulture

Advantages

S.No.	Application	Water saving (%)	Water Use Efficiency (%)	Major Advantages
1	Drip Irrigation	40 - 70	30 - 70	Can be used in unlevelled lands Saves water, fertilizers, electricity besides labour costs Controls weed growth Eliminates soil erosion
2	Sprinkler Irrigation	30 - 50	35 - 60	Reduces soil compaction Provides frost protection Saves land as no bunds are required
3	Plastic Mulching	40 - 60	15 - 20	Helps conserve soil moisture - reduces need for irrigation Maintains soil temperature, control weed growth Crop matures faster, increases yield, keeps crop clean, early fruiting Prevents soil erosion & compaction
4	Greenhouse	60 - 85	20 - 25	Manifold production - Off-season cultivation. Early maturity of crop - Better quality of produce. Controls pests & diseases
5	Shade nets	30 - 40	30 - 50	Protects plant saplings by cutting intensity of sunlight – which reduces evaporation losses Enhances yield during summer season.
6	Plastic / Low tunnel	40 - 50	20 - 30	Miniature Greenhouse - cultivation during extreme winters. Control environment - enhances nutrient uptake and photosynthetic Used for raising early & healthy nursery.
7	Farm Pond line with plastic film	100	40 - 60	Rainwater can be harvested in farm ponds/water tanks for irrigation of short duration crops. Reduction in seepage loss.

4. Water Managament with Plasticulture

India accounts for 16% of world population and 30% of livestock but only 4% of global water resources. World bank has estimated that demand of fresh water would rise to about 105 bn cu.m by 2025 against current level of 75 bn cu.m. It is therefore essentially to use and manage water resources judiciously. Plasticulture is essentially the use of plastics in water management, agriculture and allied sectors which results in the following.

a) Productivity improvement – Improvement in quality and quantity of agriculture produce.

b) Stretching the available land and water resources for agriculture production.

c) Improvements in pre and post-harvest operations.

Applications like mulch films conserve water, retain moisture by preventing evaporation and arrest weed growth resulting in significant increase in crop yield as well as savings in intercultural operations. Plastic green houses and low tonners provide favorable microclimate for crops and optimize crop yield, thus increasing crop availability throughout the year.

5. Benefits of Micro-Irrigation.

Micro-irrigation techniques such as drip irrigation not only serve to conserve water, but also result in better yield as given in Table 3 for various horticulture products.

Table 3: Water Use and Yield for Various Crops in Micro-Irrigation

Crop & Water Use Efficiency - MI

Crop	Yield / ha		Kg/m³	
	Conventional	Drip	Conventional	Drip
Sweet Orange	109	130	0.7	1.4
Guava	120	163	0.6	2.0
Papaya	1500	2000	36	73
Mango	160	200	3.2	7.9
Banana	610	680	11.8	18.6
Pomegranate	105	150	1.5	3.0
Grapes	162	200	1.0	1.9
Potato	300	400	6.8	13.4
Tomato	205	270	7.5	11.6
Chillies	185	260	6.3	11.9

Source: NARCONS

Use of lower quantity of water also saves electricity and the cost (Fig.2). Crops such as capsicum, tomato, cucumber, cabbage, strawberry, carnation, rose, gerbera etc., respond to greenhouse and shaded net cultivation positively resulting in better yields (Table 4)

Fig 2 : Benefits of Micro-Irrigation

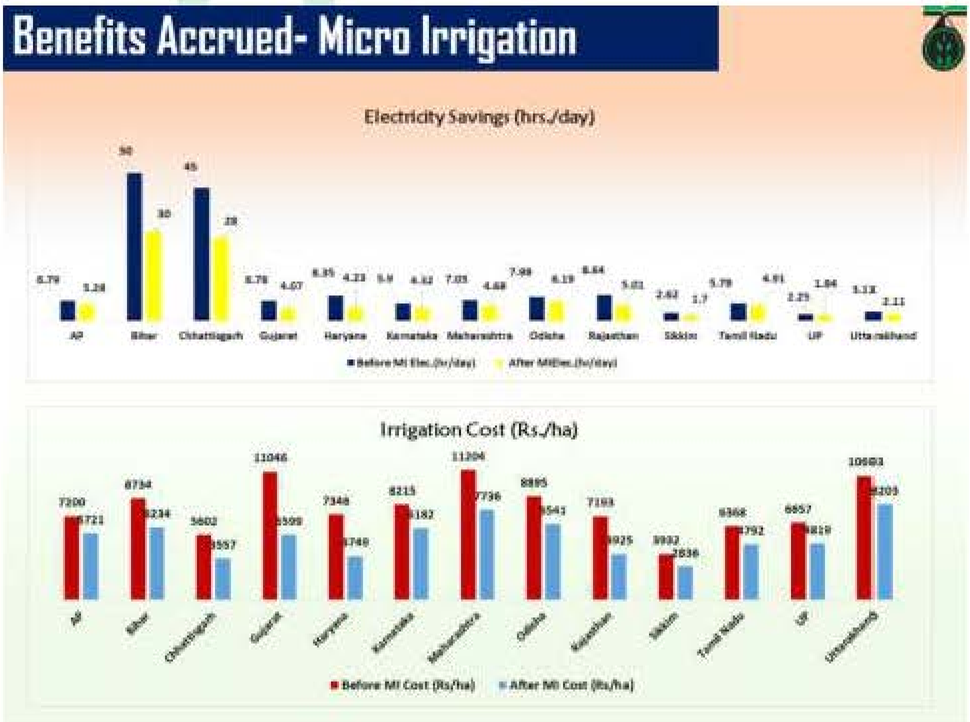


Table 4 : Crop Response to Greenhouse and Shednet Cultivation

Crop Response to Greenhouse & Shadenet Cultivation

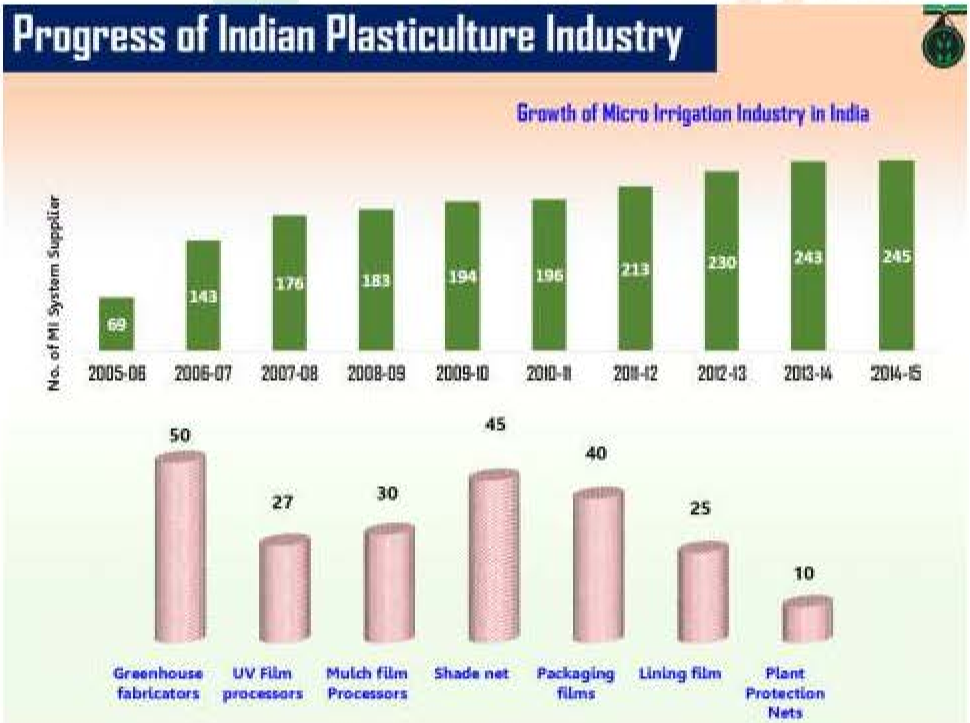
Yield (Ton/Ha)

Crop	Hi-tech GH	Naturally Ventilated GH	Shade Net	Open Field
Tomato	162	110	74	60
Capsicum	150	120	80	49
Cucumber	160	105	80	22
Spinach	120	100	50	42
Okra	28	23	12	7
Cauliflower	24	20	11	8

6. Progress of Indian Plasticulture Industry

Micro-Irrigation Industry, as well as various plastic film fabricators for various uses have grown steadily since 2005 in India. The progress has been illustrated in Fig. 3 below.

Fig 3: Progress of Indian Plasticulture Industry



In the manufacturing of plastics, additives are added to plastic used in various agriculture applications to suit different crops, growing areas, growing seasons and agro-climatic conditions. This has been summarized as follows.

Cladding Material – Protected Structures Innovation made Highly diffused IR -Suitable for hot growing areas with high radiation during daytime & cold nights. -Protects the canopy of the plant from high temperature. -Provides light interception to the lower region of the plant	Banana Bunch Covers Innovation made Insecticide additives. -Better quality of produce. -Disease free -Protection against harmful insects. -Enhanced self-life produce. Better market price.	Plastic Mulch Film-UV in Silver Mulch film Innovation made UV-stabilizers -Acts as insect repellent. -Heavy chemical environment (sulphur) also damages UV radiation. -Aluminium paste in Silver pigment. -Superior to other UV stabilizers. -Especially designed for harmful chemical environment.

