Comprehensive Land Development of Assigned Lands

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I. Introduction

The lands are quite an assorted lot proposed for comprehensive development. There is both inter and intra variability in terms of soils, water and vegetation. Some are government lands, some are 'bhoodan' lands, some are purchased lands, some are under irrigation etc. But most of them are unirrigated / rainfed areas, poor in quality (depth, texture, slope, erosivity) with rolling terrain (multiple slopes). A few parts of the lands are moderately good or medium in quality. Most of these areas are hinterlands and bestowed with logistic problems. They are infested with several problems – boulders, pebbles / stones, bushes, scrub jungles, denuded pastures and stumps of felled trees or overgrazed native grasses. Slopes are often times more with distinct catenaries situation – uplands, medium lands and lowlands. In such cases the quality of land improves as move down along the slope. Due to long fallows, the soil fertility might have recouped in some cases and the first year cropping would lead to higher productivity. But in many cases soil organic matter, the one that gives life to the soil, will be very very low. Then available nitrogen, in particular, will also be low.

There could be problems of salt infestation (salinity and alkali) or waterlogging or both in some of the irrigated areas. In the high rainfall areas, particularly tribal region (agency areas), soil acidity could be a problem.

Some of these lands are assigned and some are yet to be allotted.

Under such a scenario there cannot be a universal panacea in bringing back such lands to productivity. Further, the average holding size would be about 0.5 ha. Thus even if the soil is brought back to productivity, alternate enterprises are needed for sustainable livelihood security. Livestock in combination with the cop enterprise is the best in contributing to the livelihood sustainability and in environment-friendly management systems. Wherever feasible fruits, vegetables, medicinal and dye plants may be considered but on a community basis for easy marketing. Also non-land based activities may need attention. Homegardens for nutritional security are also necessary.

II. Specific Issues

Before we move on to the gemalities, some specific issues need our attention.

1. Poorer the quality of land more would be the investment needed for its retrieval to normal productivity. During our discussions with the clients we found the land is assigned along the slope in a few cases, but in other instances relatively good pieces of land have been allotted to the more vocal and/or other persons who are helping in coordination. The fund for correctives for the owners of poor quality land need be more.
2. If the land is already assigned, each small plot needs a separate wasteweir. As a trade-off the landholder must be encouraged to farm across the slope so as retain rainwater uniformly in his field and also detain the light weight organics over the entire field instead of allowing to gather at the lowest point in the field.
3. If the land is not yet assigned, regual soil conservation may be adopted and land assigned equally distributing poor, medium and good quality lands to all the clients.
4. Since catenary situations are more frequent, the investment in crop production must also be scaled up as the quality of land improves. In any case the concept of low external input sustainable agriculture (LEISA) must be adopted.
5. Biomass generation in any form, should receive priority attention so as to incorporate organics as much as possible in the field. This avoids logistic problems in nutrient management systems. Even composting elsewhere could be a problems as carrying the compost / FYM to the field might become a problem. One way is to plant MPTs in the ditches created to form field bunds and planting *Stylo* and *Anjan* on the field bunds. The other way is demarcate each holding with closely planted MPTs trained as bushes. These may include *Gliricidia*, *Pongamia*, *Vitex*, etc. The biomass so generation can be augmented by roadside plantations with MPTs, particularly on both sides of the path leading to the assigned lands from the habitation. Loppings from such MPTs could be either incorporated directly into the soil are allowed to decompose within shallow pits and spread later.
6. If livestock enterprise is accepted, ley farming can be practised on a community basis using *Stylo* and *Anjan*. Palletized seed may be used to save on the seed rate. Such systems are also a surer way of ensuing better germination of the legume and grass fodders. The ley could be for a period of 2 years. Grazing as well as cut-and-carry

systems can be adopted. Ley farming leads to sustainable crop production with almost no external inputs.

7. In all situations every effort must be made to ensure supply N only through organics. Such organic recycling not only improves the soil health, but all increases soil moisture storage and response to any external input. After all soil has to be a living system.

8. With large turnover of organics, the need for external application of secondary and micro-nutrients vanishes. Soil physical conditions, an important component in productivity enhancement, also improves. The organics @ 2t/ha would be adding 30-35 kg N besides other nutrients. And these are applied best by burying the same in shallow pits within the fields (may also consider burrow pits) immediately after the harvest of the monsoon crops. In wet semiarid and dry subhumid or humid zones, a legume may be taken as a second crop which incidentally adds consider leaf litter in the fields. The arid and dry semiarid regions, pigeonpea may be grown alongwith the base crop (sorghum, pearlmillet in most cases; groundnut in parts of Rayalaseema and south Telangana; castor in south Telangana). The leaf litter of pigeonpea adds 30-35 kg N/ha besides providing other nutrients. The stalks are a good fuel and the burrows left after sloughing off of the roots are good conduits for enhancing the soil moisture in the root profile.

9. All these systems warrant additional labour. Suggestion is to provide Rs. 8/kg organic N as subsidy as is presently provided to urea-N by the government. Such a subsidy not only covers the additional costs in labour, but also leads to carbon credits / sequestration, so important is reducing greenhouse gases emission. The system is eco-friendly. It improves soil health, so the plant, animal and human health.

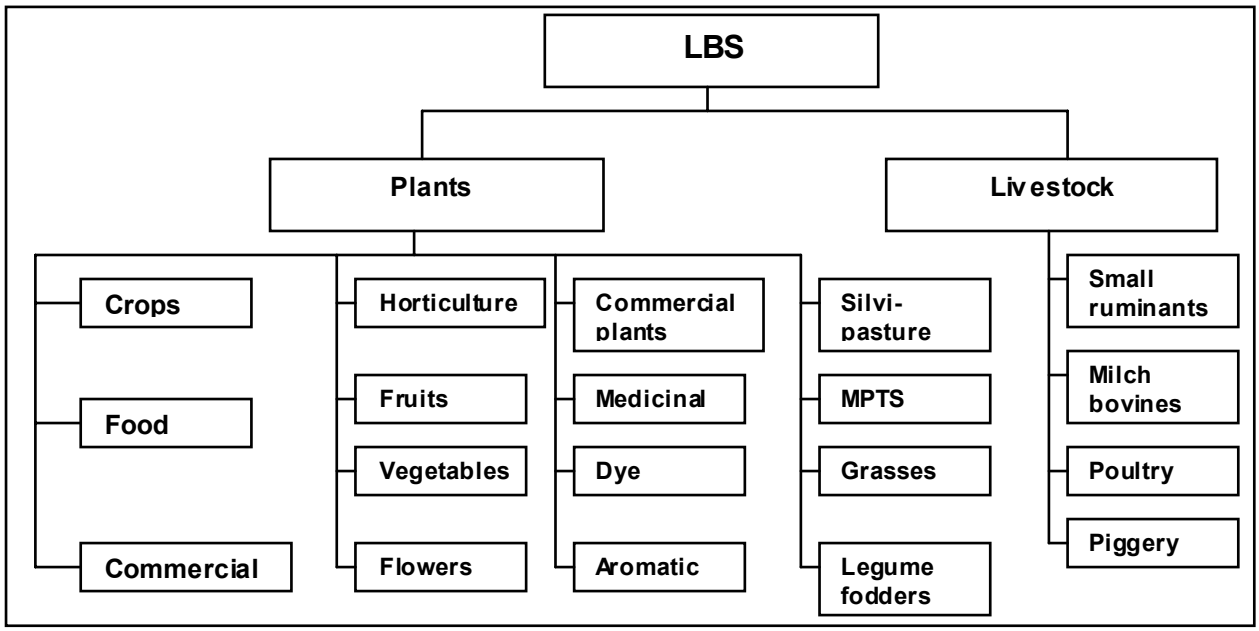
10. Any water harvesting through structures like checkdam, percolation tank, rock fill dam leads to enhanced groundwater recharge. The water so created must be treated as CPR. It must be treated as LIQUID GOLD and should be more efficiently used preventing using it for high duty crops like rice. However a market support for alternate crops is to be provided. Community action in this direction is more relevant. Growing vegetables (rainfed) organically provides a sure way of healthy family. Vegetables like cluster bean, field bean, cowpeas, cucumber, ribbed guard, tomato may be organically grown. Some of the vegetables may also find a way to local market.

