Int.J.Curr.Microbiol.App.Sci (2018) *7*(4): 867-880

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 7 Number 04 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.704.094

Participatory Land Use Planning to Enhance Rural Livelihoods in Eastern Maharashtra Plateau of Central India

V. Ramamurthy*

ICAR-National Bureau of Soil Survey and Land Use Planning, Regional Centre, Hebbal, Bangalore-560024, Karnataka, India

**Corresponding author*

Keywords

Participatory land use planning, India, Soil suitability, Land use changes

Article Info

Accepted:
07 March 2018
Available Online:
10 April 2018

A B S T R A C T

Integration of farmers preference, bio-physical, socio-economic resources with scientific evaluation is important for viable land use planning to conserve and use available resources in a sustainable manner. In many countries, participatory approach has proven to be essential in successful planning and implementation of land use plans. The main aim of this study to enhance the rural livelihoods through participatory land use planning approach. This paper reports Participatory Land Use Planning (PLUP) methodology developed by integration of farmer's preference through PRA, bio-physical evaluation of soils by land evaluation and socio-economic resources and tested in Eastern Maharashtra plateau of Central India. The study revealed that land use planning is dependent not only on the soil suitability criteria but also on the market forces, economic situation of the farmer, short term family needs, level of perception, social status, proximity and fragmentation of land and migration (labour). The introduction of such PLUP, which are mutually agreed by stakeholders and researchers improved the adoption of alternate plans and in turn increased the productivity of different crops by 14-48 per cent. Crop selection based on soil suitability, soil and water conservation measures using local resources coupled with application of required inputs were the key ingredients of this approach.

Introduction

India has an agrarian economy, which is strongly influenced by agriculture and allied enterprises. In India, nearly 50 per cent of lands suffer from severe land degradation. An increasing population has put more pressure on land, shortened fallow periods, increased deforestation and the use of animal dung for fuel and crop residues for fodder have drastically reduced in their contribution to soil enrichment. Soil erosion is rampant, as over-grazing and grazing on steep and unprotected slopes continue. In many areas, rainfall is becoming scarce and less reliable and under groundwater table has declined drastically. Due to these physical constraints and increased input costs the existing farming systems are no longer able to meet farmer's subsistence needs. This means that families have less reliable source of food.

Land use planning aims to encourage and assist land users in selecting options that increase their productivity, are sustainable and meet the needs of society (FAO, 1993).

However, the two most crucial constraints to effective land use planning are conflicts on land use objectives between different stakeholders/interest groups (Hoanh and Roetter, 1998; de Haan and van Ittersum, 1999; Velayutham *et al.,* 2002) and uncertinity about future land use objectives, land resources and exploitation technologies (Hoanh and Roetter, 1998).

In India, land use planning at local level are governed by farmers own requirement and market prices (Velayutham *et al.,* 2001) rather than land suitability criteria (Ramamurthy *et al.,* 2000) which is followed in developed countries. The land use plans suggested by national and state land use boards and research Institutes are seldom adopted by local communities/ stakeholders. The reason for non adaption are the initiatives usually come from government officials or others outside the local community and the techniques, resources and skills suggested rely heavily upon innovations developed at research stations. Moreover suggested plans developed from soil survey and land capability assessments (Patil *et al.,* 2011; Dhanorkar *et al.,* 2013), focuses upon the relationship between land use and its environmental compliance alone. The socio-economic and political factors at the household, community and national levels, which influence land use, are often neglected. Also, there is a tendency to focus on land use per se and to neglect the details of land management and husbandry. Such land use plans have limited replicability because it involves considerable manpower and technical resources like maps and field staff and farmers do not easily comprehend the technicalities in this top down approach. As a result the implementation of land use planning is often difficult.

It has now been endorsed that successful land use planning depends on the participation of farmers. Thus, Participatory Land Use Planning (PLUP) is considered as an important tool for sustainable resource management by local communities (Amler *et al.,* 1999; Oltheten, 1999; Fagerstrom *et al.,* 2003; Sawathvong, 2003). The aim of PLUP is to strike a balance between technical approach and farmer's requirements to maintain natural resources in sustainable manner. The plan should blend with bio-physical, socio-economic, gender, policy, equity, community participation and institutioalised management of common property resources on a village or watershed basis. Keeping this in view, an attempt was made to introduce the participatory land use planning concept under Indian situation and assess its feasibility in Kokarda village of Nagpur district, Maharashtra.

Materials and Methods

Location and Agro-climate of the study area

Present study carried out under Technology Assessment and Refinement through Institute-Village Linkage Programme. The village (Fig. 1), where participatory land use planning was implemented is situated at 21^0 20' N Latitude and 78^0 51' E longitude on an altitude ranging from 340m to 360m above MSL. The geographical area of the village is 280 ha.