Mandate of the National committee on Plasticulture Applications in agriculture is:

- Co-ordinate in promotion of horticulture /agriculture development through use of plastics in agriculture.
- Suggest ways and means for effective implementation of centrally sponsored schemes.
- Suggest suitable strategies in development of quality standards for products use in plasticulture
- Recommend suitable policy measures for promotion of plasticulture in the country.
- Facilitate increased adoption of various plasticulture applications.
- Facilitate innovative R&D.
- Supervise and monitor effectively the performance of Precision Farming Development centres (D=DCS)

7. Success Stories.

There are several success stories of plasticculture applications using various micro-irrigation schemes depicted below quantifying the benefits.

Success Story -Sugarcane

1	Name of Farmer	D.V. Krishna Rao
2	Village	Alajangi
3	Mandal	Bobbili
4	District	Vizianagaram (AP)
5	Contact Number	9440365899
6	Area (ha)	1.0
7	System Cost (Rs)	56848
8	Annual Fixed Cost (Rs)	9266
10	Operator Charges (Rs)	3750
10	Repairs & Maintenance (Rs)	927
11	Total Annual Cost of MI System (Rs) [8+9+10]	13943
12	Cost of Cultivation (Rs)	15563
13	Total Expenditure (Rs)	29506
14	Yield (Tons)	100
15	Market Value (Rs/ton)	900
16	Gross Income (Rs)	90000
17	Net Return (Rs)	60495
18	Addl. Income due to MI System	33750
19	Pay back period (yr) [7/18]	2

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Success Story- Banana

1	Name of Farmer	A.K. Parandhama
2	Village	Lingayapalem
3	Mandal	Thulluru
4	District	Guntur (AP)
5	Contact Number	9885523344
6	Area (ha)	1.21
7	System Cost (Rs)	71,130
8	Annual Fixed Cost (Rs)	11,594
9	Operator Charges (Rs)	3,750
10	Repairs & Maintenance (Rs)	1,159
11	Total Annual Cost of MI System (Rs) [8+9+10]	16,504
12	Cost of Cultivation (Rs)	57,500
13	Total Expenditure (Rs)	74,004
14	Yield (quintals)	625
15	Market Value (Rs/quintal)	300
16	Gross Income (Rs)	1,87,500
17	Net Return (Rs)	1,13,496
18	Addl. Income due to MI System	37,500
19	Pay back period (yr) [7/18]	2

SUCCESS STORY – VEGETABLES

Sl. No.	ITEM	Particulars	
1	Name of the Farmer	**Pesaragoni Laxmamma**	
2	Village	Dandempally	
3	Mandal	Nalgonda	
4	District	Nalgonda	
5	Crop	Bitter gourd & Ridge gourd	
6	Area in Ha.	0.83 Ha	
7	Type of MI System	Drip – Inline	
8	Subsidy received	Rs.73,778/-	
9	Contact No.		
	Subject	**With Conventional Irrigation**	**With Drip Irrigation**
10	Yield (per Ac)	5 T	10 T
11	Total Expenditure (per Ac)	Rs.30,000/-	Rs.30,000/-
12	Sale price (per T)	Rs.10,000/-	Rs.10,000/-
13	Total value of the crop (per Ac)	Rs.50,000/-	Rs.1,00,000/-
14	Net Income (per Ac)	Rs.20,000/-	Rs.70,000/-
15	Additional income with Micro Irrigation (per Ac)	--	Rs.50,000/-

8. Conclusions

Economics and usefulness of plastic usage is inevitable in horticulture and agriculture. Plasticulture helps to enhance capacities and competition to drive growth and its increased adoption. As a result of higher yield, better quality, water savings and innovative packaging, the losses are reduced and production cost decreases. Plasticulture provides an emerging agro-base with higher value addition and growth potential. Because of food security, growing population and shrinking agriculture land, plasticulture is a necessity rather than an option.

Water Resource Planning and Utilization for Agriculture Growth: Gujarat way.

M.S Patel,
Former Member Secretary,
Water Management Board,
Govt. of Gujarat, Gandhinagar.

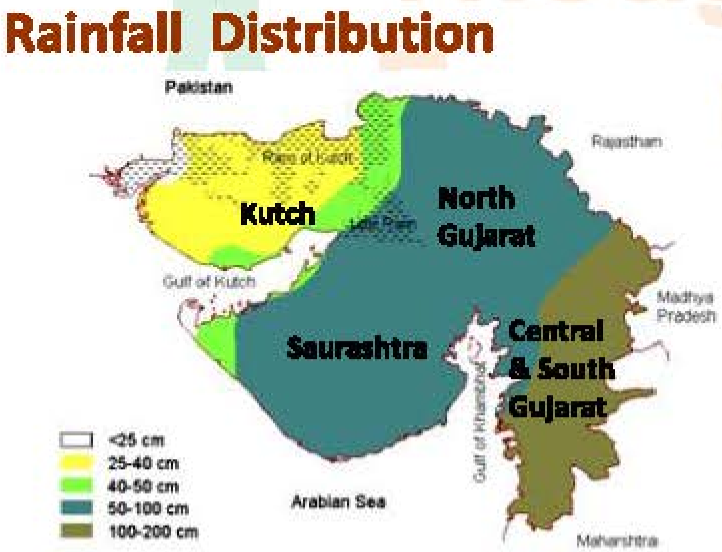
1. Introduction

Gujarat state has land area of 196024 Sq. Km, that is 6.4% of India and has 5% (60.3 million) of Indian population, but its surface water availability is only 38000 MCM, which is only 2% of India's surface water. In terms of water availability, it is therefore only next to Rajasthan, which possesses only 1% of India's water resources. However, Gujarat is the only Indian state that has basin wise planning's. Through interconnection of various river basins, ponds and canals, Gujarat has the distinction of achieving drinking water supply to all the villages. This presentation describes the water resources planning and implementation in the state of Gujarat that may serve as model to the country.

2. Water Availability in Gujarat.

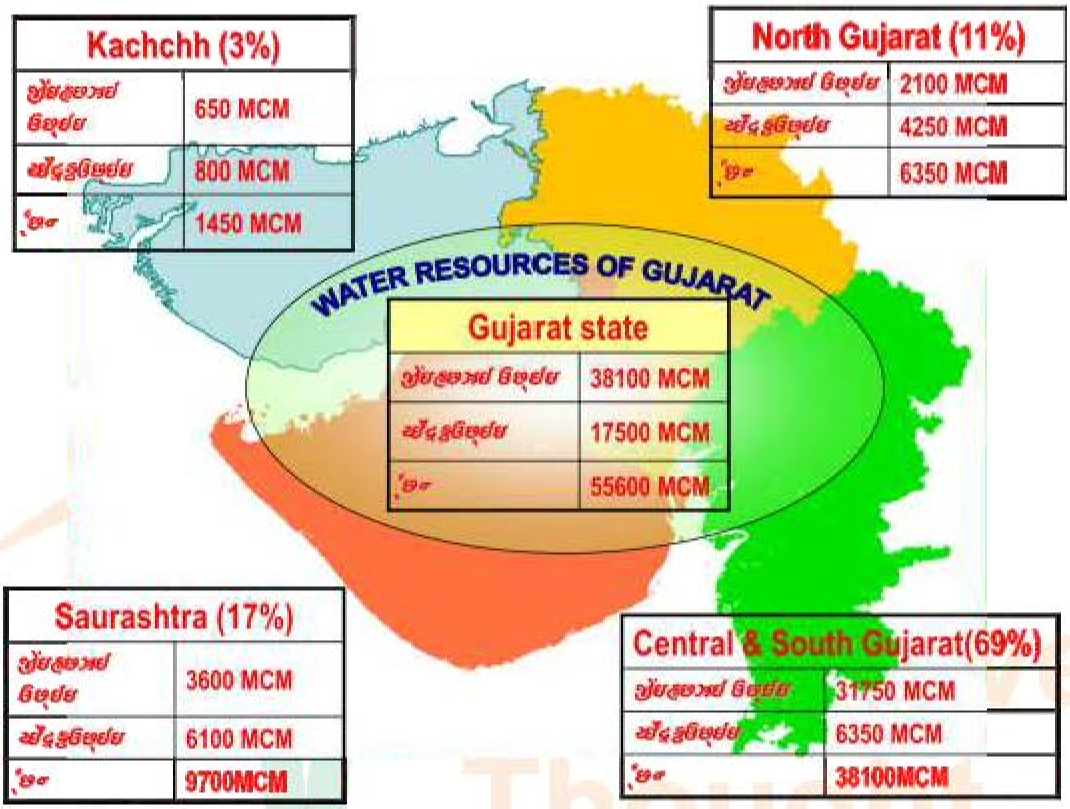
Rainfall in Gujarat is highly non-uniform with central and south Gujarat receiving most rainfall (Fig. 1), the western part, namely Kutch receiving only scanty rains. In a monsoon period of about 4 months, actual rain days are only twenty seven and by hours only thirty. Availability of surface and ground water in Gujarat and four regions are given in Fig.2.

Fig.1: Rainfall Distribution in Gujara



Gujarat	80 -200 cm
Saurashtra	40 - 80 cm
Kachchh	< 40 cm

Fig. 2 Availability of Surface and Groundwater in Gujaratt



It is noted that per capita water availability in Gujarat is less than half of the India's average (Table 1.)

