Land Use Planning for Conservation of Land Resources

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International think-tank, such as "Our Common Future' in 1987, the Rio Declaration' and 'Agenda 21' in 1992, and the Johansberg Declaration ' in 2002, have created recognition that concerted efforts are needed to develop sustained land use practices to minimize further harm to natural resources. Maintaining and enhancing the quality of natural resources have emerged as key issues globally (World Bank, 2001). Control over the use of resources on land has emerged as significant issues in natural resource management (Yencken and Wilkinson, 2000), and the land use planning system provides an opportunity to control land use, further conservation of natural resources. The challenge faced by natural resource management agencies either governmental or non- governmental will involve changing perceptions over how land is used (Mitchell et al., 2004).

Functions of Land

Production function- Basis for many life supporting systems (food, fiber, fuel, timber, other biotic material for human use)
Biotic environmental function: Basis of terrestrial biodiversity (providing biological habitats and gene reserves for plants, animals and microorganisms, above and belowground)
Climate regulative function- land and its area source and sink of greenhouse gases and form a co-determination of the global energy balance – reflection, absorption and transformation of radioactive energy of the sun, and of the global hydrological cycle
Hydrologic cycle- regulates the storage and flow of ground water resources, and influences their quality
Storage function- Storehouse of raw materials and minerals
Waste and Pollution control function-Has a receptive, filtering, buffering and transforming of hazardous compounds
Living space function-Provides physical basis for human settlements, industrial plants and social activities (recreation etc.,)
Archive or Heritage function- Store and protect the evidence of the cultural history of mankind, and a source of information on past climatic conditions and past land uses
Connective space function- Provides space for transport

Some key terminologies in Land Use Planning vis- a vis land resource conservation (FAO, 1993)

Land: " Land is a delineable area of the earth's terrestrial surface, encompassing all attributes of the Biosphere immediately above or below this surface, including those of the Near Surface Climate, the SOIL and TERRAIN FORMS, the Surface Hydrology (including shallow lakes, rivers, marshes and swamps), the near surface Sedimentary layer and associated Ground Water reserve, the PLANT and ANIMAL populations, the Human Settlement pattern and physical results of PAST and PRESNT HUMAN ACTIVITY (terracing, water storage or drainage structures, roads, buildings, etc.). " . Thus, a Natural Unit of Land has both: Vertical Aspect: from atmospheric climate down to ground water resources and Horizontal Aspect: an identifiable repetitive sequence of soil, terrain, hydrological, and vegetative or land use elements

Land Characteristic: An attribute of land that can be measured or estimated, for ex. Slope angle, soil depth or mean annual rainfall. The land characteristics that are measurable properties of physical environment that affect the land use and land qualities (both internal and external), which are practical consequences of land characteristics are considered in land evaluation.

Land Evaluation: It is the process of estimating the potential of land for alternative kinds of use. These uses can be productive such as i) Arable farming, ii) Livestock production, iii) forestry or other uses such as a) Catchment's protection, b) Recreation, c) Tourism, d) Wild Life conservation. It involves interpretation of surveys, climate, soils, and vegetation and other aspects of land with the requirements of alternative land use.

Land Mapping Unit: It is mapped area of land with specific characteristics. These units differ with the level of generalization. These units can be single plot of land, soil family, soil association, a physiographic unit or agro climatic zone. These units form a basis for land evaluation.

Land quality: A complex attribute of land that affects its suitability for specific uses in a distinct way. For ex. The land quality, availability of water is interaction of a number of land characteristics like rainfall, available water capacity of the soil, potential evapotranspiration.

Land Use Requirement: Land conditions necessary or desirable for the successful and sustained practice of a given land use type includes crop requirements or plant growth requirements, management requirements and conservative requirements.

Land Use System: A land use system is a combination of a land mapping unit and a specified (actual or alternative) land utilization type. Each LUS thus has a land component and a use component. The land component of a LUS is described in terms of land characteristics (e.g. length of growing period. % slope, soil texture etc.,).

Land Use Type: It is a specific type of land use described in terms of diagnostic or key attributes that may include: produce, management characteristics (e.g. the use of power and machinery, material inputs and technology) and socioeconomic characteristics (e.g. market orientation, capital intensity, labour intensity, technical knowledge, scale of operations and land tenure)

Land Use: Land use is a kind of permanent and cyclic human interventions to satisfy human needs. It is a geographic concept. e.g. Rainfed agriculture, Irrigated agriculture, forestry, Recreation.

