

# **Appropriate Technology for the Sustainable Watershed Development**

## **Mirages, Audits and Communication barriers**

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It is the most appropriate time and place to share the honest documentations of our 22 years long chase of mirages of evergreen revolution, cold blooded analysis of the miserable failures and a very few replicable successes. Thanks to the organizers of this long awaited discussion where the science and technology people and social scientists are brought together.

Everybody now knows that the real political power will flow through water and electricity – the rivers, dams, canals, pipelines and the electrical powergrid. But before they become politically explosive at all the levels, we must break all the communication barriers between ourselves and undertake the joint audits both technological and sociopolitical. Sociopolitical illiteracy of the block-headed technologists is as dangerous as the technological illiteracy of the social scientists. Generally we laugh at the famous communication joke of an entomologist experimenting on an insect, ordering to jump from height and trying to find out its reducing obeying capacity by cutting its legs one by one and seriously concluding that no insect can hear whose all six legs are cut. Unfortunately this joke becomes cruel reality especially when problems of rural development, farmers, droughts, famines, suicides of the rural poors and farmers are discussed in seminars, workshops and media at large. Communication barriers are responsible for this cruel reality. In fact we are playing the role of that entomologist. We, the members of Science and Technology Community of shining and rising India, though 'feel good', situation is desperately dangerous. We are living in a false security of luxury liner Titanic fast cruising towards waiting rows of gigantic icebergs. Only small tips of the icebergs of farmers' unrest are visible. In fact, we have no time to escape safely. The speed is dangerously high, the rudders are jammed. Totally unaware of the reality, we are happily busy in decorating the dancing floors, dining halls and the bars. Our management 'Guru's are busy in optimizing the accommodations of the luxury suites of the sinking liner.

In order to know the real communication barrier; let us ask some frank questions to ourselves. Are we really equipped and capable of even understanding the problems of drought or famine correctly? Can we communicate with the rural people? Can we leave our typical middle class social work attitudes of charity, development or so-called conscientisation? Do we work 'for' the rural people or 'with' the rural

people? Do we really know how our heads get gas filled and attain pseudo heights? Do we look down to the rural areas from those pseudo heights through the spectacles and goggles provided by the ruling class? Are we aware that we are getting distorted images of our society? Do our heads get timely punctured to get ourselves Declassed to our own heights? Do we know our strengths and weaknesses as middle class and the historical role? Do we know our exact role in the development of appropriate technology? Do we really know that our rural people are knowledge thirsty and if given chance, or properly communicated, can develop revolutionary technology? Do we really respect their unconditioned collective intelligence, skills to handle the local material and situation and overall robust wisdom? Do we really understand the needs, felt needs, demands and the political wills of the people? Are we really their friends?

Now let me audit our 22 years' experience of staying on a dryland farm, situated in the great desiccator of Bhima-Seena ridge. Looking through the eyes of a real farmer, let me tell you frankly that we are really tired of listening to the so called exceptional success stories of rich farmers and the lucrative statistics presented by Agricultural experts and the so called Agricultural media because none of them is replicable. Even the experts themselves will not dare to leave their jobs or put their own sons or daughters in actual farming and follow the success stories. Today's so called 'green revolution' and those success stories are miserably bankrupt on any environmental audit – especially water and energy audit. The presentations show the basic science illiteracy. This is evidenced by the fact that no intellectual or Agricultural scientist could accept the simple challenges, which we published in the newspapers in the year 2000. Some of the challenges were like, "showing 100 matrimonial advertisements of graduate brides preferring full-time farmers as bridegrooms" or "showing 100 farmers wealthier than nationalized bank employee" or "showing 100 successful USA or Israeli farmers not benefited by subsidies", (during last 30 years they got 690% and 1100% subsidies respectively). "showing 100 postgraduate Agricultural experts who have encouraged their own sons and daughters to follow the grand success stories of the modern farmers"

Our farmers are so unorganized, that they have totally lost their bargaining power in the market. Following table shows the comparison of exchange values of Agricultural produce with some nonagricultural produce. Generally people get shocked to see the disparity. On my farm there is a display board at the gate (see the photograph). Visitors gather in front of the board and get further shocked. That board is about sale of organic produce available on the farm at the market rates of 1970. Initially visitors are very happy that they are getting the organic farm produce at very cheap rate of 1970 because everybody including economists think that the Agricultural produce has become many times dearer these days than 1970. But immediately they get slapped when they read further down the board that we refuse to sell the farm produce in exchange of Indian currency but ready to barter with the nonagricultural produce like cement, steel, diesel, gold etc. but at the rate of existing in 1970. Generally people get ashamed at the disparity between Agricultural and nonagricultural sector. Generally first time in

their life they come across the reality but when asked to buy at the 1970 rate, they refuse. No media has dared to publish this board because it is directly hitting their readers' interests and the media know that the farmers are not their customers.