Table 1: Per Capita Availability of Water in India and Gujarat

Per Capita Water Availability in India & Gujarat

Year	INDIA		GUJARAT	
	Population (Million)	Available Water (m³ / annum)	Population (Million)	Available Water (m³ / annum)
1961	439.2	4467	20.63	2468
1981	683.33	2858	34.08	1470
2001	1027.02	1901	50.60	990*
2015	1245.83	1567	67.83	738*
2025	1402.13	1393	83.34	601*

Low water availability impacts life constraints in several ways that are summarized in Table2.

Table2: Impacts of Low water Availability on Human Life

Impact of Low per Capita Availability of Water (M.Falkenmark)

Below 1700 m^3 per capita	Local shortages of water
Below 1000 m^3 per capita	Water supply begins to hamper health, economy growth and human well being
Below 500 m^3 per capita	Water availability becomes a primary constraint to life

3. Water Resource Planning.

Surface water storage capacity in Gujarat is 26287 MCM against an availability of 38100 MCM; 11813 MCM surface water runs to the sea. Total gross storage capacity is provided by 18 major irrigation projects; large Sardar Sarovar Dam on Narmada, 70 medium irrigation and 1041 minor irrigation canals. In spite of this 58 lac hectare of agriculture area in Gujarat is rain fed. The distribution of cultivable area and various water resources is given in table 3

Table 2 : Irrigation Area in Gujarat

Irrigation facility in Gujarat

	Area in Lac ha
Total geographical area	196
Cultivable area	126
Rain fed area	58
Surface water irrigation	17.77
Sardar Sarovar Project	17.92
Minor irrigation	4.95
Check dam	6.15
Ground water irrigation	20.00

The important challenges that came in way of water resource management in Gujarat or India are :

- Scarce water resources.
- Unequal distribution of water resources.
- Droughts & drinking water scarcity.
- Overexploitation of ground water.

- Salinity.
- River pollution due to untreated industrial effluents & sewerage.
- Water logging.
- Floods and cyclones.

The solution lies in adequate water resource planning & management with people's participation, interlinking of rivers and dams, rainwater harvesting and recharge of groundwater resources and ground water. Gujarat is the first state in the country that has carried out basin wise planning of water resource with help of M/s. Tahal Consultants Israel. As per this study, except three river basins all other river basins are deficit in water resources. Gujarat published a white paper on water resources planning and management with the help of IRMA and thereafter periodically upgraded water resources. Due to rigorous and continuous persuasions and implementation of various projects, there is no scarcity of drinking water in the state today. Also Gujarat has achieved the highest agriculture growth in the country in the last decade.

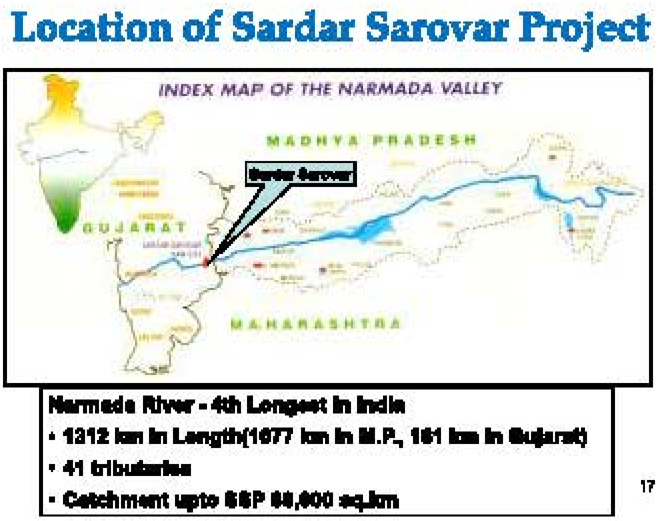
After completion of presently ongoing projects like Sardar Sarovar, Sauni, Sujalam Suphlam and Kalpasar and Damanganga – Sabarmati link projects etc, there will be assured enhanced agriculture growth with fulfillment of all domestic and industrial water requirements in the state.

4. Sardar Sarovar (Narmada) Project.

Rightly said to be the life line of Gujarat, Sardar Sarovar has command area of 18 lakh hectare that include 15 districts, 3112 villages and 74626 km length of canal net work. Narmada river is the fourth longest river in India with 1312 km length and has 41 tributaries (Fig. 3). Planned benefits of Sardar Sarovar project are :

- Irrigation water for 17.92 lakh hectare agriculture land.
- Drinking water for 9633 villages and 131 urban centres.
- 87 lakh tonne agriculture production per annum.
- Hydropower of 1450 MW installed capacity producing 100 crore unit per year
- Flood protection to 30,000 hectare

Fig.3: Location of Sardar Sarovar Project



5. Success story of Interlinking Rivers

Gujarat is adopting an innovative approach of interlinking rivers and create an inter basin transfer. In order to take care of seasonal flood waters, Sujalam Suphelam canal system has been created parallel to Narmada main canal. This canal has been built to divert surplus water from Kadana project (Fig. 4) and Narmada For augmenting water resources in water deficit and over –explained areas. Sujalam Suphalam is a 330 km long unlined canal passing through 7 districts through gravity. It starts from Kadana, major irrigation project at an elevation of 385m and it crosses 21 rivers through its coast and has a capacity of 2000 cusec. The canal has helped to recharge ground water to the extent of 3 to 5m long its path and irrigates more than 70,000 hectare of agriculture land. It is planned to connect Narmada main canal and Sujalam Suphalam canal through pipe line to provide water to various regions. (Fig. 5)

Fig. 4 : Sujalam Suphalam Canal

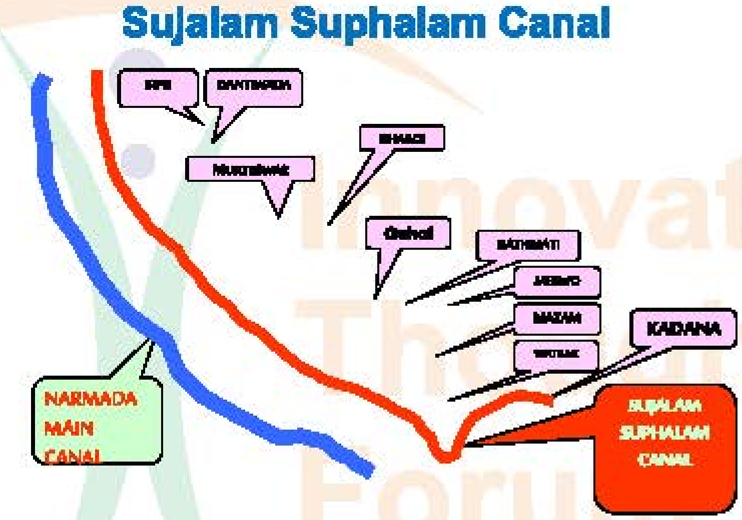
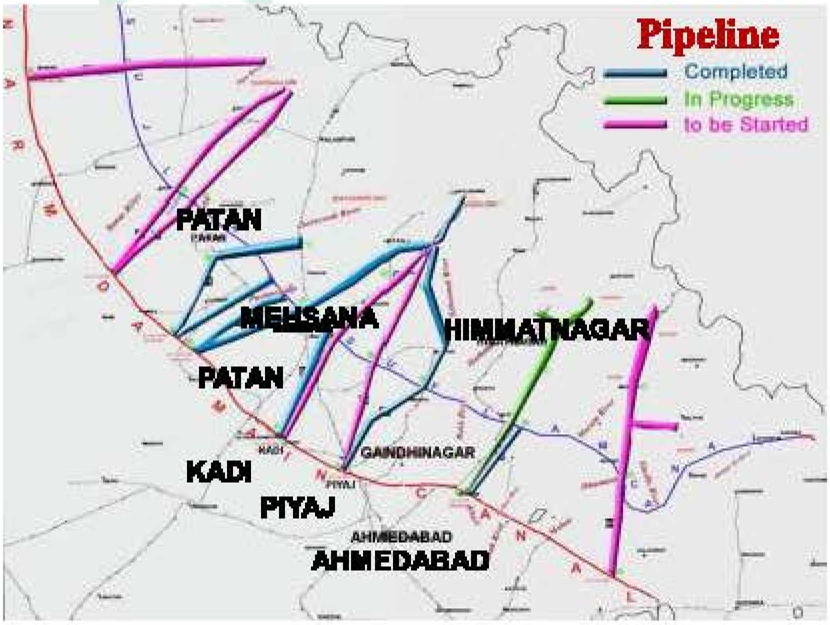


Fig. 5 : Location pf Pipe Lines connecting Narmada Main Canal and Sujalam Suphalam Canal



Gujarat has 1600 km long coastal line of which 765 km length lies in Saurashtra region. There are 71 rivers in Saurashtra, most ending into Arabian Sea. There are 40 tidal bandhras constructed to act as barrier to prevent sea tides. River flood water is transferred from one bandhra to the next by constructing spreading channels that divert water from one river to another. Presently 200 km long spreading channels interlinks 30 rivers near sea.

Narmada main canal is 460 km long and has a capacity of 40,000 cusec water. It is a contour canal starting from Sardar Sarovar and ending at Rajasthan border. It crosses 17 en route rivers along its path. Through Sulalam Suphalam project, Narmada main canal is linked to Saraswati river. All village ponds in command areas are connected with canal net work. All major canals have been provided escapes at each river/nala crossing and release flood water trough canal escape to river.

