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Alternate Land Use Systems in Rainfed Areas

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Abstract: Rainfed agriculture in India is now facing a dilemma. Prime lands for rainfed agriculture, which are mostly with big farmers, are being gradually taken out of food crop cultivation for commercial cropping and even non-arable systems. On the other hand, demand for food and oilseed crops are increasing due to rise in population. A large part of the available land with resource-poor farmers can ill-afford improved technologies. Thus higher demands mean cultivation of less suitable lands with lesser returns and greater risk of land degradation. To tackle the problem land users, at various levels, are to be made aware of the proper use of their land resources. Providing the alternative for sustainable land uses should follow proper evaluation of the land resources. The land users are to be encouraged to participate in the whole exercise of land inventorization and evolution of an action plan for proper use of their lands.

Key words: Land use, land resources, land literacy, resource mapping, alternatives.

Cultural demands and land use are interlinked (Box, 1993). They both have to be compatible. There is bound to be conflicts in land use. No one knows exactly what the future holds. But it can be imagined by creativity and vision. Proper land use can be achieved by creating awareness. The simple steps in creating awareness are: (i) resource literacy at the village level, (ii) possible options in solving the problems in resource use on sustainable basis, and (iii) sensitizing the stakeholders to be participants in this holy exercise of sustainable land use.

Setting

There are around 100 million farm holdings in India. About 75% of them are small and marginal farmers with holdings less than 2.0 ha. In a democratic nation like India, equity is the most important requirement that needs attention. Unfortunately, it is these small and marginal farmers that hold only 25% of land resources, who are less attended to. As Douglas (1989) rightly pointed out, these farmers are faced with a variety of distinct socio-economic constraints, such as: (i) they have little in the way of formal education and limited means of acquiring knowledge of improved farming practices, (ii) their holdings are not only small, but scattered, (iii) there is shortage of cash for investment in the farm and access to credit is usually limited, (iv) draught is less adequate - both animal and mechanical, and (v) they tend to avoid risk than intending for profit maximisation.

Thus, they are both ecologically and economically disadvantaged. And it is they, who have lands that are not ideally suited for arable farming. However, these farmers

Table 1. Shift in area to oil seed crops from coarse cereals in the last 40 years

Year	Per cent area under	
	Coarse cereals	Nine oilseeds
1960	29.20	10.59
1970	28.04	10.58
1980	25.05	10.92
1990	19.86	15.31

tend to grow the staple crop of the region year after year to meet their immediate needs, partly if not fully. These farmers are well aware that their lands are not ideally suited for arable farming and also that solo cropping is not proper. But they do not have many options.

On the other hand, better lands are drifting from food crops to commercial crops and even to non-arable systems. Bhalla and Singh (1997) have clearly demonstrated that over the last 40 years, there is a definite shift from coarse cereals to oilseed production (Table 1).

The shift is more in the last one decade. This could be attributed to gradual increase in the National Net Product (NNP) as well as the consumerism taking over as per the present cultural demands. This is besides the economic advantage in growing oilseeds which have an attractive support price. The trend analysis of Kumar and Mathur (1996) also show the same scenario in so far as demands and targeted growth rates are concerned (Tables 2 and 3).

Not only that. Vast and very productive areas are now moving from arable to tree farming. Poplar tree in areas under the Yamuna and Sutlej basins, as well as Terai region, is a case in point. Similarly, *Leucaena leucocephala* is taking over productive lands of Prakasam district in Andhra Pradesh of south India which were under pearl millet grown under protective irrigation, later shifted to virginia flue-cured tobacco. In all such cases, it is the large farmers who are also economically well off who opted for these tree systems. This shift is for two reasons. These farmers more often are absentee farmers, sometimes staying outside the country, and want to avoid tenancy as well as labour problems. They also get ready cash from the corporate sector who are interested in the wood for their industry.