I appeal to the audience of this gathering of scientists – both S & T and social - to purchase Agricultural produce for their own family consumption at 1970 barter rate if they are really concerned about farmers and the rural area. I am sure if they try to purchase even one month's farm produce requirement at those rates; they will face unrest in their own family and in the neighborhood also. How can you defend purchasing one litre of milk with four litres of diesel when one litre of milk is available with the shameless exchange of one litre of 'Bisleri' water.

Generally sugarcane growers in Maharashtra State are supposed to be organised by their so-called sugar lobby. Let us see what has happened to the bargaining power of this politically organised grower.

One ton of sugarcane could be bartered with 11 grams of gold or 200 kg of steel or 1250 kg of cement or 400 litre of diesel in 1970 -----

Whereas after 35 years the same ton of sugarcane produced by the grandson of the same organised sugarcane grower gets 1 gram of gold or 20 kg of steel or 160 kg of cement or 20 litres of diesel in exchange. Same barter rates can be observed for one quintal of Jawar and 100 litre of milk. Anybody can refer newspapers published in 1970 and 2005.

Mahatma Phule, nearly 150 years back, in his famous book 'Shetkaryancha Aasood' (Farmers' Whip) and Dr. Panjabrao Deshmukh, 50 years back in his famous thesis 'Shetkaryanche Denekari' (Farmers' Debtors)- both have used stronger language to show the shameless disparity in those periods. I am sure that most of the Mahatma Phule Krishi Vidyapeeth and Panjabrao Krishi Vidyapeeth alumni have not read these revolutionary writings of the great visionaries after whom the Universities are named. The media also avoids these disturbing facts even though the disparity further deteriorated many times in last fifty years. I am asking for the barter rates of 1970. I am in search of an Intellectual from that shining and rising India ready to accept challenges and the reality of 1970. I am not bothering this class to accept the reality and analysis posed by Mahatma Phule and Dr. Panjabrao Deshmukh which is much harder to accept.

On the other hand, in the same period of 35 years farmers have lost biodiversity and self-sufficiency in agricultural production. Most of them have become monocrop growers and victims of market economy. They have almost lost self sufficiency in Agricultural inputs like labour, energy, implements, machines, seeds, seedlings, fertilizers, other soil additives, pesticides, growth hormones, veterinary services, irrigation systems both on farm and off farm, post harvest services, transport, packing material, marketing services, credit services, extension services, consultancy, legal services etc. etc. All these inputs and services require cash and farmers have become more and more dependant on organized market forces beyond their control. For all these bought out agricultural inputs, farmers have to desperately produce and exchange 5 to 10 times more marketable biomass. This exchange is nothing but a distressed sale where farmer is not even allowed to calculate the cost of production and transport.

In this situation, no farmer can earn a single rupee net profit. What is shown in those success stories, is based on false calculations and false costing methods. The success stories can be compared with the success stories of lottery prizewinner or Warali matka winners where thousands are losers.

1. Most of them are so exceptional that they become news or subjects of research paper. You cannot show any repeated performance.
2. Costings do not include the family labour, cost of unpaid labour of women and children, unpaid supervision charges.
3. Animal labour charges are considered free.
4. Natural Capital losses, depreciation are never calculated e.g. loss of the basic soil fertility, structural losses, textural losses, water absorbing capacity, soil cover losses – generally these are the permanent environmental losses to be faced by next generations.
5. Water pumped out from the depths and used for irrigation, which is accumulated there for centuries together, is never calculated in the costing. This is like consuming fixed deposits and ancestral savings as if this is the last generation on the farm.
6. Many times the statistics is so funny that the income shown is actually the gross sales returns. Even the sales of the Natural Capital are shown as income!