Land Users: All people who obtain their livelihood directly, either wholly or partly, from the land, e.g. farmers, foresters, pastoralists etc.,

Land Utilization Type: A land utilization type is any use of the land defined in greater detail than a major kind of land use. e.g. Dry land farming - Land utilization for soybean, cotton. These land utilization types are defined with respect to the produce and the factors influencing the management.

Local level land use planning: Planning based on a village/microwatershed/local community. Large scale maps are used, such as 1:10,000, 1:4,000.

Map scale: The ratio between distances on the ground and distances on map. Small scales refer to maps which cover a large area such as a country on one map sheet,e.g. a scale of 1:10,00,000.Large scales refer to maps which cover a small area on one map sheet,e.g. a scale of 1;4,000 or 1:10,000.

Matching: This term is used in two ways. In its narrower sense, the process of comparing land use requirements with land qualities or land charactersistics,to arrive at a land suitability classification. In its broader sense, the process of adaptation of land use types, and consideration of land improvements, so as to arrive at land use types which are better suited to the land.

Natural resources: The resources of the land relevant to its potential for land use, e.g. climate, water soils, pastures, forests, fauna.

Remote Sensing: In land use planning, remote sensing refers to the gathering of information through the use of aerial photographs and satellite imagery. Remote sensing should be conducted in conjunction with field survey on the ground.

GIS: Geographical Information System (GIS) is a computer based information system used to digitally represent and analyze geographic features on the earth surface and the events that

taking place on it. IS has both a data base system with specific capabilities for spatially referenced data as well as a set of operations for working with the data. Thus, GIS is a set of tools for collecting, storing, retrieving, transferring and displaying the spatial data from the real world for particular set of purposes.

Soil landscape: A soil mapping unit defined its landform pattern and associated soils.

Soil mapping unit (SMU): Any unit describing the spatial distribution of soils, which can be mapped. SMUs may be simple, consisting of one type of soil or complex, consisting of two or more types of soil.

What is Land Use Planning ?

LUP (FAO, 1993) is the systematic assessment of physical, social and economic factors in such a way as to encourage and assist land users in selecting land use options that is an interactive and continuous process of development ; requires flexibility ; does not have a clear end-product; is problem oriented, is area specific and involves all stakeholders

LUP Principles: 1. Appropriateness to local context 2.Flexibility 3.Transparency, 4.Participative approach 5.Gender specific and 6.Inter-disciplinary

Why Land use Planning for Conservation of natural resources

To achieve a sustainable, environmentally sound, socially desirable and economically appropriate form of land use.

Different Perceptions about LUP

Land use planning is not just crop/farm planning on a different scale, but it has a further dimension, namely, the interest of the whole community. LUP means different thing to different people:

For researchers - it is the systematic assessment of land and water potential for alternative land use under existing economic and social conditions in order to select and adopt the best options.

For small farmers - The effective utilization of land and water resources for crop production in order to minimize crop failures and risks and to sustain family needs. To market driven mismatching land suit abilities. The farmers expect family sufficiency and profit with or without sustained use of natural resources.

For Large Farmers - An effective utilization of resources to maximize profit from the whole farm, based on principle of comparative advantage

Kinds and extent of land degradation:NBSSLUP and NRSA has done an exercise, in 2007, on harmonization of data base on waste lands and kinds and extent of land degradation in India and has come out with a figure of about 120 m ha. The kinds and , causes and management of lands under degradation are briefly given below.

Physical degradation: Soil erosion by water and wind: Water erosion is the most serious one. 16.35 t/ha/yr.Soil loss of 20 to 100 t/ha/yr due to sheet and rill erosion in rainfed regions. In red soils regions with 750 to 2000 mm annual rainfall,- rapid surface due to low water intake and surface crusting, results in rapid run off and erosion.Jhuming, cycle narrowed to 3 to 6 yrs.Forest cutting, burning, clearing and dibbling of seeds cause nearly 4.1 t/ha of soil to slide/roll down to foot hills. Wind erosion predominant in western desert region. Coastal areas where sandy soils predominate and cold desert

regions of Leh. Wind erosion is moderate to severe in arid and semi arid northwest India covering 28600 sq.kms, of which sand dunes and sandy plains cover 68 %