The above are the ground realities. To reiterate, the small and marginal farmers cultivate lands that are mostly non-arable to eke out their living. The rich farmers put their valuable arable land under tree farming to become richer. On the other

Table 2. Demand for non-food grain products (Mts)

Item	1991-92	1996-97	2001-02	2006-07
Milk	56.1	72.4	88.6	119.5
Edible oil	5.4	6.5	7.6	9.5
Vegetables	64.8	77.3	88.7	108.5
Fruits	30.8	40.4	50.5	69.1
Sugar	12.1	14.5	16.3	19.6
Cotton	1.6	2.0	2.3	2.9
Meat & eggs	2.7	3.6	4.4	6.0
Fish	4.1	5.4	6.7	9.3

Table 3. Targeted annual growth rate (%) in yield of different commodities

Item	Growth achieved	Targeted growth	
	1990-94	2001-02	2006-07
Rice	1.79	2.35	2.19
Wheat	2.23	2.22	2.20
Coarse cereals	2.71	1.01	1.04
Pulses	0.83	4.41	3.8
Oilseeds	1.19	3.88	5.56
Sugarcane	1.30	3.07	3.20
Cotton	3.08	3.78	3.80
Vegetables	NA	3.53	3.20
Fruits	NA	6.04	6.04
Milk	4.26	5.54	5.37
Fish	4.27	6.25	5.98
Meat & eggs	4.55	5.54	4.95

NA : Not available.

end of the spectrum, the government policy makers plan for land use as per capability classification. There are also Land Use Boards in each of the States in the country.

Demands on Land Resources

The conflict over land use is because the demands on land are more than the available land resource. Among others, the demands on land include: (i) arable crops, (ii) grazing, (iii) forestry, (iv) wild life, (v) tourism, and (vi) urban development.

With the ever increasing biotic pressure these demands will increase. So will the conflicts. When land use and ecological carrying capacity of the land do not compromise, the land degradation starts (Toulmin, 1993). And in the face of scarcity, the degradation of the resources would be quite apparent for all to see, but individual land users lack the incentive or resources to stop it (FAO, 1995).

The FAO (1995) guidelines for land use planning indicated that it involves: (i) systematic assessment of land and water potential, (ii) alternatives for land use, and (iii) economic and social conditions.

Evidently proper sustainable land uses meet the needs of the people while safeguarding resources for the future. FAO further advocated that proper land use planning can be achieved only where: (i) the need for changes in land use, or action to prevent unwanted changes, is accepted by the people involved, and (ii) there is the political will and ability to put the plan into effect.

Thus, land use planning should aim at the best use of limited resources by: (i) assessing present and future needs and systematically evaluating the land's ability to supply them, (ii) identifying and resolving conflicts between competing uses between the needs of individuals and those of the

community and between the needs of present and future generations, (iii) seeking sustainable options and choosing those that best meet identified needs, (iv) planning to bring about desired changes, and (v) learning from experience.

FAO (1995) further opines that there can be no blueprint for a change. The whole process of planning is iterative and continuous. At every stage, as more information is obtained, a plan may have to be changed accordingly. The cardinal principles for proper land use as enunciated by FAO (1995) are: (i) land use must be economically viable, (ii) land use must also be socially acceptable, (iii) land use need to be sustainable, meeting the needs of the present while at the same time, conserving the resources for future generations, (iv) land use conflicts can be reduced by involving the community in the planning processes and by revealing the rationale behind the possible solutions, (v) land use planning must be positive, the stakeholders must accept the need for a change in land use through which alone the planning process should start, (vi) good information on the land resources is needed for proper land use planning, (vii) the technologies (agronomy, silviculture, livestock husbandry) must be doable at the stakeholder level, (viii) land use planning is not sectoral. Land use decisions are just not only made on the basis of land capability classes; but also be made based on the demands for particular products, (ix) land use planning can be applied at three levels: national, district and local, and (x) the resource maps for these three levels vary. For national level, a scale of 1:5 million may be adequate. For district level 1:50,000 maps may be suitable, while for village level, 1:10,000/ 5,000 maps are the best.