5. Other water harvesting structures

In the vision to provide enough water for irrigation and drinking, Gujarat has aggressively worked on constructing check dams, farm ponds, bori-bunds and ponds. Number of these facilities already available to people are

Check dams - 1,59,730
Farm ponds - 2,61,785
Bori bundhs - 1,22,035
Ponds - 24,497

All these structure have impacted the ground water levels in a positive fashion besides providing the necessary irrigation and drinking water. Gujarat is dedicted to provide drinking water to all by a strategy driven by

- Inter-basin transfer of water from surplus area to water scarce area.
- Narmada water to 9633 villages and 131 towns of Saurashtra, Kachch, North Gujarat and Panchmahal areas.
- Irrigation reservoir canal to central and south Gujarat.
- Mini-water supply schemes, hand pumps & recharging structures in Easter tribal belt.

6. Kalpasar Project: A Game changer.

A visionary project has been envisaged to create world's largest fresh water reservoir at sea to store state's 25% average annual surface water resources by constructing 30km long dam across the Gulf of Khambat. This reservoir will store 10500 MCM of surface water.(Fig.6).

Fig. 6 : Kalpasar Project at Gulf of Khambat

The salient features of this envisaged project are

Salient features (Tentative)

1.	Construction of Dam	
	Length of dam (in sea)	30 km
	Top width of dam	100m wide, 12 lane road + railway
2.	Fresh Water Reservoir :	
	(i) Reservoir spread	2000 sq.km
	(ii) Live Storage	10500 mcm
	(iii) Full Reservoir Level (FRL)	(+) 3.0m
	(iv) Maximum Water Level (MWL)	(+) 5.0m
	(v) Minimum Draw Down Level (MDDL)	(-) 4.0m
3.	Bhadbhut Barrage and Narmada Diversion Canal	
	(i) Barrage including earthen dykes	10 km
	(ii) Narmada Diversion Canal	
	Discharge	1,00,000 cusecs
	Length	34 km

4.	Irrigation command			
	(i) Water envisaged for irrigation	6500 NCM		
	(ii) Water conveyance through three garland canals, lifting water 11 pumping stations			
		Level	Discharge (cusec)	Length (km)
		100m	8000	647
		80m	6300	348
		60m	2700	151
	(iii) Irrigation	10.54 lakh ha in 39 talukas of 6 districts of Saurashtra region will get irrigation facilities including rejuvenation of rivers and filling of more than 60 existing dams as well as check dams, tidal regulators, spreading channels permanently.		
5.	Life of Reservoir	400 to 500 years		
6.	Ground water improvement in periphery of reservoir: 7.0 lakh ha			

8.	Extra land to be recovered	1.5 lakh ha to 2 lakh ha
9.	Reduction in distance	
	Bhavnagar – South Gujarat	136 km
10.	Ports: Bhavnagar port (will be revived), Dahej port (to remain out of reservoir), New ports are proposed at downstream of reservoir.	
11.	Rivers debouching in the reservoir : Sabarmati, Mahi, Dhadhar, Narmada (through diversion canal), Limbadi Bhogavo, Sukhbhadar, Utavali, Keri, Vagad, Kalubhar, Rangholi, Ghelo & Maleshree	
12.	Construction period for dam	5 to 7 years

The project will enable a land of 2000 sq.km out of sea and may become a hub of a smart city in future.

Kalpasar Dam

Agriculture, Technology, Markets and the (missing) Link: A Dutch Perspective

Robert Ossevoot
WAGENINUENDUR, Netherlands.

1. Introduction

Netherlands, by area is less than the state of Punjab but it is the second largest exporter of agri-food products after the USA. The country is number one producer of onions and also exports 25% of the world's tomatoes. Agi-food sector is one of the main drivers of Dutch economy adding €52.2 billion to Dutch GDP and providing employment to 6,60,000 people. Dutch agriculture entrepreneurs are front runners in efficient and sustainable production systems and processes resulting in five time higher productivity than the European average. Farmers in Netherlands have small farms ranging from 2 ha to 25 ha and are characterized by large yields. The success of Dutch farming system is the result of sound R&D and establishment of required logistic system to connect production to market covering all aspects of supply chain. Indian agro system may be able to learn from the system in Netherlands and improve yield as well as profits both.

2. Food Valley Region

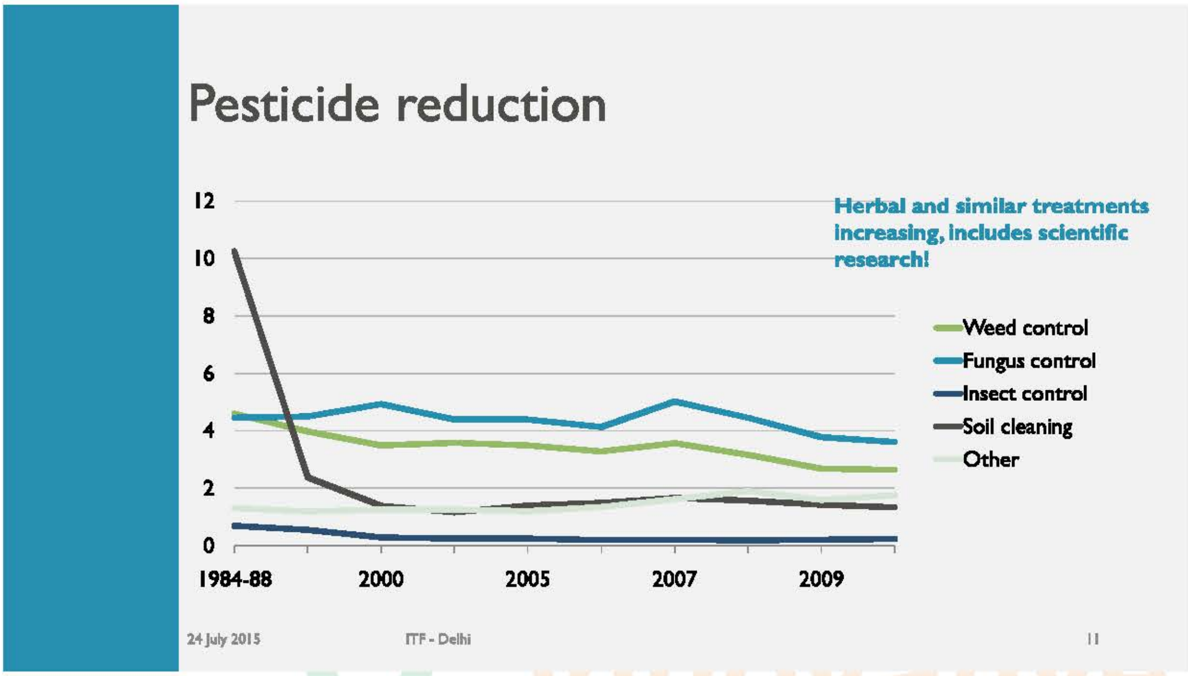
Important R&D players like Wageningen UR, TI Food Nutrition, Food & Nutrition Delta, TNO Innovation for life, NITO and Universities have converted Netherland in to a food valley region like silicon valley in the US; the region being the most authoritative food centers of the world. (Fig. 1).

Fig.1: Food Valley of Netherlands

3. Innovations in Agri-production

Using appropriate technology and farming skills, it is possible to feed the growing population of the world. Greenhouses, in Netherlands, are able to produce 80kg/m2per annum agro-food products. The greenhouses are not energy produces, use biological pest control and are able to produce food round the year. The indoor environment is controlled and the farmers observe high food safety standards. The pesticide quantities in the agriculture have been reduced considerably and herbal & similar treatments are on the increase (Fig. 2)