Then why those false success stories are published?

They are published because the publishers are so sure that no real stake holder i.e. farmer is going to read, watch and counter react or challenge. So these success stories go unchallenged & safely carried forever using the techniques of Gobels.

They are also published to hide the bankruptcy of the so-called green revolution or modern Agriculture. These success stories justify the huge and wasteful government expenditure in the name of Agricultural development, rural development, research and extension. No farmer dares to ask questions. Further they justify the sales, profits and exploitation of 'Agricultural input Agencies and traders' – MNCs, banks, international funding agencies and marketing agencies. Those success stories further justify the existence of parasitic NGOs. The most important reason is the success stories are prompted by income tax consultants and the racketeers to make black money white, because the income-tax department exempts Agricultural income. The false success stories, especially published by so called Agricultural experts help and certify those tax consultants and racketeers. There is a mushroom growth of so called private limited companies, agribusiness companies etc. Eleven such private limited companies got registered overnight alone in my village Ankoli. Those were registered by family members, relatives and friends of the top government officers. (Unfortunately most of the officers are Agricultural graduates.) These companies can show grand economic successes on paper and can even prove that the modern horticultural plantations, bio-diesel, ethanol production, animal husbandry, poultry etc. etc. are profitable. Sometimes they even show world records of production broken on their farm. This is to hide and convert huge earnings by other sources. Sometimes they try to prove theoretically impossible calculations.

On the other day, while travelling together, one top income tax officer asked me, 'How on earth some businessmen cum farmers have claimed

Lac of rupees as their net income from their Agriculture or horticulture – though their land holdings are within the limits of Governments' land ceiling rules, maximum being say 20 hectares? Can anybody claim 50 Lac Rs. Net income in drought prone district like Solapur?'

I told him to take out his pocket calculator & calculate the water requirement. Basically, to earn one Rs. net profit from Agriculture, you must irrigate the farm by one cubic meter of water i.e. 1000 litre. If somebody is really claiming Rs. 50 Lac net income from his 20 hectares, he must show from where he got 5 million cubic meters (5 mcm) of water. Either he should show that his farm in Solapur district received well distributed rainfall of 2500 cm i.e.1000 inches or he got that water from external sources or his farm must be floating on underground water, continuously recharged by some miracle. Even he imports and implement the most modern irrigation technology and reduces the water requirement by Factor 10 (thus increasing the cash and energy input 100 times) then also the effective rainfall in that area is at least 100 inches or 250 cms which is impossible even in flood irrigated area in Ujni command. The Income tax person got totally confused by this bitter water audit and promised me that anybody claiming Rs. 2lac/anum from Agriculture will be strictly scrutinized. One builder promoter from the city, careful listening to the discussion later on shouted at me, 'Who told you to educate that income tax person? I will be the first to get scrutinised!'

So in a nutshell these success stories of, horticulture, winery biofuel, animal husbandry, poultry, piggery, agroforestry, floriculture, high tech. Agriculture for exports etc. are not useful for our discussions because they are bankrupt on any economic audit. Any external input bought by cash increases the economic bankruptcy of Agriculture.

#### Environmental Audit –

Now let us see how this economic exploitation and bankruptcy of farmers leads to further bankruptcy of present Agriculture on environmental audits. Sometimes it reaches to the point of no return.

1. Water Audit : It is the most important environmental audit. To understand this audit, let us try to understand the water requirement for satisfying every human need, i.e. for providing fuel, generating electricity, for conditioning and purifying air, for pumping water, providing water for cooking and cleaning, for producing food, for producing fibers for clothing, for building shelter, for health needs, for education – to make paper, for entertainment, for transport, for travel and tourism etc. Almost every human need requires water. Water requirement can be direct or indirect. Many methods are being developed all over the world to calculate 'virtual water content' of every product or service and thereby calculating the total direct or indirect water requirement of the society. Methods of calculating 'virtual water trade' and transport between the regions, between the states and between the countries are also being developed because water has already become globally, politically explosive material. Thus water flows from the rural areas to urban centres, from Bharat to India, from India to Middle East, from Africa to Europe, from Phillipines to USA, from South America to North America.