Government Programmes

Presently, the Government of India (GOI) has launched a huge programme on area development on watershed basis with about 500 ha area as a basic unit. The GOI endeavours to involve people in this exercise. Through such an attempt, GOI hopes that eventually voluntarism would prevail and the rainfed areas would, in due course, turn more productive. In this watershed development programme, bottom-up planning is initiated at the local level. The basic tenets with which the programme is taken up are : (i) resource inventorisation, (ii) sustainable resource management, (iii) use of traditional/indigenous technologies as the starting point, (iv) use of doable technologies, (v) creation of assets that are small, benefiting more people, (vi) provision for post-operational maintenance of such assets by the beneficiaries, (vii) the products from commons be shared by all, particularly the poorer participants, (viii) provision of financial support for critical inputs at the individual level, (ix) provision of full financial support for community works, and (x) involvement of the beneficiaries in drawing up the action plan.

Resource Inventorisation

From the various issues discussed above, it is now clear that area development on watershed basis involving the beneficiaries in resource inventorisation, as well as evolving action plan, is the mode set by the GOI. In other words, resource inventorisation is the preamble for better management of the natural resources. And in the sub-

sequent steps, land use planning is the major component.

As rightly pointed out by Dent (1993), there is no prospect of a few of land resources specialists directly supporting 100 million farm families (the decision makers) in providing information about their resources. If it were feasible to some extent, it would be extremely difficult for the farmers to unscramble the complex data for evolving the action plans. Thus, there is a need for a more fundamental reappraisal of the information requirements. Fortunately, some efforts have been initiated.

PRA method

The participatory rural appraisal (PRA) is a case in point. This is carried out through transect analysis involving the key informants in the village. The details are not discussed here as PRA is a familiar approach. However, PRA is a tool only: (i) to enthuse the villagers in knowing their resources, and (ii) at best is a qualitative resource situation in the village. It would be a very useful backdrop information in inventorisation of the resources.

BGVS approach

Sinha and Verma (1994) of Bharat Gyan Vigyan Samithi (BVGS) have developed the concept of land literacy for participatory resource mapping. The details of this approach are: (i) select two volunteers from the village, of which, one be a woman, (ii) keep the villagers informed of the programme through folk communications, (iii) identify some more volunteers, if needed, for mapping, (iv) conduct household socio-economic surveys through local volunteers, (v) arrange for cadastral map of the village which generally will be of 1:8000 scale and would contain the field survey numbers of the plots, (vi) train the volunteers to collect plotwise data for the resource mapping, (vii) finalise the thematic resource mapping and compile the data base, (viii) also recruit a few scientific assistants to prepare the maps like terrain map, land use map and a map showing the location of water bodies, (ix) some derivative maps are then prepared by the volunteers and the scientific assistants, in consultation with the supervisory technical group using the resource maps and the data base; they may include suggestive land use map, and (x) these derivative maps are then placed before the villagers for a discussion and final acceptance.

These derived maps are used for preparing the action plan in consultation with the stakeholders. Such an approach is widely in adoption in West Bengal at the village Panchayat level. *Gram sabhas* participate in this endeavour.

KRIBHCO Indo-British method

The KRIBHCO Indo-British Dryland Farming Project located in the districts of Panchmahals (Gujarat), Jhabua (Madhya Pradesh) and Banswara (Rajasthan) has a different approach in the resource mapping. They use modified PRA approach, seeking information from the farmers. Some others are: (i) soils (types, distribution, management problems, depth, etc.), (ii) soil erosion and conservation measures, and (iii) land use and farming systems, including the distribution of private, common and encroached pasture and forest land.

Insofar as soil types are concerned, the types recognised by the farmers are

taken into account. These locally recognised soil types are important for matching with the soil and water conservation as well as cropping practices.

A soil map could be prepared by asking the farmers what the dominant soil types are on their farms. Individual characterisation of the soil types can also be taken up with the help of the farmers. They include, depth, texture, stoniness, colour, slope, run-off potential, water holding capacity/ droughtiness, and management problems.