Chemical degradation: Nearly 3.7 M ha.Due to several processes like loss of nutrients and/or OM,, accumulation of salts, pollution by toxic substances of industrial/urban/mines/huge quantities of fertilizer application, pollution of ground water etc.,

Waterlogged soils: Low topography, Diara lands,Tal lands(lying beyond levees)

Physical due to WL effected 5.7 M ha,poor aeration, degradation of soil physical /chemical/biological properties, fertility; **Causes:** Transmission losses in command areas, faulty on-farm magt, lack of natural drainage, inundations in coastal /flooding/cyclonic storms etc; **Management:** Proper drainage, lining of canals, ingression magt in coastal areas

Salt affected soils: confine to arid, semiarid, sub humid areas,. About 10 M ha in Deccan Plateau covering black cotton soils , 2% in arid and coastal areas; **Alkali soils**: excess salts, viz. carbonates, bicarbonates and silicates of Na, , pH > 8.2;ESP>15; Ca carbonate concretions at 1 m depth;**Saline soils:** White encrustations of salts on surface due to chlorides and sulphates of Na, Ca, Mg; pH < 8.2; ESP>15; flocculated soils, high osmotic pressure causing physiological drought, nutrient deficiencies **Causes:** Due to rise of under ground water table ; **Management:** Alkali soils by fallowing, amendments such as pyrite, gypsum, manures, tolerant tree/crop/grass species, balanced nutrition, right agronomic/water/reclamation methods **Management: Inland Saline soils** by proper land drainage/irrigation magt.,disposal of drainage effluent, checking drain clogging, tolerant tree/crop/grass species, balanced nutrition, right agronomic/ water/ reclamation methods

Sands : Coastal Saline soils **by protective embanking, avoid summer fallow,mulching,leaching of salts, tolerant tree/crop/grass species, balanced nutrition, right agronomic/ water/ reclamation methods, use of amendments, etc**

Coastal sandy soils: >95% crystalline minerals, low in CEC/OM/fertility/AWC, high permeability; **Desert sandy soils:** av. Soil temp 34 0C,structureless,lime hard pans at 60 to 120 cm deoth,presence/accumulation of alkaline earth carbonate, low CEC/AWC/fertility, pH :8 to **Causes:** Wind erosion, desertification, paleoclimate,ingressions, marine deposits etc.,;**Management:** Proper water magt,

Sand dune stabilization,afforestation,shelterbelt plantations, and crop diversification

Acid sulphate soils: Presence of sulphuric acid horizon with pH < 3.5;Al toxicity under dryness while Fe toxicity under waterlogged condition.Def, in Ca,Mg,Mo,P; also present sulphide ;**Causes:** Near sea, when inundated, water undergoes reduction & sulphate gets reduced to sulphide;**Management:** Flood the area, water table control, liming & leaching

Barren rocky soils: fractured rock, coarse gravel /loose boulder ;**Causes:** geology

Management: Planting sparse forest covering selected micro sites/soil pockets

Mine dump soils: Soils of varying physical and chemical nature; **Causes:** mining

Management: Characterization,stabilizatio and conservation through mechanical/agro forestry

Tools in land use planning for conservation of natural resources

Resource Survey: Resource identification; Remote Sensing: Land use, Land cover
Land Evaluation: Resource based interpretation;
Information System: Documentation ,Integration , Retrieval
Modeling : Forecasting.

Steps in Land Use Planning for conservation of natural resources. Land evaluation is done

based on certain principles:

- During land evaluation, land suitability is assessed and classified with respect to specified kind of use.
- Evaluation requires a comparison of the benefits obtained and the inputs needed on different types of land.
- Land evaluation is a multi-disciplinary approach.
- Evaluation is made in terms of relevance to the physical, economic and social context of the area concerned.
- Land suitability refers to use of the land on a sustained basis keeping in view the ecosystem.
- Evaluation involves comparison for more than a single kind of use.

The relevant qualitative land evaluation procedures for land resource conservation are:

- Land Capability Classification
- Land Suitability Classification

Land Capability Classification: It is interpretative groupings of soils based on inherent soil characteristics, land features and environmental factors that limit land use or impose risk of erosion. Soils are grouped in 8 capability classes on the basis of their ability to produce commonly cultivated crops. The risk of soil damage progressively increases from Class I to Class VIII. Arable lands are put in Class I to IV and the non arable in Class V to VIII. There is a provision to assign subclass on the basis of kind of predominant hazard, limitation or conservation problem. A sub-class may be further divided into capability units according to similarity in potential and response to management. While land capability classification system is useful for relatively broad level planning it needs to be supplemented by more precise evaluation for micro level planning. Further, the land capability classification is conservation oriented which considers the negative aspects . Yet this system is still widely used because Of its simplicity and ease of comprehension. The capability classification gives general idea about the Capability of the soils but does not explain specific crop performance unless supplemented by additional information. This method could be followed effectively for highlighting the conservation oriented limitations that need immediate attention and for broad grouping of soils into agricultural and non-agricultural lands.