In Agriculture, the virtual water content is calculated on the basis of water received by the farm during the year in the form of natural

precipitation and by artificial ways like irrigation. While calculating, we have to take into account the water consumed to provide energy for irrigation i.e. for producing food and fodder for animals used to lift water, water used to produce biomass to produce electricity i.e. wood, coal and biodiesel, ethanol etc. In case of hydal or thermal power plants, the water is required for turning the turbines etc. etc. Thus the total water consumed is divided by the total dry or wet biomass produced by the crop to get the virtual water content. We have calculated some of the following figures of virtual water content and the water content of one rupee gross income of the farmer.

Product	Water content	Gross Income	Water/Rupee
Income		Rs.	Litres
1 kg. of sugarcane	600 litres	0.80	625
1 kg. of Jawar	7500 litres	6.00	1250
1 kg. of Wheat	8000 litres	8.00	1000
1 kg. of Oil seeds	12000 litres	20.00	600
1 kg. of Pulses	8000 litres	20.00	400
1 kg. of Cotton	10000 litres	16.00	625
1 kg. of table Fruits (like grapes)	2000 litres	8.00	250
1 litre of bildiessel	20000 litres	25.00	800
1 litre of ethanol	10000 litres	16.00	625
1 litre of milk	10000 litres	8.00	1250
1 kg. of meat	48000 litres	50.00	960
1 kg. of silk cocoons	80000 litres	80.00	1000

Note : Non-vegetarian products like milk, meat and silk require generally 5 to 10 times more water than vegetarian products of same energy. Irrigation though increases the production, it takes more water to energise the system resulting in more virtual water content. In the semi-arid tropics especially in the descicating conditions water requirement is more.

Off-farm irrigation efficiencies are very poor if the water is stored in shallow lakes, transported through open canals and the on-farm irrigation efficiencies are still poorer, if it is provided by flood system. If electrical power is used to lift water from wells or canals, the virtual water content increases many times because the generation and transmission require more water. If diesel is used to lift water, and if you calculate the bio-mass like meat exported to Middle East to import that diesel and the virtual water exported or if you calculate the water required assuming that bio-fuel is used to produce the bio-diesel or ethanol for energising the irrigation, the virtual water content still increases many more times.

Fallacies of Modern Irrigation Systems: Drip or sprinkler system requiring more power, are bankrupt on water audit. They do not save water but require more water because the virtual water requirement of the final agriculture product is many times more e.g. a drip irrigation system does not save water but consumes more water not only because it requires more power but it takes more water to pay cash for the other running costs like interest, depreciation, repairs and maintenance. To pay for

these costs, farmer has to produce more and more bio-mass for sale in the market. This desperate sale of bio-mass takes away more water from the watershed than the water saved by the system.

In one calculation, drip-irrigation system for one hectare of sugarcane seemingly saved 12,500 m<sup>3</sup> of water/year but it required 16,000 m<sup>3</sup> of water for its energy needs (diesel or electricity) and 12,500 m<sup>3</sup> of water to pay for the above running costs,(approximately Rs.25,000/year @ 0.5 m<sup>3</sup>/Ruppee) totaling the virtual water to 41,000 m<sup>3</sup>/year. In fact, 16000 m<sup>3</sup> more water is spent to produce same yield.

Now let me tell you about water audit of my own farm of survey no. 34, village Ankoli, Taluka Mohol, District Solapur – of drought prone Maharashtra.

High-tech. Agriculture of so called modern 'green house' is 'absolutely bankrupt' on water audit because it requires many more times more energy than the drip system. The energy required to build & operate the air conditioned green house in the dessicator like Solapur district is so high that the virtual water required for the bio-mass produced is certainly three times more than the flood irrigated crops. One rupee gross income will require 1500 litres water. Direct & hidden subsidies provided for the so-called high tech. Agriculture are environmentally costly. We are exporting more water if we export the bio-mass.

My nano watershed of 50 acres - 20 ha. is a part of a huge natural desiccator of 100 Lac ha. This nano watershed is situated on degraded, eroded ridge of Bhima-Seena river basins where the annual average precipitation is 500 mm But the total evaporation is 2500 mm annually out of which 600 mm evaporation occurs during rainy season only. As a thumb rule that number of rainy hours are equal to the cm of rainfall and the total rainfall occurs in 50 hours and half of it occurs in 10 hours only. So any experiment done on this land can become replicable for the entire semiarid zone of South India.