11. As the assigned lands are generally far away fro the habitation, a water point for drinking purposes is needed to meet the requirements of both human beings as well as livestock. Borewell is cheaper than a dugwell. Community bore well may be considered for the purpose. The remaining water can be used for providing a critical irrigation to the standing crop or a come-up irrigation for the ensuing post rainy crop. Also we may consider protective irrigation for the possible local fruit trees (Jackfruit, *amla, seethaphal*, cashew) during the first 2 years for their establishment.

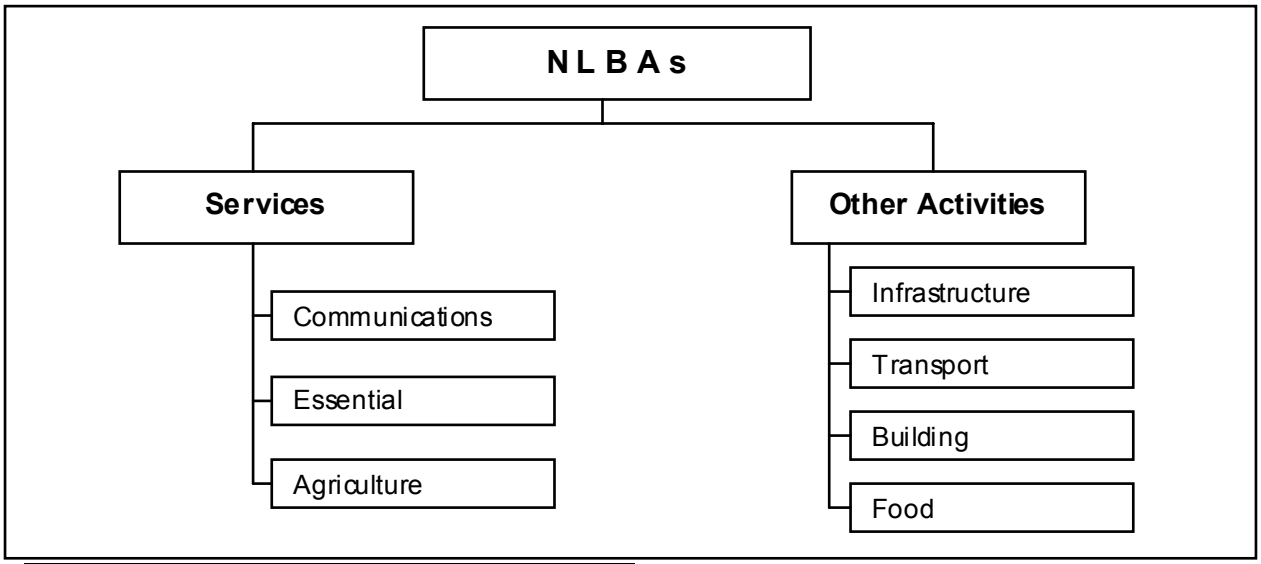
Expenses towards installation of the community borewell, storage tank, lead pipes, leveling of fields meant for critical / come-up irrigation may be out of project funds.

12. The land based and non-land based activities may include the following

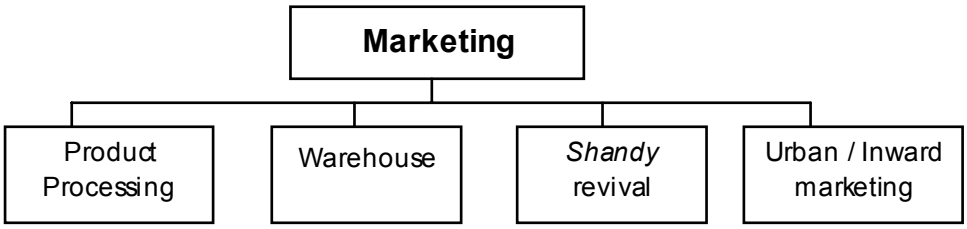
Land-based activities



Non-land-based activities



13. Internalized marketing systems is to be evolved as follows



14. Insofar as crop production is concerned, efforts needs be to dovetail the requirements of the livestock as well. This means growing of nutrition cereals (maize, sorghum, pearlmillet, fingermillet, foxtail millet, minor millets) along with legumes like pigeonpea in arid and dry semiarid regions and following with a legume like horsegram in wet semiarid red soils and proceeding or following with other short pulses (greengram, blackgram, chickpea) in other agroecological zones.

A legume in the cropping system is a MUST. Whenever commercial crops like groundnut, sunflower, niger, castor, soybean, safflower may be considered using HYVs but not HYBs.

Using seed drills to enhance seed use efficiency need be a part of crop improvement programme. Timely weeding is equally important.

Primary tillage using tractors / tillers with sowing and subsequent interculture using animal draft may be provided in the scheme of things. Wherever possible joint ownership of bullocks for draft may be encouraged.

15. Labour saving devices which also reduce drudgery must be introduced. Improved sickle is a case in point. Hand operated thresher of maize cobs is another. One a custom-hire basis plant protection equipment an even harvesting combines may find a place, at least on a Mandal basis or a cluster of habitations basis.

16. In order to improve the nutritional security homegardens need be encouraged by supplying quality seed of vegetables including leafy ones and seedlings of drumstick, papaya, amla, curry leaf, etc. The traditional vegetables like ash gourd and pumpkin may be grown. They have very long shelf life. As backyard poultry 10-20 Vana Raja / Giri Raja breed may be considered.

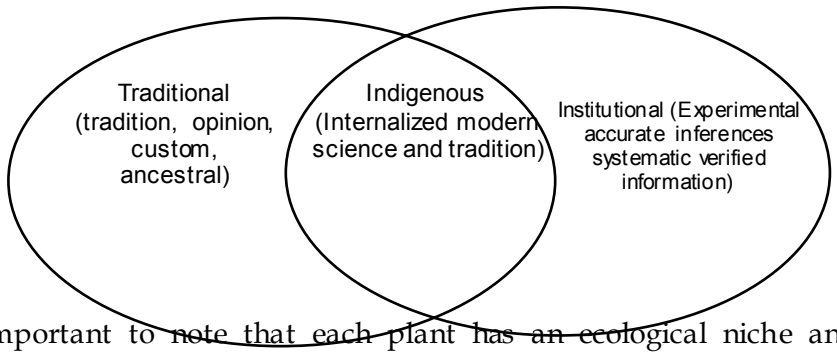
17. Livestock enterprises may consider two approaches. First is the viable unit at household level.

Type of livestock		Viable unit
Cows	::	2-3
Murrah buffalo	::	2
Sheep	::	50 Ewes + 1 or 2 Rams
Goat	::	30 Does + 1 Buck

Second enterprise is to rear 3 months old calves upto 2 ½ years age and then selling. In case of buffaloes, the rearing period may be increased to 3 years. Another alternative is to rear dry animals for 6 months during which they may conceive and when 3-4 months old pregnant be sold.

18. Green fodder need be produced for such livestock based enterprises besides providing nutritious cereals as feed.
19. Charcoal from trees mesquite and fibre for agave also are distinctly feasible.
20. In all production system the traditional and institutional technologies may be internalized and indigenous systems evolved to suit each of the agroecological niches. The scheme may be depicted as follows

Indigenous technologies



21. It is important to note that each plant has an ecological niche and cannot be universalized. This is not only with crops, but also true with fruit trees, vegetables and MPTs.
22. Further, cultivation of fruits, vegetables and for that matter flowers needs greater skills and personal interest. It is here that we reiterate these plants are grown organically for better health at the household level and marketing as well.
23. Droughts are not uncommon in our state. We have to live with them. There are a few ways to mellow the efforts of drought.
    - A good crop is an insurance against drought

- We must capitalize on good rainfall years and produce more foodgrains and fodder to meet the needs for the lean years
- As water becomes scarcer, we must first meet the demand for drinking water (Human and livestock)
- Seed would be another causality. Alternate seed for the delayed sowing may be stored to cover cropped area @ 1/3rd area in low rainfall, 1/5th area in medium rainfall and 15% area in high rainfall areas. Seed for next *kharif* may be produced in the *rabi* season under irrigation or procured from outside.