Then they collect data on land use through a questionnaire. The questions may include fallows and their areas, type of fallow - current or long term, changes in the fallow periods over time during the last 3-4 decades, the area under each crop during the monsoon and post-monsoon periods, existing cropping systems - rotation, sequence, intercropping or mixed cropping, and any other relevant information.

Also they collect data on farming practices, land ownership, management of pastures and other commons. Based on these data sets, the present land use map is prepared.

Suggested approach

Keeping the above principles and existing methods in resource inventorisation and land use mapping, the following resource mapping and land use planning are suggested.

(A) Resource Inventorisation

Soils: For proper management of soil resources following steps are suggested:

- First collect the cadastral map of the village.
- Visit the village with one or two persons from the government department, university or voluntary agency working in the region.
- Select two or more key informers and have a preliminary discussion on the objectives and then ask them to list out the important soil types as identified by local names.
- Traverse through the village including the habitat and the farm fields. Observe the broad drainage system in the village to assess the slope of the land. Also assess the broad soils and cropping systems occurring in the village.
- Along with key informers, collect the farmers in small groups of 8-10 and ask them to identify their fields in the cadastral map. Ask them to indicate the soil type (by local name) of their fields. Collect some of the data on: (i) colour, (ii) depth, (iii) texture of top soil, (iv)

Table 4. Traditional land types and their use in arid Rajasthan

Type of land	Local name	Class	Land use
Excellent	Unav, Unam Kundala	Barani-I	Pearl millet, Sesame
Very good	Jod, Jodio	Barani-II	Pearl millet, Sesame
Good	Dabla, Banola	Barani-III	Pearl millet, Sesame
Fair	Dada, Tiba Dhal	Barani-IV	Moth bean, Clusterbean
Poor	Mago, Magrio	Barani-V	Grassland, Silvipasture

Source : Bharara, L.P. (Personal Communication).

Table 5. Suggested criteria for land use capabilities

Character	Method	Classes	Symbol
Depth	Visual	Shallow	d1 (0 - 22.5 cm)
		Medium	d2 (22.6 - 45.0 cm)
		Deep	d3 (Above 45.0 cm)
Texture	Feel method	Heavy	H
		Medium	L
		Light	SL
Permeability	Visual	Slow	1
		Moderate	2
		Rapid	3
Slope of the land	Use of	Nearly level	A (0.1-2%)
	A-frame	Moderate slope	B (2-6%)
		Steep slope	C (6-33%)
		Very steep slope	D (Above 33%)
Erosion	Visual	Sheet (slight)	e1
		Sheet and rill (moderate)	e2
		Sheet, rill and small gullies (severe)	e3
		Gullied land (very severe)	e4
		Very severely gullied, and sand dunes (very very severe)	e5

permeability of the top soil as well as subsoil, (v) slope, and (vi) erosion status.

This is best done for each of the locally identified soil types. For instance, in the arid Rajasthan, traditional names of soil types are as given in Table 4.

For the purpose of land use capability classification, the following criteria (Table 5) may be adopted.

Once the locally identified soil types are characterised using the simple procedures suggested above, they can be grouped into the standard 8 land capability classes (Table 6).

Water: The water resources of an area (in this case watershed) are determined by the rainwater received, evaporation, surface and subsurface drainage and ground water potential. The artificial concentration of rainwater in structures of different nature is the other source.

Surface and subsurface drainage: Surface drainage systems are best determined by plotting on the cadastral map the water courses as seen from the top of a ridge line in the watershed after a good rain event. Aerial photographs, where available, are also handy tools.

Subsurface drainage is generally determined by the perennial vegetation that it would support and also by the physiographic situation. So could be the old meanders and paleochannals.