I have tried everything on earth and every single technology known to S & T Community or being discussed here. This watershed is owned by five families and going to be further subdivided into 22 narrow strips, 600 meters long and merely 15 meters wide along the slope and across the contours. These subdivisions along the slope, as usual could be responsible for further erosion and degradation of the watershed. It took me 6 long years to convince all the 22 legal owners to come together for the collective water and soil management. Then I could trench the watershed accurately on contour, bund every smallest stream, undertake plantation, build green wind barriers, cover every cm by thick mulch etc. etc. By doing this, I have converted the whole watershed into a sponge absorbing every rainwater drop and conserving it, recently undertaken the project of 'Water Bank' of 50,000 m<sup>3</sup> capacity.

So by assuming 50% efficiency, I can conserve 50 thousand cubic meter of water (50,000 m<sup>3</sup>) out of the total 1 Lac cubic meter of rainwater (1,00,000 m<sup>3</sup>) in my nanowatershed. 30 thousand cubic meter (30,000 m<sup>3</sup>) conserved in soil moisture and 20 thousand cubic meter (20,000 m<sup>3</sup>) percolated in the two shallow wells for seasonal irrigation. This is the maximum possible efficiency.

Now let us calculate the virtual water requirement of one family in the watershed.

For producing bio-mass required for their own consumption/year	
Food – Cereals, pulses, oil-seeds, vegetables, fruits etc.	
1 ton dry biomass	2500 m <sup>3</sup>
Fodder – Apart from the above crop residues	
1 ton dry biomass	2500 m <sup>3</sup>
Fuel – Apart from above crop residues	
1 ton dry bio-mass	2500 m <sup>3</sup>
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Total virtual water requirement for own consumption/year	7500 m <sup>3</sup>

For producing biomass for the cash requirement i.e. biomass for marketing or sending out of the watershed @ 0.5 m <sup>3</sup> /Rupee	
For agricultural inputs to be bought from the market i.e. from the external sources like seeds, seedlings, Fertilizers, pesticides, energy, labour, hiring charges etc.	
Rs.10,000/-	5000 m <sup>3</sup>
(This is the minimum requirement)	
For other basic family needs like energy, fuel, food, Clothing, shelter, health, education, entertainment, Travel, communication, justice, security, prestige etc.	
Rs. 25,000/-	12500 m <sup>3</sup>
(This is also the minimum requirement)	
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Total virtual water requirement for the bio-mass	
To be sold in the market i.e. to earn Rs. 35000/-/year	17500 m <sup>3</sup>
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The total minimum water requirement to lead a 'below poverty line rural lifestyle', every family requires minimum average of 25000 m<sup>3</sup> of water every year. So five families in the nano watershed require 1,25,000 m<sup>3</sup> of water for their survival. But the total water conserved through all the possible methods of watershed development is 50000 m<sup>3</sup>. Hence the net minimum deficit is 75000 m<sup>3</sup>.

Assuming all the 1000 nano watersheds of our panchkroshi, i.e. the area of 5 kos diameter or 10 miles or 16 km diameter or area of 20 thousand ha are converted into perfect sponge, by every technology available on earth, and conserving 50% of the total precipitation, the total deficit per year will be 75 mcm i.e. 2.646 tmc of water.

**BANKRUPTCY OF THE ENERGY AUDIT**

By definition, Agriculture is a cultured photosynthesis where human knowledge intervention has played very important role and where the efficiency of photosynthesis is many times more than the natural photosynthesis occurring in natural forests or natural grasslands. Agriculture is the only human enterprise where the energy output can be exceptionally more than the energy input because solar energy input, on which it works, is free and abundant. In other words, it is a man-made system where the solar energy is harvested through carefully & skillfully cultured photosynthesis. In order to harvest the free solar energy, the farmers have to spend some stored solar energy in different forms e.g.