24. The ultimate goal in such ecologically and economically disadvantaged areas should be sustainable development thorough

Soil – Plant – Livestock – Human beings - Continuum

The system seeks positive synergism for the smallholders, in particularly

III. General issues

We propose to discuss peoples way of assessing soil classes for their subsequent efficient use. Then the present state-of-the-art in the management of water and vegetation are discussed.

A) User-friendly landuse classification & present status

Landuse classification is meant for proper use of the natural resources. Land includes soil, water and vegetation. In the present paradigm of participatory management of these natural resources, any classification need be simple and demystified. It must be easily understood by those who use these resources. In fact they need be involved in such an exercise in classifying the land for its proper use. We are attempting a simple method in such an endeavour.

a) Soils

Let us take soils first. The easily determinable characteristics in soil classifications are:

Depth
Texture
Slope
Erosion
Permeability

There are several subclasses in each of the above characteristics used by both national and international institutions. But we propose few classes which can be determined by the users. Details.

Depth	Visual	Classes
Depth	Visual	• Shallow (<50 cm) • Medium (50-100 cm) • Deep (> 100 cm)
Texture	Feel	• Light (Moist soil ball falls apart) • Medium (Moist soil ball holds together) • Heavy (Moist soil mall becomes sticky)
Slope	A-frame	• Nearly level (0-2 %) • Moderate (2-6 %) • Steep (6-33 %) • Very steep (> 33 %)
Erosion	Visual	• Sheet (More or less uniform removal of surface soil) • Rill (Removal of soil through conspicuous water channels) • Gully (Large channels conspicuous)
Permeability	Visual	• Slow (Heavy soil; hard subsurface) • Moderate (Medium textural soils) • Rapid (Light soils)

Internationally accepted are 8 classes in land. Of then I-IV are cultivable and the rest are not for farming, but for permanent vegetation. Based on the above classes of the characteristics, the soils can be divided as follows:

International classification	Depth	Texture	Slope	Erosion	Permeability
I	3	2,3	1	1	1,2
II	2,3	2	2	1,2	1,2
IIII	2	2,1	2	2	2
IV	1,2	2,1	2,3	2,3	2,3
V	1,2	2,1	2,3	2,3	1,2
VI	1	1,2	3,4	3	2,3
VII	1	1	3,4	3	2,3
VIII	1	1	4	3	3

It is here a further refinement in simplifying the classification is suggested. In the world over and in our country as well, the soils are traditionally classified based on productivity of the soils. For instance the red soils in Telangana are known in three categories – *Batte, Dubba* and *Chalka* and black soils at least in 2 categories – *Nalla* and *Regadi*. The characteristics of these soils are

Local name	Depth	Texture	Slope	Erosion	Permeability
Batte	1	1	2	2,3	3
Dubba	1,2	1	2	2	3
Chalka (Erra)	2,3	1,2	1	2,1	3,2
Nalla	2,3	2,3	2,1	1	1,2
Regadi	3	3	1	1,2	1

Evidently the soil classification would be

Local Name	Meaning of the local name	Soil class
Batte	Drought prone	IV
Dubba	Loose	III, IV
Chalka (Erra)	Red	III
Nalla	Black	II, I
Regadi	Clayey	I

In order to encourage the farmers accept the above classification, they may be clustered into 8-10 persons and asked to identify their fields in the cadastral map of the village. Then we can seek information on the local names and their characteristics. After listing them in such tables as above they can be grouped into classes I-VIII. Once this is done, the following information may be placed before the stakeholders for a discussion as to where their soils fit in.

Class	Definition
A. Soils suitable for cultivation	
I	Very good with no limitations
II	Good with minor limitations
III	Moderately good with perceptible limitations
IV	Fairly good with major limitations
B. Soils not suitable for cultivation	
V	Suitable for silvipasture (tree, grass) with no limitations
VI	Can be put to silvipasture with minor limitations
VII	Can be put to silvipasture with major limitations
VIII	Suitable for occasional trees, act more as catchments for rainwater harvesting

However with the ever-increasing population even lands that are not suitable for cultivation are opened up for farming. The possible management systems need and the associated risks are as under.

Class	Management systems	Risk in crop production (%)
I	Prime land, highly productive, soil erosion manageable at farm level	< 20
II	Good soils, prevent degradation by proper conservation measures, respond to good management, risk can be reduced through good conservation practices	20 – 40
III, IV	Not adequate to cropping, particularly class IV, conservation is a MUST, external inputs (organics and inorganics) needed to improve productivity, risk is high	40 – 60
V, VI	Low in productivity as well as low in resilience, degradation could be serious if the resource conservation is not attended to, otherwise risk is very high	60 – 80
VII, VIII	Not suitable for cropping, retain under naturals vegetation, if not degradation is serious, risk is very high	> 80

2. Soil degradation

When we look at the soil situation in the state, 54.5% are red soils, 19.5% are black soils and 3.2 % are coastal alluviums. The soils vary in depth, generally shallow in low rainfall regions of Ananthapur, Nalgonda, Mahaboobnagar and east Ranga Reddy districts, medium in medium rainfall regions of Kurnool, Kadapa, Nellore, Chittoor and Prakasam districts and deep in high rainfall areas of Khammam, Medak, Warangal, Nizamabad, Adilabad, Krishna, Guntur, Srikakulam, Vizianagaram, Visakhapatnam, parts of east and west Godavari districts.

There is continuous degradation of the soils. Water erosion is the main cause (83% of the soil degradation). About 54.7% of the soils are degraded, but are at different stages – slight, moderate, strong and extreme, areas bring 12.5, 23.3, 15.3 and 3.5 percent respectively. Of these the slight and moderate levels of erosion are manageable at the farmer level through agronomic manipulations (improved cultivation, better vegetation).

About 11.2 % of the total geographical area of the state is drought prone. Again not all is severe. The areas are divisible into 3 classes. They include

Class	Area (lakh ha)	Districts
Chronic	8.43	Ananthapur, Kurnool and Kadapa
Moderate	67.10	Throughout the state
Mild	36.32	Medak, Warangal and Nellore
Total	**111.85**	

Of these the chronically drought affected areas need a separate dispensation while the others are manageable with suitable interventions at farm level.

b) Water

1. Rainfall

Water resources include rainfall, surface ponded water, groundwater and soil moisture.

The rainfall and soil moisture determine the assured moisture availability periods in a given area. The rainfall in terms of monsoon rainfall and the length of the rainy season (in days) and soil moisture storage (mm) are needed to determine the length of the assured moisture availability periods for the *kharif* season.

First considering the soil moisture, the water holding capacity (WHC) would be as follows in different soil types.

Soil type		WHC (mm)
Texture	Depth (cm)	
Light	100	100
Light	50	50
Medium	100	150
Medium	50	75
Heavy	100	300
Heavy	50	150

The rainfall varies from as low as 568 mm in Ananthapur district as high as 1160 mm in east Godavari. The length of assured moisture period for crop production is provided in selected districts.

District	Annual rainfall (mm)	Length of the rainy season (days)	Soil moisture storage (mm) ★	PEt (mm/day)	Assured moisture availability period (days) ★★
Ananthapur	440	90	50	4	102
Kurnool	449	90	300	4	165
Adilabad	917	120	300	4	195
Vizianagaram	928	150	150	4	225

★ Major soil type; ★★ Also known as length of growing period

Evidently, the low rainfall areas, which incidentally are predominant in with poor soils are bestowed with short assured moisture periods.

2) Tank systems

We limit our discussions on surface ponded waters to tanks. In the state there are as many as 81,687 tanks. Of then only 63.5 % are in use. The area under irrigation from the tanks decreased from 9.0 lakh ha in 1961 to 7.27 lakh by 2001. The tank systems are under different management agencies.

Agency	No. of tanks	Percent tanks
Government	53184	66.5
PRI	15238	19.0
Cooperative	659	0.8
Private	19772	27.7

Earlier the water releases and related issues were decided by GP and traditionally managed employing *Nerradi / Neergatti*. About 100,000 families were eking their livelihood

through such systems. Now they are dismantled. WUAs have supplanted them in government managed tanks. Some *Neeradi* systems are still associated with other management systems.