Surface water : The water bodies already existing in a watershed can easily be iden-

Table 6. Suggested land use capability class rating

Class	Texture	Soil depth	Per cent slope of land and symbol						Erosion & symbol		Permeability class
			Alluvial Himalayas soil	Black soil	Red soil	Arid soil		Ghat region	Effect of erosion	Susceptibility of erosion (distance to active gully heeds)	
I	H,L,SL	d_3	A	A	A	A	A	A	e_1	Very far away	2
II	H,S	d_3	A	A	A/S	A	A/B	A	e_1	Minimum 60 m	2/3
III	H,SL	d_2	B	B	B	A/B	B/C	B/C	e_2	6-10 M for A class slope	1 to 3
IV	H,SL	d_1	C	B	C	A/B	C	C	e_3	–	All classes
V	All as in Class I land, except one or more limitations of wetness, stoniness, or adverse climatic conditions										
VI	–	d_1	C	C	D	C	D	D	e_4 sand dune	Gully sides and beds	–
VII	–	d_1	C	C	D	C	D	D	bed lands	Quality sides and beds	–
VIII	–	Rock	---------- C/D ----------						–	–	–

tified either through satellite data or through aerial photographs or participatory approach. These water bodies, among others, include (i) tank/*talab*, (ii) village pond, (iii) *nadi*, (iv) check dam, (v) percolation tank, and (vi) *khadin*.

Ground water: The existing wells/tube wells can easily be identified and located. There is a great scope for groundwater recharge through rainfall. But there are certain geomorphic units that are associated with groundwater potential (Table 7).

Table 7. Geomorphic units associated with ground water potential

Geomorphic unit	Ground water potential
Riverine	
Alluvial plains	Highly suitable for shallow/deep aquifers
	Old meanders & back swamps areas - excellent shallow aquifers
	Paleochannels - excellent shallow aquifers
Flood plains	Highly suitable for shallow/deep aquifers
Valley fills	Good for shallow/deep aquifers
Deccan trap	
Shallow weathered	Suitable for shallow aquifers in pediplain watershed zone
	Fracture/fault concentration zone possess good prospect
Moderately weathered	Shallow aquifers limited to pediplain fracture/fault concentration zone (moderate)
Deccan plateau	Good along faults, fractures and bedding planes

Table 8. Climax grass cover in different regions

Climate	Climate grass cover
Tropical	*Sehima - Dicanthium*
Subtropical, Semi-arid	*Dicanthium - Cenchrus - Lasiurus*
Humid Per humid	*Phragnites - Saccharum*

Biological features: The vegetation includes forests, pastures, plantations, orchards and crops of both monsoon and post-monsoon 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. Each region, if fully evolved, will have the climax species of grass (Table 8).

The percentage of present vegetation which consists of the original vegetation, is one index of the status of the natural pastures. It is classed excellent when percentage varies from 75 to 100%, good when it is 50 to 75%, fair when it is 25 to 50% and poor when it varies from 0 to 25%. However, in arid zone the vegetal cover in pasture would be low. Hence, different criteria are suggested (Table 9).

The total and different species that contribute to the livestock and their age that are living in the watershed need to be compiled. This is essential to work out the fodder needs for the watershed. Also, planning for health cover could be easily made out. Wherever possible, trends in the compositional changes of the livestock may be assessed as it has a relevance to the dynamic change in the silvipasture systems and their degradation. The draught animals, milch cattle, nonfunctional livestock, and the young ones should also be assessed on time series.

The total human population, male and female, children and different age groups may be worked out. The family occupations, status of the village arts, handicrafts, literacy, credit availability, access to inputs including extension services (government or non-government), status of cooperative bodies, readiness for voluntarism, besides the economic/social status, may be elicited though appropriate formats.

(B) Land Use

Based on the standard classification, the USDA (1951) suggested the broad possibilities of their use. The main use to which each class, along with sub-classes,

Table 9. Criteria to determine extent of degradation in arid zone

Degradation condition	Criteria				
	Yield (q/ha)	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 -------		–
Desertified*	<2.0	–	–	–	Few

* Ephemeral grasses contribute in biomass.

can be put to have been suggested at the national level by Govinda Rajan (1968).