muscle power of humans and animals, burning of wood or coal, electricity, petroleum, use of chemical fertilizers and pesticides and plastics etc. etc. In an ideal Agriculture, the input of this stored solar energy is less than the energy output. That's why it is the only man-made system where true wealth and surplus energy is generated. The whole human culture in the world is based on this man-made miraculous system. The sustainability of Agriculture and thereby sustainable human development are dependent on continuing this surplus and continuous wealth generation. But the moment the energy input is more than the solar energy harvested, that Agriculture and human development become bankrupt and unsustainable. For example, on this energy audit if the input is one food calorie and output is five calories, then this is sustainable. But if the input is five calories and the output is one calorie, then this becomes totally bankrupt. In the early human history, in the hunting and gathering stage, the food gathering was many times bankrupt because the energy required for hunting and gathering was more than the actual energy received by the consumption of the gathered and the hunted food. With the rise of domestication and training of animals like trained hunting dogs, this started becoming energy positive. Then with the domestication of big animals – cattle, horses, goats etc. it became more energy positive. Later on the revolutionary stage of domestication of plant species i.e. cultured photosynthesis was developed. Some domesticated animals like bullocks, horses, buffaloes, camels etc. were used for the agricultural tillage operations, transport and processing etc. Use of human slaves was another revolution, which lasted for thousands of years till the industrial revolution and the use of steam engines, diesel engines, electricity and the farm machines. Till then, it was sustainable on energy audit because it was dependent on the food and fodder produced on the farm and the excreta of human being and animals was recycled in the form of manure. The energy input was always less than the energy output. With the rise of modern green revolution, Agriculture has become bankrupt on energy audit and hence unsustainable because it consumes fossil fuel energy –stored solar energy of million years.

Now let us calculate the input and output of energy as on today, - on my nano-watershed of Ankoli, which is partly mechanized - mainly for irrigation and transport

Total output of energy on the basis of dry biomass produced on 20 hectares is  $50 \text{ tons/year} \times 0.20 = 10,000$  litres of diesel equivalent energy.

On the basis of calories harvested, 12.5 kcalories/day/sq.m for 60 days

So the total solar energy harvested on 20 hectares by seasonal cropping is equivalent to 10,000 litres of diesel.

To harvest this solar energy, we have to spend stored solar energy i.e. energy input in the following modes.

1. Humans: adults – men and women: 15 nos.  $\times$  6 hours  $\times$  300 days  $\times$  0.1 h.p. /person = 2700 hp.hours = 675 litres of diesel equivalent
2. Bullocks: 4 nos.  $\times$  8 hours  $\times$  300 days  $\times$  0,4 hp./bullock = 3840 hp hours = 960 litres of diesel equivalent
3. Electricity: 10 hp  $\times$  4 hours  $\times$  100 days = 4000 hp hours = 1000 litres of diesel equivalent  $\times$  10, because the efficiency is 10% = 10'000 litres of

diesel equivalent. This electricity is used for pumping out 20'000 m<sup>3</sup> of water from 20 m depth.

4. Petroleum: For harvesting, threshing and transport of biomass: 3500 litres

5. Chemicals: Fertilizers and pesticides: 2000 litres of diesel equivalent.

Total energy requirement today is 17,135 litres of diesel equivalent and the output is only 10,000 litres of diesel equivalent. Hence the net energy deficit is (as on today) 7135 liters of diesel equivalent energy every year.

Non-vegetarian bio-mass production like milk and meat, by consuming the fodder is 10 times inefficient on energy balance.

The energy bankruptcy does not stop here. It is further increased by transporting this bio-mass by using fossil fuels like petroleum or coal to the market places, then for processing, packing and distributing to the final consumer i.e. from farms to the dining tables. The petro-calories or coal-calories required are many times more than the food calories in that food e.g. a litre of milk, after leaving the farm goes to the collection centre, then cooled by ice then transported to the district dairy by tankers, then to the processing plant for pasteurization, then transported by tankers and stored in cold storage, then transported by tankers to the mega cities, gets processed again and again, then packed into plastic pouches and bottles, gets distributed to the final customer. The customer boils it again & again on the gas stove, puts it in the refrigerator and consumes throughout the day. After consuming the milk, the customer gets 600 food calories but the energy intensive process from 'farm to the mouth' consumes 100 times more petro calories or coal calories. So the Indian customer does not drink Bharatiya milk but drinks 'diesel' imported from the Middle East! For importing these petro calories, we have to export bio-mass mainly meat to the Middle East and so on----- the energy bankruptcy goes on increasing!