Classes

- Groups of land units that have the same degree of limitation.
- The risk of soil damage or limitation becomes progressively greater from Class I to Class VIII.
- The classes show the general suitability of a land unit for agricultural use.

  I to IV - Arable; V to VIII - Non-arable

Sub-classes: These are based on major conservation problems such as :

e - erosion and run off; w - excess waters - root zone limitation - climatic limitations

Capability unit: Grouping of one or more individual soil mapping units having similar potentials and limitations or hazards

(a) Produce similar crops - under similar management.
(b) Require soil conservation or management.
(c) Have comparable potential productivity.

Land Suitability Classification: Land suitability classification refers to the fitness of a given type of land for a defined use. Suitability classification is arrived at on the basis of soil survey information, economic and social analysis, kinds of land use and the need for change. Separate c1assification are made with respect to each kind of land use that appears to be relevant for the

area (FAO, 1976). The categories recognized *in* land suitability classification are order, classes, sub-classes and unit. There are two orders suitable(s) and non-suitable (N). The classes distinguished are 5-1 highly suitable, 5.2-moderately suitable and 53-marginally suitable. The sub-classes reflect kinds of limitation as in land capability sub-classes. The suitability units in a sub-class differ in management requirements. Depending upon the purpose, scale and intensity of study either all or limited number of categories may be adopted. An ideal method to decide adoption of a cropping pattern (land use) on a particular soil unit is to have prior knowledge of the yield performance or yields are the integrated end products of interactive processes of all factors and inputs and' are, therefore, :the best indices of productivity potentials. It is hardly possible to obtain such information for all soil units in all the area in view of neither the cost nor it necessary. Soil survey and classification aid in transfer of technology and are therefore the basis for evolving rational land use and management methods. Analysis of crop yields obtained by farmer over the years in relation to management levels "on known soils (soil series) in surveyed area or field experimental data should help in deciding cropping pattern and transfer of technology to similar areas.

Land Use Requirements of some Land Use Types

Crop Growth Requirements: Energy, temperature, moisture availability, ability to retain water on soil surface (wetland rice),oxygen availability (soil drainage) nutrient availability, rooting conditions, conditions affecting germination or establishment, air humidity as affecting growth conditions for ripening, physiographic hazard, climatic hazards, biological hazards, excess of salts, soil toxicities

Management Requirements: Conditions for site clearance and land preparation, conditions for mechanized operations soil workability, conditions affecting timing of production conditions for harvesting, conditions affecting transport, storage and processing, conditions for nursery sites, accessibility, size of potential management unit's conditions for road construction and maintenance

Conservation Requirements: Erosion hazard, land degradation hazard, tolerance to vegetation degradation Preservation of plant and animal species

Land Use Planning for conservation of land resources: Attempts and experiences

a. Experiences of National Bureau of Soil Survey and Land Use Planning (NBSS&LUP) : NBSSLUP developed Soil Resource data base on 1: 250,000 at soil family level for broad planning at national and state level, soil resource maps for several districts 1:50,000 scale for district level land use studies and selected large scale maps at 1:10,000 /1:5,000 at watershed/ village level. Delineated 20 Agro ecological Regions and 60 Agro ecological Sub regions (AESRs) for agricultural planning. Spatial variability in the factors like bioclimate, physiography, soils and length of growing period were used in delineating the regions and subregions with details on agroecological settings and the land use potentials and constraints of each subregion along with information on major bench-mark soil series occurring in the sub region AESRs are homogeneous land units to implement a wide range of land resources applications. The Agroecological Zoning land resources appraisal linked to Geographic Information System (GIS) greatly enhanced the capability to develop alternate land use plan scenarios, management and decision support systems and improved interfaces to promote use of such systems together by scientists, development administrators and land users (Velayutham et al.1999).Concerted efforts made by NBSSLUP in to implement land use plans after