The shrinkage in area under tanks is largely due to mutilation of the catchment areas through various interventions under watershed development programme as well as Neeru-Meeru programme. As much as 1298 million cum of space has been made available with these programmes leading to much reduced inflows into the traditional tank systems. There are also the other reasons like lack of maintenance of the catchment area, bunds, wasteweirs, feeder channels and sluices. This is leading increased silt load.

3) Well systems

Coming to the wells, the picture is much more alarming. The area under open wells and bore wells increases thus

(000's ha)

Year	Open wells	Bore wells
1961	629	147
1981	1021	283
2001	888	1066

The doubling period for open wells is 30 years as against 4 years in the case of borewells. And digging borewells is cheaper.

The present level of exploitation of groundwater in the state is

Status	Percent area
Overexploited (> 100%)	9
Critical (90-100 %)	6
Semicritical (70-90%)	15
Safe (< 70%)	70

There is a need to realize that the demand for drinking / domestic purposes would be doubling by 30 years. Presently 70-90% of water in all forms is used for agriculture. The water use efficiency (WUE) is very inadequate, being 30-40%. The WUE can be enhanced to 60-70% by using the modern gadgets which are no doubt expensive. The other way is to improve the groundwater recharge. By vegetating the catchment areas of the water bodies this can be enhanced. Wherever, the CPRs exist vegetating them with usufruct rights to the poor (who carry out the process of vegetating) will not only benefit them but also benefit the lower reaches with enhanced groundwater. A win-win situation.

In any case, all the forms of water need be conjunctively used with participatory planning. No doubt the infrastructure by way of marketing facilities need be provided by the government so that heavy duty crops (e.g. rice) may eventually be phased out in cropping patterns under wells and tanks.

It would also be prudent to identify the groundwater potential in relation the geomorphic units. Some examples are as follows

Geomorphic unit		Groundwater potential
A.	**River based**	
i.	Alluvial plains	• Highly suitable for shallow / deep aquifers
		• Old meanders & back swamps areas – excellent shallow aquifers
		• Paleochannels – excellent shallow aquifers
ii.	Flood plains	• Highly suitable for shallow / deep aquifers
iii.	Valley fills	• Good for shallow / deep aquifers
B.	**Deccan trap**	
iv.	Shallow weathered pediplain	• Suitable for shallow aquifers in weathered zone. Fracture / fault concentration zone possess good prospects
v.	Moderately weathered pediplain	• Shallow aquifers limited to fracture / fault concentration zone (Moderate)
vi.	Deccan plateau	• Good along faults, fractures and bedding planes

c) Vegetation

It includes forests, pastures, plantations, orchards and crops of both *kharif* and *rabi* seasons. The forests include dense forest (more than 40% crown density), open forest (10-40% crown density) and scrub (less than 10%). Similarly the pasture area and its present level of degradation can be demarcated using the following guidelines.

Ecological status: Each region, if fully evolved, will have the climax species of grass. For example

Sl. No.	Climate	Climax grass cover
1.	Tropical	*Sehima – Dicanthium*
2.	Subtropical, semiarid	*Dicanthium – Cenchrus – Lasiurus*

The percentage of present vegetation which consists of the original vegetation is one index of the status of the natural pastures.

Class	Percent of climax grasses
Excellent	75 – 100
Good	50 – 75
Fair	25 – 50
Poor	0 – 25

However in arid zone the vegetal cover in pasture would be low. Hence different criteria are suggested as below:

Degraded condition	Criteria				
	Yield (q/ha)	Percent (%)			
		Basal cover	Tall perennial grasses	Low perennial grasses	Species of poor edibility
Excellent to good	15-20	13-18	7-15	-	-
Moderate	7-15	13-18	3-7	5-8	-
Severe ★	2-7	80 % reduction			
Decertified ★	Less than 2.0	-	-	-	Few

★ Ephemeral grasses contribute in biomass.

Vegetation from CPRs is one of the resources for livelihood security of the poor including shepherds. The state has 14% area of CPRs. About 17% of the total income of the poor emanate from the CPRs through fuel, livestock grazing, NTFP and employment. We require to rejuvenate these CPRs, wherever available, for improving the livelihood security of the landless and the poor. As pointed out earlier, then a win-win situation develops wherein the poor and landless get some additional income from the CPRs and the land owners below get improved groundwater recharge. The APPS has shown us the way for natural revegetaton of reserve forest lands for sustainable livelihoods of *Dalit* committees. In the process 228 villages in 28 mandals of Ananthapur district were covered, protecting an area of 30206 ha by 2003. In all 6808 members (of which 40% are Dalits) were involved. The usufructs were shaved and the family benefit per annum was Rs. 675/-.

It is here we may also note that there are hundreds of tribal villages in the country that are moving towards self rule, declaring that the village assembly (*gram panchayat*) is the decision making body for all local activities including management of natural resources. Many have declared part of their surroundings as peoples' protected areas, banning destructive extraction of resources or hunting.

d) Landuse

Presently the land use does not match with their potential. The soils that should not be cultivated are under plough. What is more, these soils are largely owned by the poor (SMF). The water resources are misused and/or overexploited. Traditional management systems are given a goby. Present systems are highly politicized. With the extraordinary subsidies groundwater depletion is alarming moving a point of no return. Free access to CPRs is the new paradigm after independence. And it is the prime cause for their

overexploitation. Vegetal cover on the soil is fast depleting. Fodder, fuel, manure and others of plant origin are becoming scarcer. Soil erosion is on increase. Silt loads in runoff are more. The traditional tanks are getting silted up. In the catchment areas several interventions (watershed development and 'Neeru – Meeru') are made to harvest the runoff beyond the permissible limit of 30% of the runoff. In the process two things are happening. First the inflows into traditional tanks have diminished. Some tanks are drying up. Second these interventions triggered and catalyzed 'bore well' activity. The groundwater exploitation is on rise. This is true even with drip and sprinkler systems. As more area is brought under irrigation, the groundwater depletion continues, thanks to all the subsidies and overzealous marketing strategies of the industry.

With these processes sustainability, particularly in rural areas, is in jeopardy.

II. Retrieval of the degraded lands

A) Soils

The soil erosion leads to loss of top fertile soil. Continuous cropping without proper nutrient management depletes the soil fertility. Loss of organic matter with high external inputs not only leads to loss of life in the soil, but also results in poorer soil physical conditions. Further even the responses to added nutrients would decline. So the twin problems of soil erosion and loss in productivity need be tackled.

1. Soil erosion

Soil erosion by rain is primarily due to the hydro-dynamic energy associated with the rainsplash. The individual raindrops strike at high velocities (upto 9.0 m/sec) and so are the main cause for the detachment of soil particles. Next is the flowing water. Rainsplash detachment occurs over vast areas while detachment by flow is often concentrated in small definable channels (e.g. Rills). Sediment carried in the process is deposited when the sediment load exceeds the flow's total transport capacity to transport coarse – sized particles present in the sediment load. As the transport capacity of the flow decreases the bed-load material first get deposited followed by suspended-load and finally the colloidal component. Light rains may produce little or no runoff and hence cause little or no erosion. Intense storms of 25.0 mm/hr and above generally cause sheet erosion. The sheet erosion is followed by rill erosion. This may finally lead to gully formation.

Farmers Interventions

Vegetation in some or other form reduces the erosivity of the rainfall. However, the interventions at the farmer level had been:

Black soils, low rainfall

- Field bunds with wasteweirs
- Land leveling, deep ploughing
- Surplus through field to field by stone wasteweirs

Black soils, high rainfall

- Field bunds with conservation drains
- Grass strips on boundaries of land with mild slope
- Surplus through boundary waterways
- Stone checks on boundaries to harvest soils and reclaim gullies

Red soils, low to medium rainfall

- Low cost stone checks across hills (intra-field)
- Field bunds with wasteweirs in upper reaches
- Field drains with wasteweirs in low reaches
- Surplus through boundary waterways

Red soils, medium to high rainfall

- Field bunds with wasteweirs
- Field drains with wasteweirs
- Vegetation on field bunds / drains
- Boundary waterways for surplussing

High slope, low rainfall

- Stone bunds on the boundary across major slope
- Stone mulching
- Surplussing through field to field stone bunds
- Stone checks for soil harvesting and reclaiming gullies high slope, high rainfall
- Stone bunds on the boundary across the slope
- Boundary waterways for surplussing
- Stone checks on boundary to harvest soil and reclaim gullies

Thus the interventions are **doable** at the farmer level within the resources that are locally available. Field bunding has been all pervasive.