Fig. 2: Pesticide Reduction in Agriculture in Netherlands



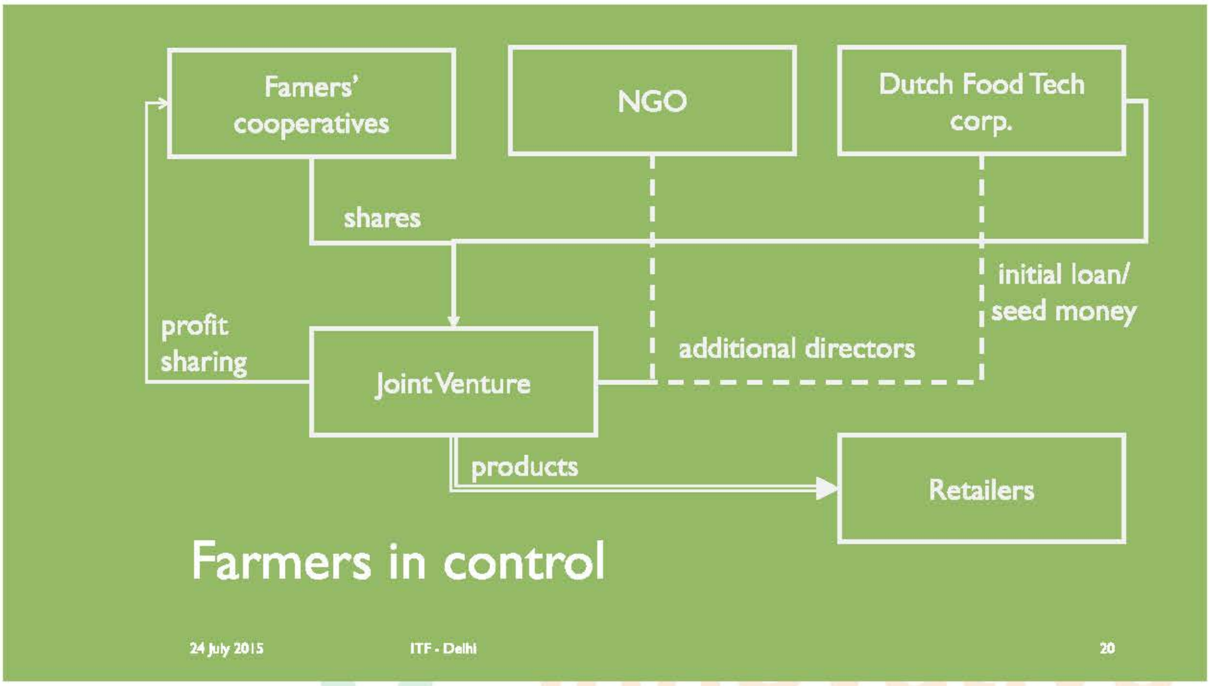
In order to create control photosynthesis process, LED's are being used in the greenhouses in three distinct spectral region, namely, Red, Blue and far Infra-Red. Using hydrophonic techniques, 90% of water is being conserved. In the experimental farms in Netherlands, water evaporating from plant surface is harvested and reused. Apart from desired light, the nutrients needed by plant are added to water and limited quantity of that water is released to feed the plant, left over water is re-used again.

Use of appropriate sensors and adequate software allows farmer to interact with plant growth and various inputs like water levels in the plant soil are monitored on line. The sensors are usually inexpensive and last long.

4. The missing Link

Agriculture needs logistics and business models for financial gains. In India, it is estimated that 30-40% food is wasted in the supply chain. In Europe also, the wastage is of the same order. However, there it is at consumer level, which is difficult to control. In India, it is at the distribution level that can be managed. As an example, farmer's co-operatives have been established in Uttarakhand with the help of NGO and a Dutch company that wanted to sell cold storages to the farmers. A joint venture has been established between farmers co-operative and Dutch Food Tech Corporation, who provided seed money and easy loans. Farmer's co-operative has 100% shares. The product, namely apples, are sold directly to retailers cutting out the middle commission agent. Profits earned are used to pay the loans partially.

Fig.3: Model of Farmer's Cooperative in Uttrakhand



The number of farmers in the co-operative has increased from 500 in 2007 to 4000 in 2014 and the model is being extended to other places and regions. Agro logistics is a crucial enabler and its success depends upon, Governance, Regulatory frame work, Investments (Public and private), Infrastructure and Innovation (technologies and new processes).

Evergreen and Sustinable Agricultre.

Dilnavaz Variava

1. Introduction.

Sustainable agriculture aims to improve soil health with farm waste and manure. It also improves water use, retention and protection. Based on multi-crop principles, it reduces energy use, reduce greenhouse gas emissions. Sustainable agriculture also encourages innovation by millions of farmers and it is based on self reliance for inputs, skills and not capital or loans. Organic farming is key to evergreen and sustainable agriculture. In the absence of chemical pesticides, organic farming protects pollinators, who in turn protect yields that benefit:

-75% of leading crops.

-35% of global food volume

-224 foods that depend on Pollinators.

Destruction of pollinators could lead to :

-$ 150 billion in yield.

-deficiency in Vitamin A for 71 million people

-deficiency in foliates for 173 n=million people

Organic farming, therefore, is key to improve economics of the farmer and necessary for sustainable agriculture.

2. Organic Farming for Agro-ecology:

In an International Assessment of Agriculture Science and Technology for Development conducted by over 400 scientists from over fifty counties, the conclusion has been that agro-ecology done by small farmers is the best approach for removing hunger, poverty and inequity. India accepted the IAASTD report in 2008, but has not implemented it yet seriously. Mr. Oliver D-Schutter, special rapporteur on Right to Food, FAQ in 2011 concluded that 289 agro-ecology projects in fifty seven countries increased productivity by seventy nine percent. Agro-ecology has been found to be best suited for :

-Raising productivity sustainably.

-Reducing rural poverty.

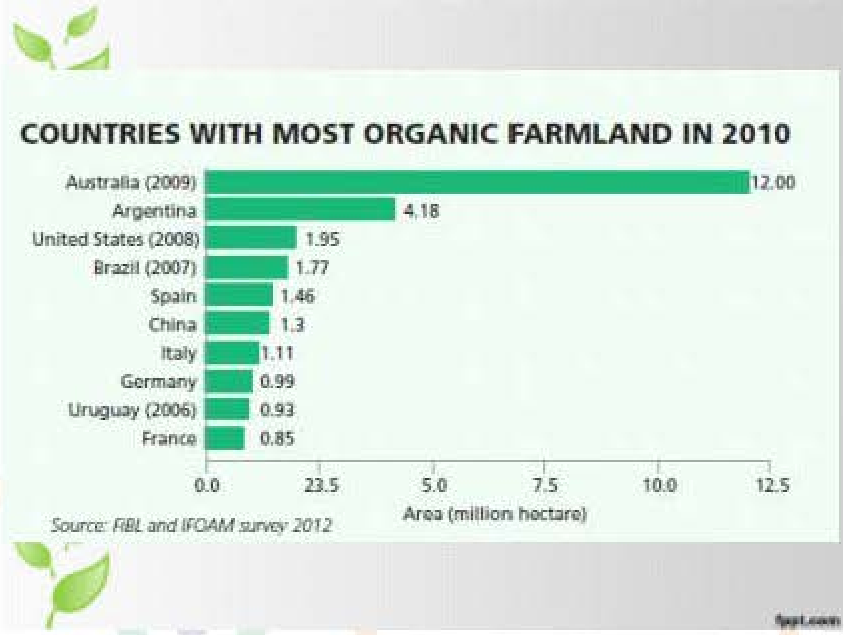
-Improving nutrition.

-Helping to adapt to climate change.

-Reducing debt and risk

Many countries are practicing organic farming, occupying sizeable farm area as shown in Fig. 1.

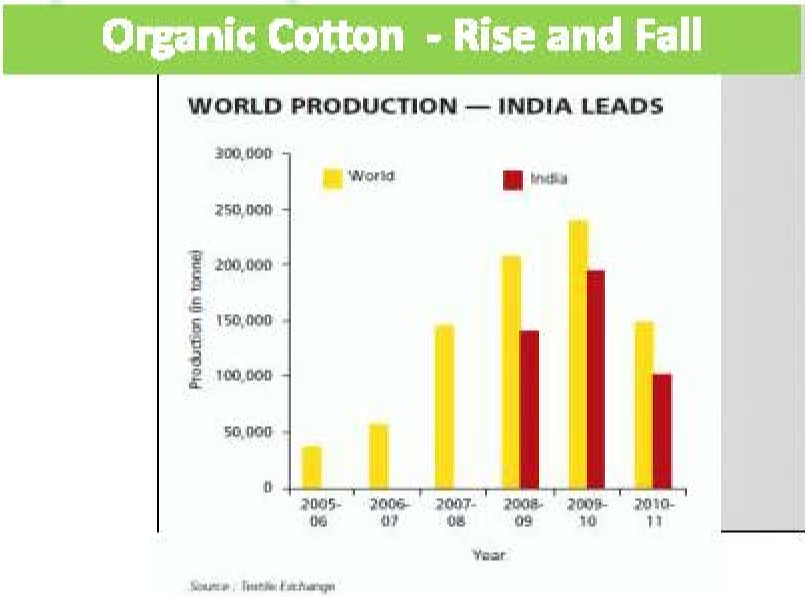
Fig. 1 : Countries with Most Organic Farm land



An ASSOCHAM study on organic farming in Madhya Pradesh concluded that practiced over five years , the organic farming would result in wealth accumulation of rupees twenty three thousand crores, exports worth rupees six hundred crores and provide employment to six million people . For West Bengal, ASSOCHAM estimated that organic farming over five years would increase farmers' income by 250%, result in export of rupees 505 billion and wealth accumulation of rupees 120 billion. This will also provide employment to 2 million people, because organic farming uses thirty percent more labour.

Another success story of organic farming where India leads is cotton . Fig.2 provides India's share of organic cotton in the world.

Fig. 2 ; World Production of organic Cotton and India's Contribution



3. **Indian studies on Organic.**

In a network project of Indian council of Agriculture Research, it was distinctly concluded that 21 crops out of 28 showed increase in the yield. The results for some district crops are :

- over 20% increase in okra, turmeric, cotton, carrot, black pepper and cowpea
- 10-20% increase in onion, ginger, dolichos bean.
- 5-10% increase in maize, soybean, berseem, brinjal, chilli, capsicum, tomato, sorghum & peas.

In a model organic farming at CAZRI Jodhpur, yield of legumes was found to increase by 25% - 30% after three years. In addition soil moisture retention was higher, soil organic carbon increased and the fauna diversity also benefitted by more than 42%.

Abstract of all these studies and other 350 students have been completed by Kavitha Kuruganthi (www.kisannwaraji.in) with the title "Ecological Agriculture in India".