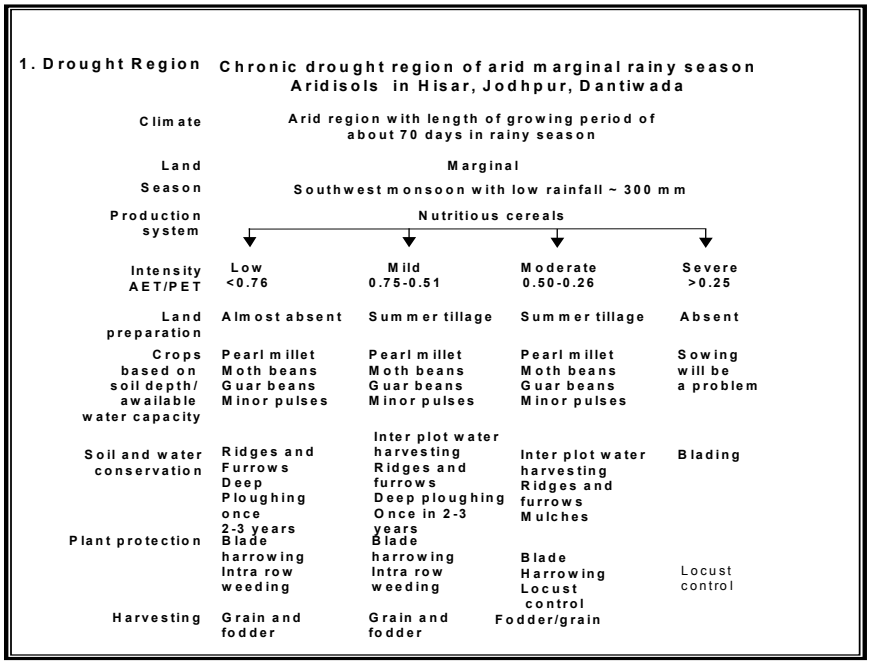
biophysical evaluation (soil survey, land capability based and land suitability based) process on identified soil series in various watersheds/villages in Nagpur district, Maharashtra and Bangalore rural district, Karnataka etc.Awareness about spatial variability in soil resources within microwatershed, enhanced productivity through crop/ land use planning based on land capability and or land suitability was amply demonstrated in 54 micro- watersheds across arid, semiarid, irrigated, hill and mountain and coastal agrocosystems through NBSSLUP led National Agricultural Technology Project (NATP) -Mission Mode Project on Land Use Planning for Management of Agricultural Resources. Developed soil site suitability for annual, perennial and other crops and its criteria. Suitability maps for various crops in different states were developed.

b. Experiences of All India Coordinated Research Project for Dryland Agriculture (AICRPDA)

Land Capability based Productive Farming Systems for resource conservation and enhanced land productivity : Based on 30 years of research across AICRPDA network centers, Productive farming systems are identified for drought prone regions based on rainfall; land capability and soil order (Vittal et al., 2003). Land used based Farmstead plan State of Art based agroforestry models linked to livestock and watershed management for soil and water conservation including water harvesting. Some of the subjects are - hedge fencing, multipurpose tree species, bush farming, cereals/millets. Pulse/ oilseeds/ cotton, parkland horticulture, floriculture, floriculture cum IPM, home remedies, water harvesting, livestock, poultry, fisheries, apiary etc. are some of the models suggested. Diversification in to higher value agricultural crops (medicinal, aromatic, dye yielding crops etc.), and non-farm activities like value addition to agricultural products offer good scope for sustained increase in per capita income. Part of the farmstead could also be used for generating seed spices. For the development of commons, these may be divided into small plots of 5-10 ha and can put on long lease of about 19 years to the user groups. The combination of systems such as fruit trees, silvipastures, multipurpose trees, or even pastures may be adopted on commons. Maximum number of trees per hectare may be limited by quantum of annual rainfall (product of rainfall, m and area, m^2) divided by volume of water one full grown tree transpires annually (a product of canopy area, surface area in m^2, and potential evapotranspiration in m per annum). Improved variety or new plant species suitable for the ecosystem and rejuvenation of social fencing of improved plant species may be attempted. In tree farming, the general cleanliness of the area is lost thus, encouraging new diseases and pests. Hence, it is important to carry out weeding and form basins for the trees and furrows for *in situ* rainwater harvesting in the case of shrubs, grasses and fodder legumes. Diversification strategies should be based on low external input strategies (Vittal et al. 2006).