However, integrating the landform, soil and vegetation with climate, surface and ground water, the concept of Major Land Resource Unit (MLRU) was developed by Abichandani and Sen (1977). The merits of this concept are: (i) the MLRUs are homogenous in respect of all the biotic and abiotic conditions that affect resource development, (ii) in MLRU mapping all the components are considered equally important, (iii) MLRU mapping precedes field verification, (iv) MLRU concept is problem and planning oriented, taking into account the resource potential and their utilization, and (v) MLRUs are flexible and dynamic.

The MLRU concept envisages use of similar technologies for a given production system for any of the MLRUs located in a given zone.

Even though such refinements are available in land use, more often they are not put to practice. The reasons are many. There is increased biotic pressure with the ever increasing human and livestock population. Consequently, the commons are degraded and better quality commons brought under farming. Even the silted up tank beds are brought under cultivation. In urban areas, one can see settlements in such silted up tank beds. As pointed out earlier, the NNP is gradually moving up. The demand for quality than quantity in food is the result. There is increased urge for income generation. To meet the quality, there is increasing demand for vegetable oils as also proteins (either legume or meat/fish/ egg). In fact, the area under coarse cereals decreased and that under oilseeds increased, primarily because of better returns per unit area with the latter.

In the process, besides diversification of land from one crop to another, more and more area is brought under cultivation, which otherwise should be under permanent vegetation (e.g., silvipasture). The other trend is putting high quality land under tree farming. So is the case of development of horticulture. To minimise the effects of such deviations in land use, there is a need to look for alternatives that are also acceptable to the land owners. The creation of awareness in proper land use is the first requirement. Among others, the alternatives are:

- All out efforts need be made to limit tree farming to non-arable lands.
- There should be vertical growth in yield of arable crops. There is adequate research data base to meet this requirement.
- Seed is the main constraint in improvement of productivity in rainfed areas. As of now, barring some coarse cereals, sufficient seed of other crops is not adequately available. Unfortunately, the monsoon sorghum area has been halved over the last 10-15 years for reasons enunciated earlier.
- So it should be the endeavour of the Government to produce seed of other rainfed crops (e.g. legumes and oilseeds) and leave rice, wheat and coarse cereals (sorghum, pearl millet and maize) to the private enterprises. Also the seed of grasses and trees should be produced by the governmental agencies.
- Additional production can come through increase in cropping intensity in better rainfall areas. Inter-cropping

and sequence cropping are a few examples.

- Providing critical irrigation for the standing rainfed crops is yet another way to enhance production of arable crops. Such a practice exists in parts of Gujarat, Rajasthan and Andhra Pradesh.

- Even under irrigated conditions, earlier efforts were through Intensive Area Development Programme (IADP) and Intensive Agriculture Area (IAA) programmes. During VIII Five Year Plan, efforts on Special Food Grain Production Programme (SFPP) was a step in this direction.

- On a similar note, more assured rainfed areas may have thrust programmes introducing a tier system of technology. Rice in eastern states, maize in northern states, finger millet in Karnataka, pigeonpea in north India, Maharashtra and Gujarat states, legumes of *Phaseolus* group (short duration) as a second crop in eastern states, groundnut in Saurashtra and Rayalaseema regions, and soybean in monsoon black soil regions with medium to high rainfall are some of the examples.

- In marginal lands that are owned by the small and marginal farmers, strips of grasses or suitable economic trees, at least on the field boundaries, should be encouraged. Both the systems improve the productivity of the land over time.

- When the above is being practised, the farmers should be covered under the new public distribution system of the GOI and also provided with cash input during the gestation period of the tree component coming to yield the economic produce.

- Palletized seed broadcast (manually or aerially) in grasslands (in the commons) should be encouraged. It saves on the seed requirements. Similarly, social fencing should be attempted in the commons while concurrently improving those areas with the introduction of improved tree and grass and/or fodder legume species.

- All the above efforts would at first decelerate the diversification of land uses and eventually limit class I to IV lands to arable farming, and the class V to VIII lands to silvipasture/tree/horticulture systems of farming, besides forests and wild life.

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