Governmental intervention

From late fifties the governmental intervention in soil conservation was primarily through contour bunding. It is estimated that 42 Mha have so far been bunded in our country. Wherever these bunds were laid across the fields, most of the farmers had been erasing them to the ground. Further cart, tractor, animal and human trespass had been the other cause for degradation of these structures. Those that remained in tact are the strengthened field bunds across the slope and those that have been laid out in community lands in some of the river valley projects. In the entire governmental programme the farmer had been a **mute spectator** except for signing an agreement on cost sharing which however was never enforced. So the bunds were freely laid out without the involvement of stakeholders and with no follow up / maintenance. Under the aegis of the World Bank Vetiver as a vegetative barrier was introduced in a big way as a substitute to contour bunds. But it could not catch up.

In this regard Robert Chambers comments are pertinent. "Soil conservation programmes around the world have provided examples of arrogant ignorance and insensitivity of imposing standardized bad practice on rationally resistant small farmers. Often "we" – professional – have been confident that our bookish education has given us superior insights, that "we" know and "they" are ignorant, that "we" should plan for "them", that our packaged technology from research stations and laboratories is superior; that, in short, we know best and they know worst. But the ignorance has often been ours".

In any case, it should be realized that the erosivity of rainwater must be arrested to prevent loss of productive surface soil. And to do this, in the participatory paradigm of the present watershed programme, we need to accept the **doable** practices at the farmer level. Some have been listed above.

We may consider the following Do's and Don'ts in soil conservation, taking an overview all the actions in this endeavour.

- Soil erosion by rain takes place when the intensity of the rainfall exceeds 25 mm / hour.
- Vegetation (e.g. a good crop canopy) is the best moderator in soil conservation.

- Do not bother of soil conservation if the slope of the land is less than 1.5 % in light soil and 0.75% in heavy soil.
- In such cases good crop husbandry would be largely adequate as the crop canopy so developed would prevent the beating action of the rain
- The contour bunds along with wasteweirs are for low rainfall (less than 600 mm) regions and in light soils, while the graded bunds are for the other rainfall zones and in less permeable soils. Also in heavy soils even with low rainfall graded bunding is to be adopted.
- Maintenance of the bunds has to be done. Vegetating the bunds with fodder legumes / grasses is one important way of protecting the bunds and also compensating the loss of about 6% land occupied by the bunds.
- If contour / graded bunding is not acceptable to the farmer, strengthen the boundary bund across the slope with the above said vegetative means and provide a wasteweir at the lowest point.
- Grassing the waterway and gully plugging should be an integral part in the watershed development.
- Vegetative barriers may be encouraged wherever possible with dual purpose local species of vetiver. They are best established combining with small earthen bunds. In any case the bunds should be appropriately provided.
- In gullied areas, brushwood dams may be considered.
- Thus bunding of farm fields is a MUST to (a) reduce soil erosion and (b) hold rainwater *in situ* for extended water availability in rainfed areas.

2. Loss in productivity

While improving crop production in rainfed areas, two cardinal principles – timeliness and precision – should be borne in mind. Early seed bed preparation and using seed-cum-fertilizer drills to place the seed and any fertilizer at the precise depth lead to better plant stands. And this is the basic foundation for a good crop, more so with HYV / HYBs. Early ploughing ensured weed free seed bed, weeds, otherwise, course serious crop losses.

Rainfed areas are not only hungry but thirsty too. *In situ* rainwater harvesting through contour sowing and harrow for weed control and soil working must be practised to tide over intermittent, but short periods of moisture stress.

a) Area shifts

Crops

The area shifts over the last 16 years have been examined in the state. The area shifts of important crops have been as follows.

Area shifts in crop cultivation (hundred thousand ha)

Crop	Percent area under irrigation	QE 1988-89	QE 2002-03
Rice	96.4	35.67	38.44
Sorghum	2.3	16.70	6.86
Pearlmillet	16.7	3.36	1.13
Maize	33.8	3.02	4.67
Ragi	23.5	1.93	0.90
Minor millets	0.4	3.32	0.62
Coarse cereals	12.4	28.34	14.17
Pigeonpea (Redgram)	0.3	2.92	4.38
Chickpea (Bengalgram)	1.9	0.51	2.37
Groundnut	19.4	18.27	17.64
Urdbean (Blackgram)	NA	3.03	5.54
Sunflower	NA	0.80	2.98
Cotton	18.9	5.57	10.53

Amongst food crops area under rice, maize, pigeonpea, urd bean and chickpea is on rise. There is a dramatic fall in *kharif* sorghum area as also that of minor millets being replaced by oilseed crops. Amongst oilseeds, the area under sunflower continued to increase while that of groundnut had been a decline but less significant. Area under cotton also increased enormously.

Productivity

The production and yield of selected crops was examined over the same period.

Production of selected crops

Crop	QE 1988-89	2002-03
Rice	77.62	107.39
Maize	4.66	14.76
Coarse cereals	20.00	23.02
Pulses	6.20	9.77
Pigeonpea	0.67	1.76
Chickpea	0.19	2.40
Oilseeds	16.40	18.23
Groundnut	15.90	14.92

It is clear that the yield of oilseeds showed a decline. It is interesting to note the increase in yield of pulses, more so that of chickpea. These trends are largely due to the fact that with increased costs of production of cotton, much of very productive areas are shifted from cotton to chickpea in particular. The area under oilseeds expanded to less favourable areas leading to diminishing yields.

But what is more interesting is the shift to maize in traditional *kharif* sorghum areas. Also there is a phenomenal increase in yield of this crop (105 %) over the last 16 years. Evidently external input use is on increase (HYB; fertilizers) and better areas are put to this crop relegating *kharif* sorghum to still poorer environs.

b) Shift to chemical agriculture

The shifts from traditional to chemical agriculture lead to several problems. Some of them are highlighted hereunder.

The HYV / HYB perform well under better endowments and higher fertility status. They are short in duration with less vegetative phase. They are bred to perform as a community. Yield potential is high. The traditional varieties perform well in less endowed areas. They are long in duration with long vegetative phase. They are bred to perform as individual plants. Yield potential is low but can be improved with LEISA.

Timeliness is sowing, achieving optional plant stands (except with perenniating crops like castor and pigeonpea and highly adaptable sunflower) are necessary for HYB/HYB. The traditional varieties can do normally even if there is some delay in sowing and/or inadequate plant stands. In fact the smallholders rent out their draft cattle to the largeholders for sowing and other operations taking advantage of these characters associated with traditional varieties which they normally grow. Even *rabi* sorghum grown by them is *Maldandi*. It has also enough flexibility over population as well as time of sowing. It can perform best with better environments and does not fail even in poor environs. Some grain is assured besides fodder unlike HYB / HYV varieties. With HYB/HYB, line sowing has come to stay. It has many advantages – weeding, fertilizer application. However harvesting has to be done at one time. Labour could be a problem.

Further with HYB / HYV, bio-diversity is being lost.

The traditional varieties are more often sown as mixed crops by the smallholders. They take advantage of the synergistic effects of legume crops (N, leaf litter) on the cereals. In fact they grow several varieties of the different crops in the mixed cropping. There is a great biodiversity. They harvest the crop / variety as it comes to maturity. Labour is not a problem under such situations. Field is their grain store. They do not have enough space even to live. If it rains, they provide shelter to the cattle in the house and they stay outside.