Land use planning and Land resources conservation in drought prone regions- An example of Chronic drought in arid marginal rainy season Aridisols: A drought prone area is defined as one in which the probability of a drought year is greater than 20%. A chronic drought prone area has a possibility of 40%. A drought year occurs when rainfall is less than 75% of the normal rainfall received. Chronic droughts occur in the arid and semi-arid region. In arid region of Western plains, Kutch and part of Kathiawar peninsular hot eco region, the length of growing period is mostly less than 60 days. Under assured conditions with deep loamy soils the length of growing period is 60 to 90 days in the hard hyper sandy desert soil. The crops are mostly grown in the deep loamy soils. The less water requirement crops may be

cultivated in these regions. So that the rainfall is sufficient enough to support the crop . If a high water requirement crop like groundnut or maize is cultivated in this region, it may encounter drought . Some management practices like soil and water conservation may be adopted to achieve higher yields (Fig. 1)



(Source: Vittal et al, 2003).

Fig.1. Management of chronic droughts in dry semi-arid marginal region

C. Learning experiences of CRIDA from NATP- Mission Mode Project on Land Use Planning for Management of Agricultural Resources in Rainfed Agroecosystem:

Scientific land use planning in drought prone regions is one of the rational approaches for drought mitigation. In several locations only 50 per cent of the farmers adopted land use that is considered scientifically correct or recommended by the NARS.One of the project outcome distinctly brought out that in a microwatershed, cadastral level (1:10000/25000) both biophysical evaluation (soil resource inventory) and socioeconomic evaluation (Participatory Rural Appraisal (PRA) etc.) followed by allocating land parcels with appropriate land utilization types viz., cotton, greengram, groundnut, pearlmillet, grasses etc. on a toposequence, could enhance the land productivity from 20 to 50 per cent compared to traditional land use across Entisols, Inceptisols, Vertisols, Alfisols and Aridisols (NATP-MMLUP- Rainfed Agroecosystem - Final Report, 2005).

Delineation of Soil Conservation Units (SQUs), Soil Quality Units (SQUs) and Land Management Units (LMUs): Delineation of Soil Conservation Units (SQUs), Soil Quality Units (SQUs) and Land Management Units (LMUs) from the detailed soil survey maps at cadastral level in a microwatershed would help in land resource management information since these units are homogeneous and has a wider application. A resilient, less risk prone farming system based on the land requirements and farmers' capacities is developed to mitigate the drought and to address the unabated land degradation and imminent climate change. Further,

SCUs are basically for soil and water conservation prioritized activities to mitigate drought and could be linked to programmes like National Rural Employment Guarantee Scheme (NREGS) in a watershed/ village to create physical assets like farm ponds etc. SQUs are to address soil resilience and improve soil organic carbon, problem soils amelioration and wastelands treatment and linked to various schemes and programmes in operational like National Horticultural Mission, Rashtriya Krishi Vikas Yojana etc. SCUs and SQUs are merged in GIS environment to delineate land parcels in to homogenous Land Management Units with farm boundaries. LMUs would be operational zed at farm level for taking decisions on arable, non-arable and common lands for cropping, agroforstry, agrohorticulture etc., and further, for leaving the most fragile land parcels for ecorestoration. Rainfed land use planning modules should be based on these units for risk minimization, enhanced land productivity and income, finally for drought proofing (Ravindra Chary et. al, 2005).

Challenges in Land Use Planning vis-a vis Conservation of Land resources

Following are some of the important challenges, that are also important while addressing land use planning issues for conservation of land resources, flashed in the Agenda Note during National Brain Storming Session on Land Use Planning and Policy Issues at NBSS&LUP (ICAR), 25-26 July 2008, Nagpur.