4. **Biological Pest control & Organic Farming in India.**

In the world's largest non-pesticidal management & community managed sustainable agriculture project in 10000 villages and by one million farmers in A.P and Telengana, traditional pest control method have been used in place chemicals. As a result, farmers saved money helping them to reclaim land from moneylenders. The project has been successful in a joint co-operation of state government, World Bank and NGO. India has an opportunity for organic farming because the demand is growing at an estimated rate of 25% per annum. This is a "Make in India" opportunity for $104 billion global market and can employ millions of Indian people. India, as known, is already the largest exporter of organic soya to the US. Actions that are required to upscale organic farming are :

- Incentivize organic and non pesticide management (NPM) FARMERS.
- Free government certification for organic and NPM.
- Make organic seeds available for village seed banks.
- Facilitate market infrastructure & premiums to farmers.
- 50% government research participatory with successful farmers to understand and disseminate.
- Stop promoting chemicals in agriculture and GM crops.

5. **GM a disaster for India.**

There are some popular beliefs in the society like Technology is superior ecology, GM is the most advance and superior technology, soil is medium for chemical inputs, damaging nature has no serious consequences & corporate are more competent than farmers. However, GM and organic can't exist together. The GM path in any crop is irreversible and therefore India needs to assess disadvantages and various direct and indirect t costs of the GM. There are several studies on hazards of GM crops and the US department of Agriculture reported in 2014.

"Over the first 15 years of commercial use, GE seeds have not shown to increase yield potential of the varieties. In fact the yields of herbicide – tolerant (HT) or insect resistant seeds may be occasionally lower than yields of conventional varieties ".

We should remember that GM eventually transfers control to large MNCs not farmers. Organic is safe, non-contaminating and evergreen in yields.

Innovative Thought Forum

Energy Trends and Challenges in Indian Agriculture

Vijay Paul Sharma

1. Introduction.

India is essentially a rural country where main employment activity is agriculture, that provides food to all Indians but also help to earn foreign exchange. Agriculture in India, however, requires immediate attention of all concerned, since this sector is not doing well. Which its contribution to National GDP is 14%, it however employs about 50% of the workforce. The Indian economy needs structural transformation and needs major drives. There are two basic important issues. The agriculture GDP contribution of 14% should be listed upon in a larger perspective. This sector employs a major portion of Indian population involving 14 crores families are involved. This constitutes about two third of rural population. Productivity of Indian agriculture is low. People involved in the Indian agriculture are not employable in the service or any other non-farm sector such as manufacturing. There is therefore an urgent need to discuss policy issues and priorities that may provide accelerated agriculture growth.

2. Transformation of Indian Economy: Diversification of Agriculture.

Since the year 1990 after liberalization, the Indian economy has undergone massive structural changes (Fig. 1). In the year 1963-64, agriculture contribution to the national economy was 44.6%, which reduced to 28.2% in the year 1993-94 and further reducing to 13.90% in 2013-14. There have been patterns of rising income of Indian society leading also to changes in the consumption patterns of various food products (Fig.2).

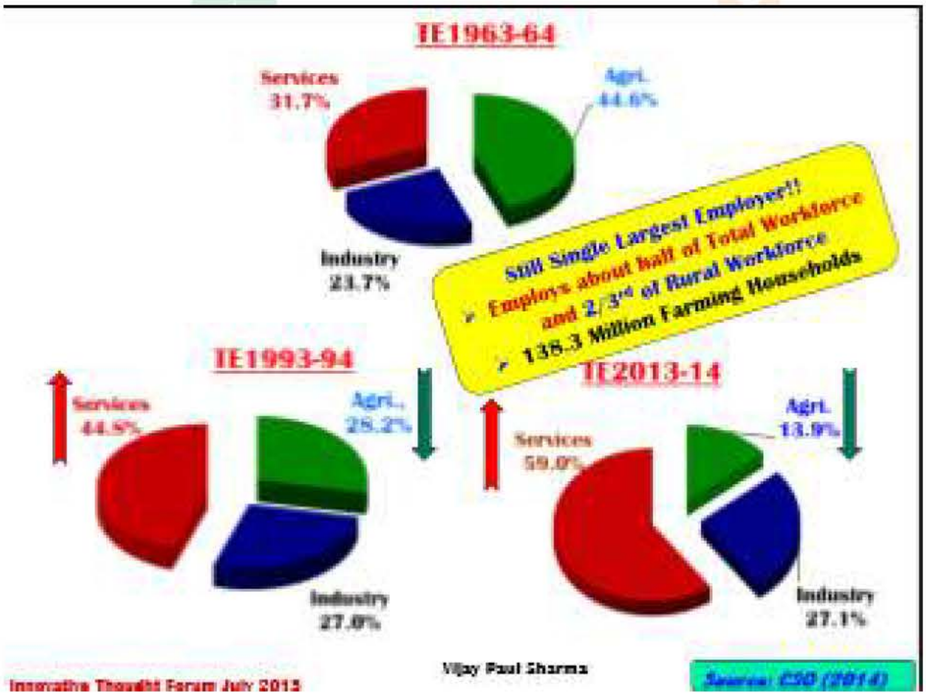


Fig.1: Structural Changes in the Indian Economy

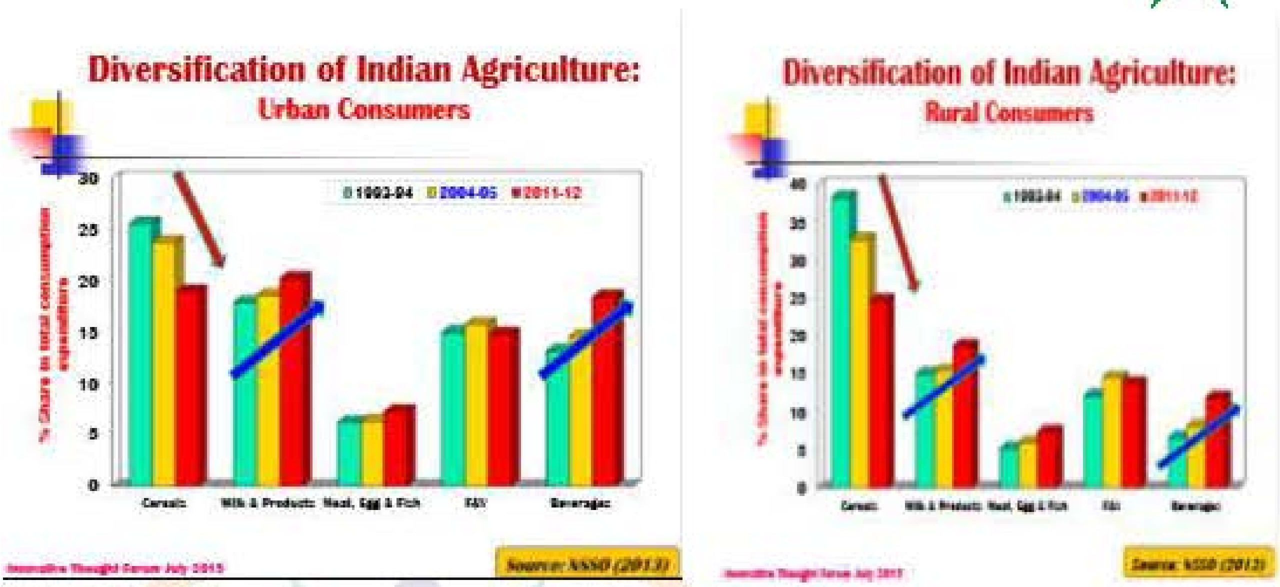


Fig. 2 : Changing Consumption Patterns of India People

It can be seen that where as the consumption of cereals have been going down, those of milk and milk products, meat, eggs and both fruits & vegetables and beverages etc has been increasing. These trends indicate huge opportunities for the Indian farmer to shift to high value commodity. Though, a high value commodity is also associated with risk. One needs to manage production as well as markets in the rural areas. Indian agriculture has seen dramatic increase in the exports, although imports have also increased. There is, however, a distinct trade surplus that has been growing rapidly (Fig. 4).