With shift to commercial crops, monocropping is seen more frequently leading to soil health problems. Deficiencies of Zn, Ca and even S are reported. Sometimes P-induced Zn deficiency is also observed as in groundnut in Ananthapur. Earlier sorghum was taken in *kharif* or *maghi* or *rabi* season in medium to deep soils with good rainfall. This was either followed by a legume (urdbean / chickpea) or preceded by it (mungbean). The turnover of the legume creates a better living condition for the soil and the nutrient disorders cited would not be seen. Thus legume in cropping system was common. Now with monocropping, such systems vanished. Naturally cost of production would increase.

c) Less external input sustainable agriculture (LEISA)

i) Nutrient management

Insofar as crop nutrition is concerned, the earlier efforts have been integrating crop and livestock production systems, legume in crop production systems, use of tank silt as manure, penning of small ruminants, besides green manuring, green leaf manuring and crop residue incorporation. The livestock have an important role in nutrient recycling.

Thus the 'manure' component in the livestock is important, but often times less emphasized or even ignored. The estimated availability of N,P_2O_5 and K_2O from the dung / night soil of the livestock and human beings is 895, 1147 and 605 thousand tonnes / annum in the state.

The soil productivity in a region is recouped through

i) the manure from livestock
ii) the leaf litter from multipurpose tree species (MPTs),
iii) nitrate - Nadded through rain

The contribution of the above depends on many variables. They include farm size, livestock owned by the farmer, periods when the livestock is kept on the arable fields and/or

held by the farmers by herding, transport losses, percent efficiency in storing number of MPTs (density) on the farm and the amount of rainfall.

Taking 1/3rd of nitrogen coming through livestock and MPTs as the readily available N for crop plants, the available N would be about 10,14, and 22 kg/ha in Zone I, II, and III respectively.

FYM / compost making is the most abused in our country. The state is no exception. But thanks to vermicompost, today there is a realization on properly preparing compost from the crop and animal residues. It should be pursued so that the end-users themselves prepare the compost / vermicompost to avoid exploitation by market.

The tank silt application has taken a new dimension. With use of tractors for hauling, the smallholders are almost deprived of its use. We must ensure that the shallow poor soils (16% in the state) receive this valuable material.

Penning through small ruminants is very valuable and need be encouraged as it one of the efficient recycling systems. In all these cases besides N,P,K, several other nutrients would be added besides organic matter, microorganisms and hormones. Secondary and micro-nutrient disorders will not be arising.

ii) Pest management

Further, the pest-predator existing earlier had been disturbed due to shortening the duration of the crops. The problem is further accentuated with high nutrition and increased relative humidity in the canopy along with shade. So more and more chemicals are used for pest control. Pest can devastate the crops. A pre-sowing ploughing helps birds in picking up pupae and larvae lying in the soil.

The NPM calls for revitalizing the earlier systems of pest control. Timely sowing, use of decoy crops in inter or mixed cropping, spray of leaf decoctions (neem, *Pongamia*, *Vitex*, *tulasi*) are some examples.

In the recent past bonfire or use of light traps for attracting insect pests and killing in kerosonated water was gaining ground. Even physical collection of caterpillar and killing in kerosenated water is picking up. Similarly use of Nuclear Polyhedrosis Virus (NPV), *Trichogramma* and *Trichoderma* is picking up. Release of *Microptilis* to control castor

semilooper has come to stay. Use of pheromone traps in cotton and groundwater crops is also encouraged.

Producing of such bio-agents by the stake-holders themselves on a network basis is now a reality. The government provides funds for creating such facilities. If the need arises, only relatively environment-friendly pesticides may be put to use. Whenever herbicides are used for weed control, it is mandatory to combine it with mechanical measures as to reduce the use of active ingredient, and thus leading to effective control of weeds.

iii) Water management

Insofar as water use is concerned the participatory hydrological monitoring (PHM) is slowly gaining ground, especially with the fast depletion of ground water. In this endeavour, groups of farmers decide on crops and cropping pattern, based on the net available water, which include soil water, rainfall, 65% of rechargeable ground water and surface water if any. Low-duty crops are taken up in lieu of rice, sugarcane and wheat. Priority is for foodgrains (e.g. nutritious cereals and legumes) followed by commercial crops like vegetables, fruits, flowers and medicinal, aromatic or dye plants besides bio-fuel plants. High-value crops can be taken up by using expensive gadgets like the micro-sprinkler or drip systems of irrigation. Such endeavours are successful only when proper market support is provided or developed and the farmers work in groups (e.g. CIGs).

To practice such innovations built into LEISA large-scale training and capacity building is needed. It is best done through the master farmers, promoted by GO or NGO agencies. Provision of infrastructural facilities like resource centre, warehouse, product processing for value addition and marketing also form a part of the capacity building.

LEISA largely suggests the principles of organic farming, but also has a space for use of some critical external inputs. The LEISA requires to be evolved through the participation of the people. The crop production technologies can be evolved through participatory technology development (PTD) approach. From seed to seed, there should be a continuous dialogue between the farmers and the facilitators through farm field school (FFS) approach. These should lead to integrated crop management (ICM) system. Master farmers can be identified to take over as private extension service providers (PESPs). In other words enhancement of production has to be achieved though a tier system.

The ICM should encompass in-village seed production, INM, NPM and even integrated water management through PHM. Finally it should be our endeavour to evolve collective marketing.

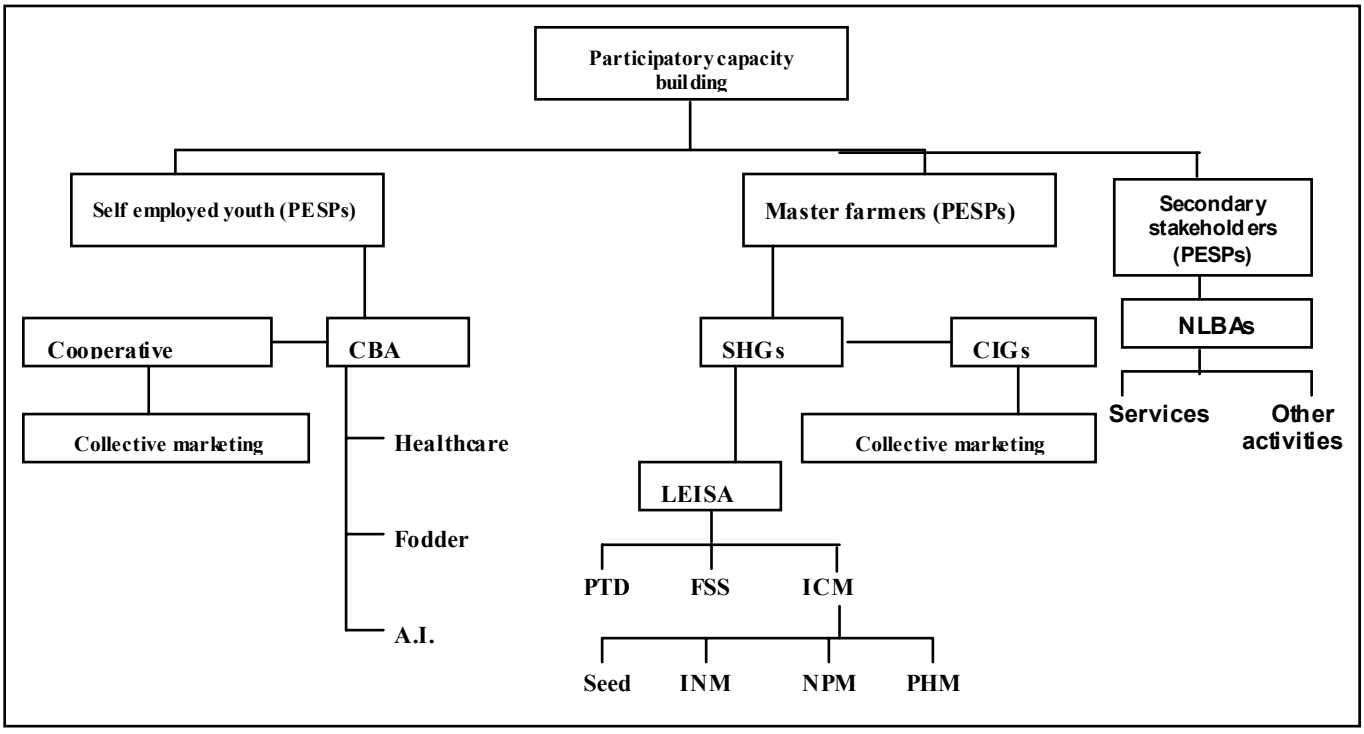
iv) Livestock management

Insofar as livestock production is concerned, self employed youth can be the PESPs. They can encourage livestock managers to form into CBAs (cattle breeder associations) and provide healthcare, artificial insemination (AI) and technologies in fodder production.

v) Extension management

Finally these PESPs can develop cooperatives of the CBAs for collective marketing. The following figure provides the flow chart for LEISA approaches.