1. Multifunctionalilty of land and land use decisions:
2. Issue of scale and data requirement
3. Issue of data integration:
4. Changing concepts and tools for LUP

Land use Planning and conservation of land resources – Some options

Some of the important technical, policy and support systems and legal options, which need immediate attention and action for furthering scientific land, use planning (NBSS&LUP, 2008) are:

a. Technological Options -1.Land use data generation at cadastral level with details about land tenure and land ownership to make effective land use plans. There is needed to re-look to resurvey and reclassify the land records and data collection mechanism at grass root level. 2.The exploratory DSS and its importance in data integration and analysis in LUP processes to provide answers for how, where, when to grow different crops to enhance the food production in the country.3.Drought prone areas need a sound land use plan to effectively utilize the limited biophysical resources. There is a need of proper integration for a holistic outlook and creation of homogeneous drought management unit in the land use methodology. 4.LUP is either prescriptive or exploratory at regional (state/ district) level, which provides a window for development options while LUP becomes increasingly participatory at village and watershed level advocating certain land uses in region and takes care of self interest of the land holder.

b. Policy options -1.Land use planning has geographical aspects like geology, soils, and climate, socio-economic aspects, which need to be synchronized in data integration processes. Land resource should be utilized as per its ecological capability.2.State Land Use Boards have to be made more active and effective in the land use planning processes at state level in general, and agricultural plans.3.Various policies and their importance in forest management and conservation, any LUP should have harmony among the forest, agriculture and environment, which is possible through integrated approach to achieve the ecological security of the country. 4.The district level land use plans are the good enough to capture the intra-

district and inter-regional variability in resources availability. LUP should also address the issues of C fixation through different systems. Carbon credits should be linked with incentives to make it remunerative. Land use in general and land use planning in particular is closely linked to land tenure, land title, land rights land lease issues etc. 5.Delineation of core Rainfed Agro-economic Zones (RAEZs): In rainfed agriculture, complex scenarios/issues call for a shift in the present research and development paradigm to an entirely new target domain approach delineating core rainfed crop zones in to 'Rainfed Agro Economic Zones'. Here, the rainfed farmers' livelihoods improvement and sustaining the land resources would be focal, wherein all the issues related to production through processing, profitability, improved livelihoods in harmony with conservation and maintenance of land resources in a win-win situation is the strategy. Instead of individual and piecemeal interventions the entire production system will be targeted to develop as a Rainfed Agro-Economic Zones (RAEZs) which would act as hubs of rainfed agriculture development.

c. Support systems options – 1.Market mechanism operating more strongly than in the past, crop and land use shifts to become more dynamic now. Land use changes and LUP should take care the rainfall aberrations, soil health, market forces and nutritional requirements. 2. New tools like crop or weather insurance can also be used either as positive or negative incentives to encourage scientific land use in rainfed areas. New opportunities are also arising in the area of clean Development Mechanism (CDM) and carbon credits where farmers can be compensated for adopting conservation practices which contributes to scientific land use and sustainable productivity on a long term basis, but relatively lower returns on short term. A combination of better technologies, new policies and support systems are required to meet the goal of realizing higher productivity and simultaneously adopting a sustainable land use.

d. Legal options -1. In view of the land use, which was perceived as a matter of local concern, has become a matter of national concern and hence the basis of distribution of power in relation to land, which was relevant and valid when constitution was drafted, has become outdated. Therefore, the amendments of the constitution transferring the subject of land from state list to the concurrent list (Komawar and Deshpande, 2008).

Epilogue

Scientific land use planning is the way out for conservation of natural resources through sustainable land management practices evolved during land evaluation process and other principles of land use planning. In a country like India endowed with diverse climate, edaphic, biota and socioeconomic settings on one side and challenged by unabated competing demands for food production, conservation of land resources and sectoral development from the finite land resources, land becomes not only important factor of production and but also the basic means of subsistence, particularly in stressed rainfed agroecosystem. Land use planning is the sectoral allocation of land to optimize the postulated objectives under the existing environmental and societal opportunities and constraints. At district level, resource managers (development planners, decision and policy makers) are often concerned about what new agricultural (including livestock) production innovations/ activities need to be promoted/supported under varying constraints of land (including quality), labour, water and capital. They are also concerned about minimizing the adverse effect of agricultural/land use (economic) activities on the quality of natural resources. They also have to incorporate several views, goals, and programmes of State and Central governments as well as problems,

aspirations and priorities lower level (Panchayat, NGOs etc.) and analyze the trade offs (current and future) on implementing them. However, considering the economic, social and environmental gamut of decision making, the best land evaluation options are not necessarily the best LUP choices. Moreover, while land evaluation and land management are based on scientific/technical and economic criteria, LUP encompasses decision making and essentially involves a political action. In its broader sense, LUP is a tool to support orderly occupation and use of land to avoid adverse developments. Apart from designing or zoning different land areas it should specify different interventions necessary for the success of suggested land uses. During land allocation, LUP also has a collective vision that considers overall welfare of stakeholders in an extensive area than a single holder.

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