The deficit will further increase to 21,675 liters of diesel equivalent energy. If that nano-watershed is fully mechanized by replacing bullocks and humans, say by tractors and other farm machines and chemical fertilizers and pesticides. This is mainly because all the farm machines including tractors require 5 times more energy because of their inherent inefficiencies as compared to humans and bullocks. Further the organic manure available by bullocks is to be replaced by chemical fertilizers. As a thumb-rule, mechanized farming is always bankrupt on energy audit where bio-mass is not produced on soil but on oil.

In totally dry land Agriculture, with age-old cultivation practices, though the energy output was 5000 liters of diesel equivalent,(50% less than the present) the input required was 15 humans and 4 bullocks equivalent to 1635 liters of diesel equivalent. Hence the net gain was 3365 liters of diesel equivalent. So in fact, on energy audit, totally dry-land Agriculture, without use of electricity, petroleum and chemicals was absolutely sustainable for thousands of years though the output was less. In last 50 years, because of the disparity and exploitation, we have to produce more bio-mass and we are forced to sell it in the market. To increase the production, we started putting more and more energy. We started irrigating our crops by digging and tapping underground water from the depths. We started mechanizing some of the farm operations. For that we had to buy and import external sources of energy like

electricity and petroleum. We lost our self-sufficiency. In order to satisfy our energy needs in Agriculture and other needs requiring cash, we have to spend more and more stored solar energy. Thus we get in to the vicious circle and the energy deficit goes on increasing.

To overcome this deficit, we have tried some Alternative Energy Technologies like Solar energy devices, bio-gas plants, wood-gas plants, wind mills etc. But none of them was successful because they proved to be bankrupt on strict energy balance. They require more energy in making those basic equipments e.g. the photovoltaic cell panels take nearly 120 years to produce energy required for making that own panel. Bio-gas plants and wind mills also take more than their life time to repay their own energy requirement. Trying to produce bio-diesel from Jatropha, Karanj, Neem or oil Palm etc. and ethanol from sugarcane and selling them in the market for cash requirement is a criminally bankrupt idea because,

1. They are directly dependant on the slavery & exploitation of unpaid labour of women and children which is taken for granted and as free. Farmer cannot even pay and recover the minimum labour charges even for harvesting, collecting of the matured crop and the on-farm processing e.g. try this for yourself. Throw and broadcast 25 kg. of Jatropha kernels on say 3000 sq.ft. area (3 gunthas) or field of stony thorny ground. Try to collect them, then try to separate the seeds, dry them in the sun and then pack them in bags and thus calculate the labour units. If they are more than 6 women hours, you cannot pay the minimum labour charges even for harvesting of the mature crop by selling those packed seeds in the market.
2. These bio-fuel productions require more energy input than the output. Generally, all the bio-diesel ideas require 2.5 liters of diesel-equivalent energy to produce one litre of bio-diesel.
3. In the desiccating conditions like semi-arid zone, they require irrigation. Jatropha being a perennial crop can not survive on dry-land or barren-land without irrigation. If we try to produce bio-diesel on our entire 20 hectares, we may get yield of 36,000 liters/year but we will have to burn 1,00,000 liters of diesel to irrigate 20 hectares.
4. Idea of growing oil Palms for bio-diesel in the irrigated area of Ujani Command should be banned because oil Palm trees are not native of this semi-arid track and are from heavy rain-fall area, hence require irrigation. Use of costly irrigation system is criminal.
5. Replacing grazing land and grassland, fodder production, food production for satisfying the greed of petroleum, should be treated as crime in our country.
6. Examples of ethanol production in Brazil are not replicable at all because sugarcane in Brazil is a rain-fed crop, requiring almost no irrigation. Bio-fuel from maize and soybean in USA is also highly subsidized. In calculating the cost of production, the huge subsidies of \$ 300 billion is not considered. Most of the maize and soybean is rain-fed in the great plains of USA. Still they require 29%, 27% more energy respectively.
7. Bio-diesel from the sunflower oil requires 54% more energy in USA. Irrigating these crops and copying bio-fuel productions is surely going to be bankrupt.