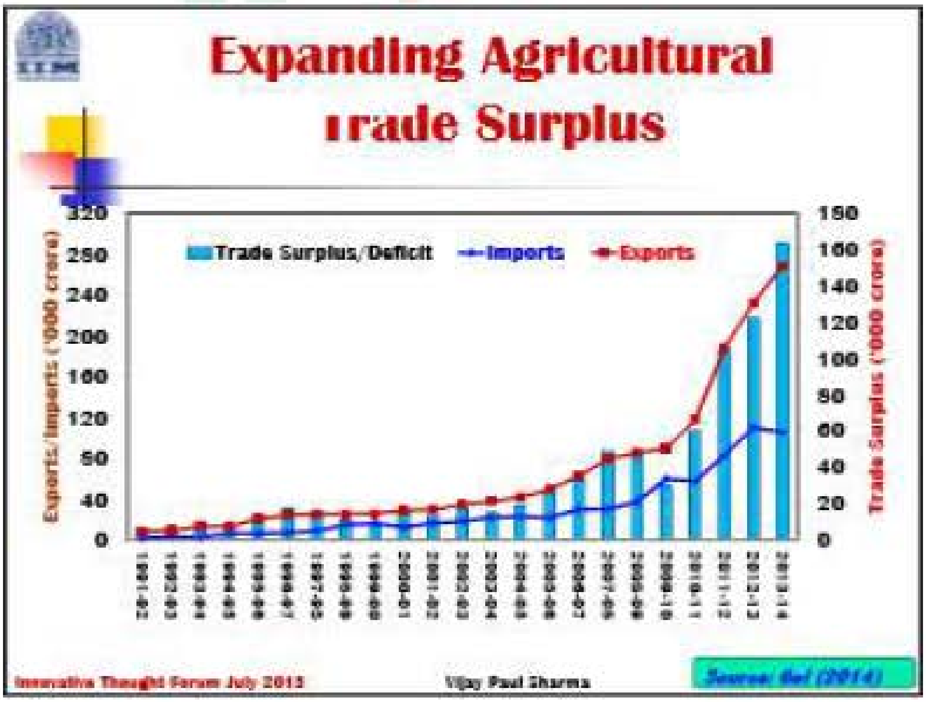


Fig 4: Indian Agriculture Exports and Imports

3. Major challenges.

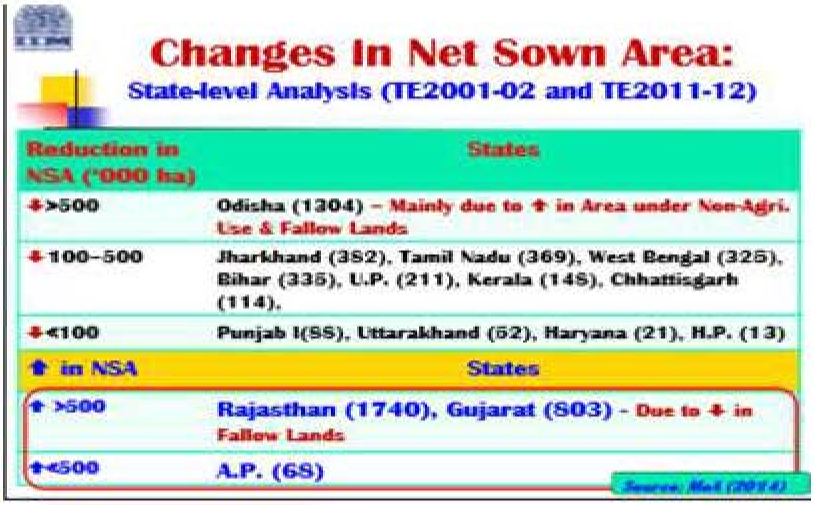
Land is the major challenge for agriculture in India. There has been a trend of shrinking agriculture land as swell as declining and fragmenting farm sizes. There is a severe competition for land use amongst food, feed, fibre, fuels and non agriculture products (Fig.5).

Fig 5: Land Resources and Respective Competition amongst Food, Feed, Fibre and Fuels as well as Infrastructure Needs

A proper land use planning can greatly reduce the competition between various land uses. Looking at the trends of land use (Fig.6) the arable land area has been decreasing while that for non-agriculture uses increasing rapidly.

Fig 6: Shrinking Arable Land

Fig 6 also shows that the country possess 17.2 M ha of barren and uncultivable land, as well as 28 M ha of cultivable and fallow waste lands. With adequate technology 28 M ha can be brought under agriculture sown area, while the barren and uncultivable land could be reserved for non-farming sectors. In the last decade, Gujarat, Rajasthan and Andhra Pradesh have been able to increase the net sown area because the area under fallow lands has been converted to cultivable area. In many other states in contrast the fallow land area has increased resulting in diminishing cultivable area.



Changes in Net Sown Area:
State-level Analysis (TE2001-02 and TE2011-12)

Reduction in NSA ('000 ha)	States
↓>500	Odisha (1304) – Mainly due to ↑ in Area under Non-Agri. Use & Fallow Lands
↓100–500	Jharkhand (352), Tamil Nadu (369), West Bengal (325), Bihar (335), U.P. (211), Kerala (148), Chhattisgarh (114).
↓<100	Punjab I(55), Uttarakhand (52), Haryana (21), H.P. (13)
↑ in NSA	**States**
↑ >500	Rajasthan (1740), Gujarat (803) - Due to ↓ in Fallow Lands
↑<500	A.P. (68)

Fig7; Changes in the Net Sown Area of Many Indian States

One of the major challenge of Indian agriculture is the trends of swelling bottom (Fig. 8), showing that the number of marginal farms < 1 ha has been increasing.

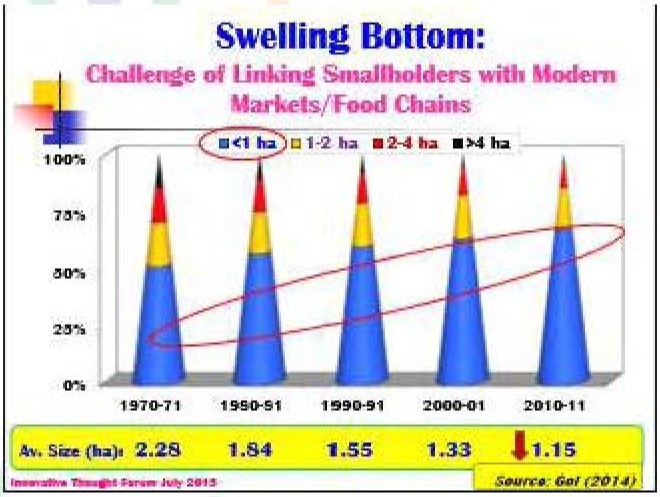


Fig. 8; Decreasing Farm Sizes in India

In fact, two third of agriculture population has farm size of 1 acre or less. This farm area is not financially viable. A basic option to have financially viable farm sizes is to allow land leasing, land consolidation and land tenancy. This requires land policy reforms in broader perspective in sates, where it is not allowed.

Another major challenge for Indian agriculture is the availability of water. India has large irrigated area and low water use efficiency. There is a vast gap between potential created and potential utilized. The estimated use of created water potential is only ten percent. If water resources could be managed efficiently, our agriculture productivity can be improved substantially. Pricing of electricity for irrigation is a politically sensitive issue, along with increasing diesel prices. Another major concern is negligible private investment in agriculture.

4. Low Productivity

Agriculture productivity in India is one of the lowest amongst emerging economics. This low productivity is linked to technology and institutional issues. Fig. 9, shows the yield gap analysis indicating technology gap and the extension gap.

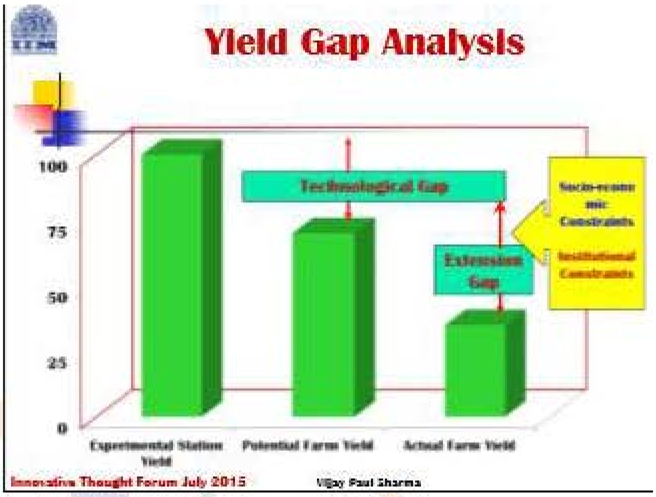


Fig. 9: Indian Agriculture Yield Analysis

A better institutional management can increase the yield by 48%. Public extension network is necessary for adequate farmer's education in latest technology and farm practices. Yield gap that occurs because of technology and extension in some states are shown in Fig. 10.

5. Institutional credit & Policy interventions.

There has been significant increase in the flow of credit to the agriculture sector from 70,810 crores in 2002-03 to 7.25 crores in 2014-15 there are however several issues of concern like:

- High dependence on non-institutional sources (44%).
- Decreasing share of co-operatives from > 50% in 1990-91 to < 20% in 2013.
- Decreasing share of rural bank branches from 58% in 1993 to 38% in 2014.
- Decreasing share of investment credit from 40% in early 90's to 22% now.
- Decreasing share of small loans less than 2 Lakhs.