PESPs in capacity building in production system



The LEISA approaches are eco-friendly and they reduce cost of production and meet the growing demands of the green-consumers. Then the health of the soil, livestock and crops can be ensured and in turn the health of the people in the habitation.

In summary, primary approach suggested is

Soil-Plant-Livestock-Human beings continuum

The concept seeks positive synergism for the smallholders, in particular.

The need for soil health to maintain health of the plants, livestock and human beings is emphasized. As the soil is a living system, there is a need to continuously replenish organic matter in any form, but at smaller levels (say 2 t/ha) Then alone the crores of microorganisms can survive and assist us in producing healthy crops, healthy livestock and a healthy nation.

In order to achieve the set goals, it is reiterated LEISA concept that provides space for critical external inputs is suggested in the place of organic farming which totally excludes external inputs.

3. Wastelands

Wastelands are also scattered in the watersheds. However they did not receive the needed attention. Wastelands are defined, for the purpose of our discussion, as areas that for any reason are presently unproductive at a level much below their potential.

Since wastelands are unproductive for different reasons, different technical solutions will be needed to retrieve them to their normal productivity. Broadly speaking wastelands can be grouped into uncultivable, cultivable, social, and marginal.

Their characteristics and the needed treatments are as follows

Class	Characteristics	Treatment
Uncultivable	Lack of soil (e.g. Himalayan peaks; frozen arid Ladakh, hot arid west Rajasthan)	• Sparse vegetation in soil pockets
Cultivable	Some soil, but alkaline, acidic, saline or water logged	• Tolerant crops and trees • Soil treatment like deep ploughing, drainage • Chemical amendments like gypsum, lime • Need community approach, expensive • Otherwise tree based system, cheaper
Social	Largely good soils, but either ownership common or absentee. Could have been overexploited, need high capital investments	• Assign on long lease to have have-less or have-nots through SHGs • Small parcels of land could be assigned to individuals in the groups • Bonus incentive to individuals and groups that perform well. • Usufructs to all the participants
Marginal	Shallow soil, infertile unproductive, either left uncultivated or owned by small and marginal farmers without investment capabilities	• Need both social and technical interventions • Need higher governmental support • Tree based systems (including MPTs and fruit trees) ideal, but difficult to implement • Provide financial support during the gestation period

Thus, there is no universal panacea to ameliorate the wastelands. No doubt tree farming would still remain the first choice in living with the problems like shallow rocky soils, sandy, duny soils, salt affected soils and other wastelands. Reclamation by other means is possible, but expensive. Wherever it is possible to grow high value crops / plants such treatment may be considered.

4. Fallow and leased lands

While we consider tree as a useful corrective measure for degraded / wastelands, foodgrain production also need be considered. The food insecure persons are upto 50% in the hinterlands. These figures vary from 25% during good monsoon periods to 75% in poor monsoon periods.

In order to minimize food insecurity the fallow lands and/or leased lands should be brought under plough. Several NGOs (eg. CEC & MVF, Hyderabad) showed that such lands can be cultivated with food crops on a community basis (eg. SHGs). Such groups are predominantly women based and generally poor. The district administration could help in leasing such lands on short term basis with the objective of enhancing local availability of foodgrains. Some details on fallow and leased lands are provided hereunder.

i) Fallow lands

The fallow lands could be from their own lands which they could not cultivate for quite sometime for want of labour or cash input. They could also be from the village panchayat (common lands). Such lands need some investment for reclamation.

While reclaiming such lands, the following points may be kept in view.

- No universal panacea
- Problems
  - Boulder (removal)
  - Bushes (clearance)
  - Pernicious weeds (deep ploughing and hand picking)
  - Capped soils (tractor ploughing)
  - Tank silt application needed in marginal areas
- Access (reach)
- So funding for reclamation NEED be site specific
- Also first preference of the stakeholder is his own fallow lands

ii) Leased lands

Many a time cultivable lands remain fallow either because of absenteeism or because of incapacity of the land owners. Such lands could be taken on lease either on annual or triennium basis by either individuals or groups of food-insecure farmers. They can, then, grow food crops. Such lands could be put to immediate farming because they are otherwise normally under cultivation. There is no need for additional cost in bringing such lands under plough.

b) Water

The decline in tank system was examined by DHAN Foundation, Madurai; Planning Commission, GoI; NGRI, Hyderabad and ICRISAT, Hyderabad. The main reasons included

- Lack of maintenance of catchment area, bunds, wasteweirs, feeder channels and sluices
- Further the catchment becoming barren, silt load was high leading to silting up of the tank
- Also the tank management became ineffective. The above 40 ha command area tanks were taken over by the government and lesser area tanks left to the Panchayat Raj Institutions (PRIs).
- There was unauthorized cultivation of the tankbeds and sometimes even foreshore encroachment
- Repair and maintenance of the tanks was not at all receiving any attention.

The tanks, as said earlier, were managed by the people. *Neergatta / Neeradi* was traditionally managing the tank water. Generally he was not owner of any land in the command area and belonged to lower classes in the society. But he was a moving repository of all the management components of the tank system. Such families were about 100,000 in the state. These institutions are now ignored. They have become unsustainable and food insecure.

Water User Associations (WUAs) are formed for the government controlled tanks. *Neergatti / Neeradi* is not even a member of these WUAs. WUAs are provided some seed money for the first three years only. So they are now finding it difficult to further act

together. These is a need to at together as repair and maintenance of tanks on a cascade / hydrological basis would be lot cheaper than addressing such problems on individual basis.

The PRI tanks do not have WUAs. They have informal WUAs. Some are still utilizing the services of the *Neergatti / Neeradi*.

But what is more disturbing the recent overexploitation of the rainwater from the catchment areas of these tanks. Several CDs, PTs, CCTs, RFDs and other activities have come up. All these are leading to very reduced inflows to the tanks. Even the subsurface flows are badly affected as several thousands of borewells are coming up. So the tanks are drying up. In fact in a recent study of Sharma, Director, NIH it is said if the present exploitation of the catchment are continues, the famous Himayathsagar and Osmansagar will dry up by another 30-35 years. Very alarming.

Digging wells was in practice in south India. As and when hydrological drought occurred, during which period streams / rivers and lakes / ponds dry up, the wells were dug and water used for supplemental irrigation.

India is known for its overexploitation of groundwater. By 2003 we have 21 million wells in the country, adding one million per year. As per IWMI, we have used up 200 cubic km of groundwater as compared to 100 in USA, 90 in China, 45 in Pakistan and 29 in Mexico and Iran.

Unfortunately the deep borewells deprive the shallow borewells as well as all the open wells of water. So they go dry. Today the state has WALTA wherein the hydrological certificate is needed to dig any borewell. It is well known that legislations bring in more corruption than discipline. Otherwise 60,000 borewells in a matter of six months would not be feasible in Ananthapur district (during the second half of 2003).

So what is more desirable to make water as everybody's business. From 2000 AD Zimbabwe has done this and succeeded inspite of lack of congenial political atmosphere. The country formed committees based on catchments with people eking a living in that area. We know there are varied demands. The users include farmers, dwellers (urban and rural), industry, hotels, amusement parks, etc. In the Zimbabwe act all these users are represented. They decide on how to use the available water. They have to clear any extraction point (borewell). We can adapt this model for sustainable use of not only groundwater, but all

other forms of water – rainwater and surface water. All these waters are to be treated as a common pool resource.

Otherwise with the competing demands, those who can afford to invest / pay more will usurp all waters. Thus the landless and smallholders would be deprived.

A twin track approach is needed to tackle these problems. First is to improve use efficiency of the water from any source. Second is to recharge the groundwater through cost effective interventions.