8. Totally mechanized farming based on these bio-fuels will be totally bankrupt. Even today's partly mechanized farming is also highly inefficient as that requires imported petroleum and electricity and harvests less solar energy.

We have so far studied the economic audit, water audit and energy audit based on my experiences of my nano watershed at Ankoli on which we have tried every possible appropriate technology during past 22 years. This was the search for sustainable, evergreen watershed development. The cold blooded analysis of the energy audit and the water audit or environmental audit proved that we are facing deficits. Our Natural Capitals like water in our 'Panchkroshi' are depleting very fast.

That means, to overcome the deficit,

1. The Panchkroshi must import this water directly from other watersheds by depleting them. We have already lift-irrigated water and stored it in the Water Bank.
2. The Panchkroshi must pump water from the untapped reserves of thousands of years i.e. from deep aquifers. We have almost dried those reserves.
3. The Panchkroshi must import water through food, fodder, fuel, energy from outside without paying the actual cost i.e. virtual water import through material and services
4. The Panchkroshi must survive on money order economy from the younger generation migrated towards cities
5. Distressed migration and sale of physical labour temporary or permanently
6. Employment guarantee scheme, government grants, doles – cash or kind, NGOs grants or help those who can not migrate
7. Loans for the temporary false relief
8. Distressed sale of the accumulated natural capital – big trees, small trees, bushes, grasses, animals etc. for temporary cash requirements
9. Distressed sale of the sand, silt, soil and stones etc. as building material
10. Distressed sale of basic natural capital like land and transfers to the land grabbing racketeers
11. Illegal professions like corruption, theft, liquors and drug trafficking, gambling etc.
12. Immoral entertainment, human trafficking or prostitution as a last resort----
13. Suicides ---

In a nutshell, even after perfect watershed development, there will be deficit of water. This is applicable to entire Bhima river basins.

So we are forced to draw the following conclusions which are probably very hard to digest.

This deficit is mainly because of the horrible disparity in the exchange values of Agricultural produce and non-Agricultural produce and the horrible economic exploitation of the farmers. This exploitation was possible during the last 30 years only at the cost of accumulated natural capital, which has come to an end. We are at the point of no return. We are bound to fail miserably and we shall not be able to fight droughts and famines ----

1. In spite of all the NGOs and the government organizations honestly work and become successful in achieving total water-shed development in all the watersheds of Maharashtra state
2. In spite of all the water and soil conservation work and development of forests is achieved by magic and every sq. cm becomes a sponge
3. In spite of every sq. cm of land is covered with a plastic sheet during the rain fall and every rain drop and a dew drop is collected and stored in covered tanks and later on used for irrigation
4. In spite of increase in the average rainfall - even doubling the average by all the modern artificial rain making technology i.e. aerial seeding of clouds, ballooning and seeding, 'yadnyas' in every village and miracles by the saints and god men
5. In spite of not a single drop is allowed to flow into the sea by damming all the river systems
6. In spite of all the rivers in Indian subcontinent are interconnected by implementing all the engineering marvels & tricks!
7. In spite of all the snows of Himalayas are brought down and melted in the rivers and dams
8. In spite of all the water accumulated in thousand meter deep aquifers is pumped out on the surface
9. In spite of every drop of water is drip irrigated
10. In spite of entire contract of water management is given to Israel forever
11. In spite of all the sugar factories are closed for ever and the entire sugar lobby is destroyed
12. In spite of 75% of the rural poor population is eliminated by some fascist means

Sounding extreme?

But it is true. Nobody on earth can satisfy the greed of modern market forces, consumerism of organised class, unsustainable development and the speed at which our cities and mega-cities are consuming the natural resources like water as if this is the last generation of human beings on earth.

This was the search for Appropriate Technology sustainable evergreen watershed development.

After the long chase, it proved to be a mirage.

In fact, in the name of watershed development we are becoming more and more bankrupt on economic as well as environmental audits.

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End of part 1

*Part 2 deals with 'Factor 10 Appropriate Technologies' where knowledge input reduces material & energy inputs. It also discusses the real decentralized sustainable 'rurban lifestyle' development model where the best practices of rural and urban lifestyles are synthesized through the 21<sup>st</sup> century informatics application and proper Science and Technology communication with the masses thus implementing Gandhian philosophy in the 21<sup>st</sup> century.*

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