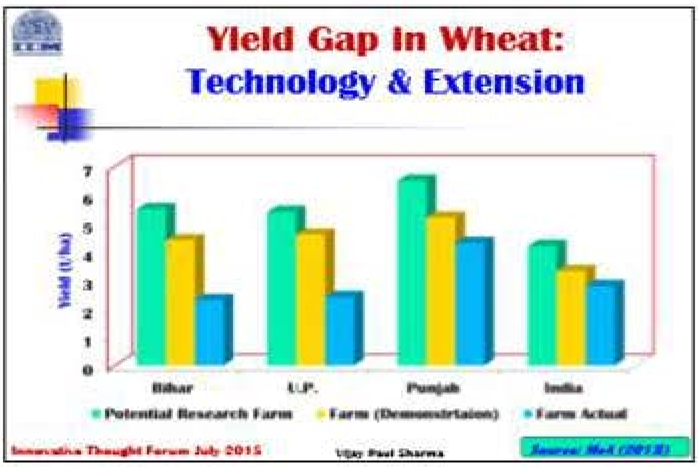


Fig. 10: Yield Gap in some States due to Technology and Extension

The agriculture sector needs policy interventions with respect to regulatory measures, market infrastructure and institutions and price of the agriculture commodity. (Fig. 11)

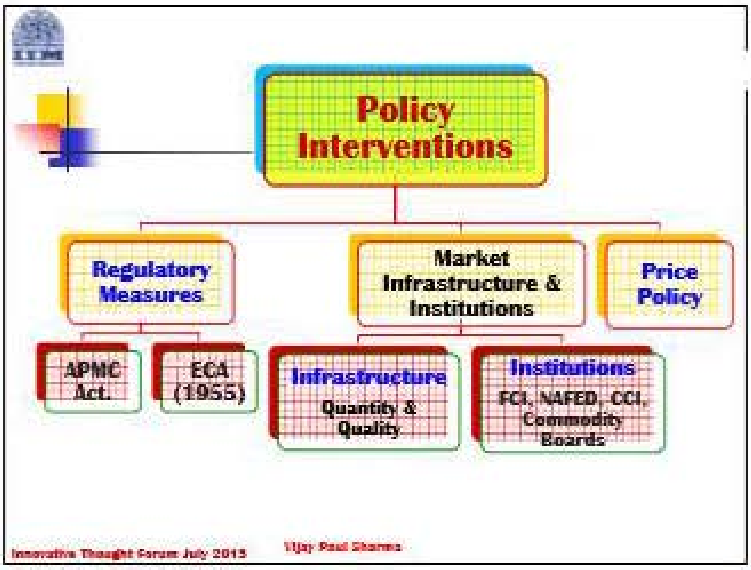


Fig.11 : Desired Policy Interventions in Indian Agriculture

Agriculture produce market committee (APMC), a marketing board by the state governments are supposed to act on two principles, namely:

- Ensure that intermediaries don't compel farmers to sell their produce at the farm gate at very low prices.
- All food should be brought to the market yard and then sold through auction.

However, APMC in some states is creating hurdles by not including the private sector. Many states have amended the APMC act to include private sector though the investments by the private sector in agriculture are almost zero. Aggregation of agriculture produce is difficult and has seasonal variability. There is an urgent need to rationalize tax structure due to following reasons:

- Financially viability
- Small volumes and therefore high transaction costs for processors, exporters and retailers.
- Seasonal variability in raw material because of lack of cluster approach.
- High taxes and statutory levies (19.5% in AP, 14.5% in Punjab, 10% in Odisha and Haryana for rice.

Agriculture in a high risk business; however the agriculture policies are very ineffective in the risk management. Due to unpredictable weather and many other reasons, the agriculture GDP has shown high fluctuations: (Fig. 12).

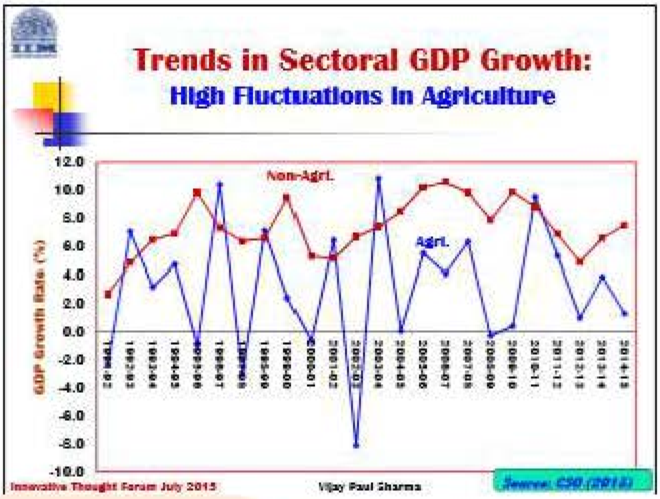


Fig. 12: Trends in Agriculture Growth

Against this the non-agriculture GDP shows a definite trend. As a result there is a rapid deceleration in agriculture growth and acceleration in non-agriculture products. There are high variations in the crop prices like onion and potato, which are two major consumer products of agriculture. National crop insurance programme in our country needs high premium and stronger government support. One can draw certain inferences from the subsidies given by the USA for crop insurance, amounting to almost 62% of the total value at a staggering sum of 14.1 billion US Dollar in 2012.

6. Policy Issues and Priorities.

To ensure accelerated agriculture growth, there is a need to concentrate on two important issues, namely:

- Improve crop productivity.
- Reforms in laws related to land markets.

Crop productivity in India can be increased by two to three times by proper R&D and improvements in the extension services. This needs higher public investments. Also the rural infrastructure including road, power and irrigation requires up-gradation and much improvement. The farmers need to be given right incentives and crop production being risky; it requires better risk management tools. The credit availability and role of rural banks require much more improvements.

Regarding the land laws, one needs to permit land tenancy and land consolidation in all the states.

Last but not the least, crop produce needs strengthening of market linkages like :

- Post harvest management and market infrastructure.
- Vertical co-ordination of agro-food chains.
- Collective action for small holder market access (co-operatives, FPOs, Producer companies etc.)
- Strengthening of market information systems.

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LIST OF PARTICIPANTS – BRAINSTORMING ON "AGRICULTURE & ALLIED SECTORS" AT INDIA HABITAT CENTRE, DELHI, 24TH JULY 2015.

01. Shri. Diwang J Acharya.
E-mail: dewang8@yahoo.co.in M-09427614390

02. Prof. N.K Bansal
Ex-Vice Chancellor. SMVD University J&K, Ex-Prof. IIT, Delhi.
C-87, Ground Floor,East of Kailash, New Delhi-110065.
E-mail: nkbansal43@gmail.com Ph: 011-64646682. M-9650504999

03. Shri. S.B Dangayach
Managing Director, Sintex Industries Ltd, Kalol(N.G)-382721.
E-mail: dangayach@sintex.co.in Ph:02764-253000. M-09998822680

04. Shri. Karan Dangayach.
E-mail: admin@shashwatcleantech.com M-9824498135

05. Shri. Bajrang Lalji Gupt,
C-30, Ahinsa Vihar, Sector-9, Rohini, New Delhi-110085
E-mail: mangalayan@gmail.com.

06. Shri. Krish Iyenger
Executive Director, National Committee on Plasticultre Applications
In Horticulture, Nehru Plcae, New Delhi.
E-mail: krish.iyengar@ncpahindia.com Ph: 011-46511279

07. Shri. R.C Jhamtani
Retd. Planning Commission, Delhi.
F-19, Houz Khas Enclave, New delhi-110016
E-mail: rameshjhamtani@gmail.com M-9810756178

08. Dr. Anoop Kalra.
E-mail: akalra@ayurvet.com M-09811010313

09. Shri. Pankaj Khandelwal.
E-mail: pankaj.khandelwal@inifarms.com

10. Shri. Robert Ossevoort.
E-mail: Robert@ossevoort.net

11. Dr. M.S Patel.
Secretary (Retd.)Irrigation, Kalpasar, Narmada etc.
E-mail: drmspatel13@yahoo.in M-09879625575

12. Prof. Ramprasad Sengupta.
Emeritus of Economics, Centre for Economic Studies and Planning,
School of Social Science, Jawaharlal Nehru University, New Delhi.
E-mail: rps0302@gmail.com M-9871840681

13. Dr. Tushaar Shah
Senior Fellow, International Water Management Institute (IWMI), Anand, Gujarat.
E-mail: t.shah@cgiar.org Ph: 02693-263861/817

14. Prof. Vijay Paul Sharma
Indian Institute of Management, Ahmedabad.
E-mail: vijays@iimahd.ernet.in M-09825415414

15. Shri. J.C Sharma.
E-mail: Sharma.jc@nic.in M-09717875571.

16. Dr. Vishal Sardeshpande.
Ph.D (IIT B) Ajunct Associate Professor, IIT Bomaby.
E-mailvishalsir@gmail.com Ph: 022-25767870

17. Dr. Ram Badan Singh
Chancellor, Central Agriculture University,
D1/1291, Vasant Kunj, New Delhi-110070.
E-mail: rbsingh@gmail.com Ph: 011-26136450, M-9810230037.

18 Dr. Nagesh Singh
E-mail: nagesh8588@gmail.com M-9968144351.

19. Dr. Ompal Singh.
Saharanpur, U.P,

20. Shri. Dharampal Singh.
Shamli, U.P.

21. Dr. A.K Singh
Head and Project Leader (Rice), Division of Genetics,
ICAR-Indian Agricultural Research Institute, Pusa, New Delhi.
E-mail: aksingh@iari.res.in Ph: 011-25841481. M-9899045037

22. Shri. Rajiv Siwach
Dy. General Manager/Executive Assistant to Chairman,
National Bank for Agriculture and Rural Development, New Delhi.
E-mail: rajiv@nabard.org Ph: 011-41539189-90

23. Shri. Omprakash Sakhlecha
M.L.A, Jawad (M.P)
Ph: 07420-232595

24. Shri. Tulsi Tawari.
Mumbai.
E-mail: tulsitawari@gmail.com M-09820113641.

25. Dr. D.K Yadav
Head, Division of Seed Science & Technology,
ICAR-Indian Agricultural Research Institute, Pusa, New Delhi.
E-mail: dkygenet@gmail.com Ph: 011-25841481.M-9868537641

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26. Dr. Dilnavaz Variava
E-mail: dsvariava@gmail.com

27. Dr. Shivang Swaminarayan.
Head, Health Care Divn., Sintex International Ltd, Kalol.
E-mail: homeo@sintex.co.in M-09898200557