Coming to the interventions for enhancing groundwater recharge, the CDs, PTs, CCTs, and RFDs are presently widely adopted. But due to the hurry, the micro-catchments of these structures received little or no attention. In the process they are getting silted up and becoming dysfunctional in no time.

But what could be the most ideal is to rejuvenate the vegetal cover in the upper reaches of the watershed / habitation. This provides a win-win situation where the landless, graziers and other would also be benefited with the Non-timber forest products (NTFPs) and the usufructs thereof. The landed peasantry in the lower reaches would have the benefit of recharged groundwater.

Yet another dimension to cover water shortage is the attempt to recycle wastewater. With minimal treatment such water can be used for growing MPTs. In fact attempts also should be minimize wasteful use of water, more so in urban areas.

In any case what is utmost desirable is ensuring safe drinking water to all – human beings as well as livestock. The minimum needs of water (litres per caput per day-lpcd) needed are:

- Human beings - 40
- Bovines - 30
- Small ruminants - 1.5 – 2.0

That area development on watershed basis generates more water is well known. But it is not necessarily true that adequate drinking water would be available. We must have separately identified borewells for the purpose. Recharging such borewells by improvised micro-catchments must be ensured. It is here, the Maharashtra model supported by World Bank is relevant. In the rural areas, the habitations are to have a committee of all users

(drinking water) with at least 50% of them being women from all categories. The inhabitants are to share 10% of the costs of providing drinking water through the committee.

Coming to the quality there are two types of problems. One is inherent. The second is created. The inherent problems in the state are

Problem	**No. of habitations**
Fluoride	12,068
Salt	8,519
Iron	441

They need special dispensation. The National Drinking Water Mission addresses these problems.

The created problems are primarily through pollution. Heavy metals discharged through effluents in urban areas, salt and dyes from textile industry and organic pollutants from pharmaceuticals are examples. These problems are not universal. They are in pockets and are in urban and semi-urban areas. The WALTA has legislative authority for checking such pollutions. But the government relaxes the stringent rules for the fear that industry may not establish factories with such controls and norms.

So the government must consider using scrubbers and phyto-remediation measures to mellow the effects of such pollutants. Such treatment would be expensive or take long time. But human / livestock health is still more expensive and warrant special dispensation for correcting such maladies.

C) Vegetation

Vegetation in any form should be welcome in the watershed programme. Vegetation includes trees (multi-purpose trees, fruit trees), shrubs / bushes (particularly medicinal, aromatic and dye plants besides fodder plants), grasses, fodder legumes and crops.

i) Land capability

We need to consider the arable (Class I-IV) and non-arable lands (Class V-VIII) separately as discussed earlier. Normally, the first category is privately owned and the second by the community (Panchayat, non-reserve forest and reserve forest areas).

ii) Choice of vegetation : Private lands

In the arable lands (private), larger emphasis would be on high value trees (fruit trees), shrubs / bushes (medicinal, aromatic and dye plants) and grasses (aromatic). Absentee land owners may opt for high value trees like *Subabool* (*Leucaena leucocephala*) to avoid labour problem and prevent land encroachment.

iii) Choice of fruit trees : Private lands

Coming to fruit trees, we need to realise that the farmers may like to choose whatever is observed by them. But as a moderator, we may suggest the following keeping in view his resources.

Resource	Choice of fruit tree
Poor soil, low quality water that too not adequate	*Ber*
Poor soil, low quality water but adequate	Pomegranate
Good soil, good quality water and adequate	Citrus, papaya
Good soil, normal water, less adequate	Mango

The list is by no means comprehensive.

iv) Tree choice for private degraded lands

There are also degraded private lands. While there are several technological options available for correcting the maladies, most of them are expensive and also warrant community action (salinity, alkali). However, a tree component is the most efficient way of managing such wastelands. Here comes the importance of multipurpose trees. They should definitely be of the choice of the end users. For instance *Acacia catachu* can be taken up with some profile modification. But it will not be acceptable to the end users as it is primarily an industrial plant and sold out through auction. Instead a fruit tree like *Seethaphal* (*Annona squamosa*) or a tamarind tree or a grass like *Bodo* (*Cymbopogan* sp.) would be welcome.

v) Choice of vegetation : Community lands

Even in community lands, which are generally over exploited or degraded, the choice of vegetation should be left to the end users. We must remember that soil is a big repository of dormant seed. If socially enclosed, vegetation regenerates in any community land and quite a large number of economical plants along with climax grass species would be seen. Several trees like *Jamun*, *Pongamia*, *Seethaphal*, *Ippa*, *Agave*, *Vitix* may regenerate.

What we can do further is to augment the diversity by introducing plant species of the liking of the end users. For instance when the climax grasses like *Sehima nervosum* and *Dicanthium annulatum* develop, such pastures can be nutritionally improved by introducing *Stylosanthes hamata* and / or *Stylosanthes scabra*.

Let us not go for woody species like *Acacia holosericea*. Farmes would opt even for *Prosopis juliflora* instead, as it provides fuel wood (household, brick kiln) and also base material for charcoal (a subsidiary livlihood support system). In Tamil Nadu when DANIDA proposed *Albizia lebbeck* and Neem along with tamarind and cashew for shelter belt plantation, farmers choice was for casuarina, hybrid (*Vridachalam*) tamarind and improved cashew, the last two being dwarf.

The nursery needed for such a revival of vegetation should be the responsibility, at the first instance, of the State Forest / Horticulture Departments and ANGRAU. Later Kisan nurseries can be contemplated.

In any case choice of trees must be in the hands of the people who shall be users of the usufructs of any such afforestation / plantation programme. Of course, we can moderate. Of course, we can moderate their demands for tree types, keeping the ecological niches for each of the tree type of into consideration.

IV. Energy in agriculture

It is well established that energy is an important input in agriculture, It is derived not only from mechanical sources (e.g. Tractors, tillers, harvesters, combiners) but also from biological sources (e.g. cattle – 0.4 hp, men – 0.07 hp, women – 0.05 hp). Energy also includes the nutrients and other inputs. Present input is very low, average being 1.16 kw/ha (1 hp 1.74 kw). In rainfed areas it is about 0.8 – 0.85 kw/ha.

NCA (National Commission Agriculture, 1976) suggested use of power tillers below 15 hp for use by smallholders. But they have no taken off as desired. However in the country, by the turn of the last century, the tractors available are

HP of the tractor	Available (millions)
31-40	1.67
> 40	0.65
< 30	0.68

Only a small fraction of the tractors (<30 hp) are the power tillers. Of the 1.2 million sold during the last five years in the country only 69,000 were for Andhra Pradesh.

On the other side, the male population of cattle and buffalo are on decline.

		Population (million)	
		1971-72	**1996-97**
Cattle	**Male**	72.56	58.53
	Female	2.07	1.87
Buffalo	**Male**	7.61	5.94
	Female	0.37	1.03

The smallholders are on increase, now 80% of the 115 million farm holdings. About 70% of the farmers still use animal draft as the energy source in agriculture, cultivating about 65% of the NCA.

We need to see draft animals and tractors as complimentary. To supplant the 65 million draft animals we need about 6.8 million > 30 hp tractors at a cost of Rs. 24,000 crores. Then we loose 5,000 crores worth annual addition of manure along with 5 million tonnes of fuel.

With this national scenario, which is also applicable to the state, we need to see the merit of complimentality. The small power tillers (~ 15 hp) have been produced, but with less promise on market side. Options, then, are limited. We have to have custom-hire service of tractors and sharing of bullock power (say 3 holdings – one piece).

As has been pointed out earlier, energy in agriculture need be used much more than of now. Timeliness and precision are important, more so in rainfed agriculture. Primary tillage or opening up of hard soils, subsoiling, soil inversion are better done using tractors. Such an approach would provide extended time opportunity for seeding. In fact the rainwater intake also improves. The root profile will be fully charged with moisture. HYV/HYBs perform well with optimal populations. So plant stand are important for better productivity. Using seed-cum-fertilizer drills and placing the seed and nutrients at the right place can be better achieved through improved implements. Then the plant stands improve. The yields also increase.