Agro climatically, the site is located in the Eastern Maharashtra plateau experiencing hot, dry, sub-humid eco-region (AESR-10.2) and are dominated by Vertisols (deep black soils) and associated soils. Moderately deep (100-150 cm)-to-deep (>150 cm) soils are found in valleys, while shallow (<50 cm) to medium deep (50-100 cm) soils occur on escarpments. The shallow soils are severely degraded, while deep soils have impaired drainage. The soil pH is alkaline, ranging from 8.1 to 8.6. Annual rainfall varies from over 975mm to less than 800mm per year and is received primarily during the southwest monsoon from second week of June to October. The maximum rainfall is received in the month of July. About 90 per cent rainfall received during June to September. Rainfall covers only 77 per cent of the gross annual water demand, even in normal rainfall year.

The dominant *kharif* (monsoon season) crops are sorghum, cotton and soybean. Chickpea is the main crop grown on residual soil moisture in the *rabi* (winter) season. Farmers have little access to timely, affordable credit and adoption of purchased agricultural inputs including fertilizer is limited.

Soil Resource Inventory

The soil resource inventory of Kokarda village (1:5000 scale) was carried out simultaneously as per the guidelines outlined by Soil Survey Manual (2000). The soil profiles were exposed and studied for morphological features and horizon-wise soil samples were collected and analysed for some important parameters as per the standard procedure. The soils were classified as per guidelines given in Key to Soil Taxonomy and identified 9 soil series in the village and are correlated with existing soils of Nagpur district. The soil series were evaluated for different crops suitability by using revised criteria developed by Naidu *et al.*, (2006) and soil suitability map is prepared (Fig. 3).

Methodology

To identify the problems of land use and land use decisions, a participatory rural appraisal (PRA) was conducted in the summer 2000. The PRA was an interactive process spreading over 3 month period with planning occurring on site. Farmers identified the causes for land degradation and its effect on their livelihood (Fig. 2). Through focused PRA, farmers' perception and priorities of land use were identified. Land suitability map of village was discussed with each landholder and their opinion was incorporated before implementation. Most of the farmers were not inclined to accept the land suitability criteria, as there were numerous conflicts between suggested and preferred/practiced land use.

To understand the non-acceptance of suggested land suitability plan, resource mapping, transect walk and discussion with stakeholder was initiated to review the land use history, describe the village land condition and production, explain the reasons of land use change, define the socio-economic factors that affect their decision and propose the preferred future land use. To implement a negotiated scientifically optimal, yet socio-economically tenable and acceptable by partners/stake holders, mutually agreed LUP options were evaluated for four years. Change in land use and productivity of different land uses during this period was also monitored.

Results and Discussion

Soil site characteristics

Based on soil survey data, soils of Kokarda village were classified in to nine series (Table 1) with maximum area (23.9 %) under shallow soils (15 cm), brown excessively drained loamy soils followed by very deep (150 cm), dark to very dark brown, moderately to well drained clayey soils (14.6 %). Soils are shallow at escarpment and deep in valley bottom. The surface texture of these soils varies from clay, clay loam, sandy clay loam and sandy loam and slope ranges from 1 to 30 percent in different landforms (Table 1). The soils are low in nitrogen and medium in phosphorus and potash. Nearly 258 ha is under different land use and remaining area in under settlement, drainage lines etc. Shallow soils, which are dominated in the village, are under *kharif* crops.

Soil suitability evaluation

Soil suitability of village revealed that only 29.6 per cent area is suitable for all crops and nearly 25 per cent of the area is highly suitable for forest/ pasture and moderately suitable for *kharif* pulses (Fig. 3). Nearly 12.5 per cent is moderately suitable for sorghum, soybean and highly suitable for cotton varieties, 12.3 per cent of area is suitable only for forest and pasture and 10.9 per cent area is highly suitable for agroforestry and moderately suitable for pulses, cotton (varieties) and marigold.

The soil suitability ratings were compared to farmer's preference and perception at each land holding level. The perceptions did not match with the scientific soil suitability ratings. More than 60 per cent of the farmers' opinion on suitability of soil site characteristics (soil depth, slope per cent and stoniness) to different crops were corroborated with that of scientific criteria. But, in practice only 60 per cent of cotton, 50 per cent of sorghum, soybean and groundnut and 20 per cent of the orange area is being grown on suitable land (Fig. 4).

The other over riding factors that decides the practices of land use system in the village are: (1) economic condition of the farmer (2) short term family needs (3) level of perception or understanding (4) social status (5) fragmentation of land (6) risk management (7) proximity of land to the dwelling (8) migration (labour).

The analysis further revealed that even though farmers perceive the optimum LUP correctly, in practice, the existing land use is quite often objectively unsuitable under the current evaluation system in many ways. This is because of the fact that farmers have to strike a balance between available or mobilizable resources (physical and economic) and the diverse household needs and decide according to the market forces. Under such prevailing conditions, Participatory LUP interventions would play a pivotal role in optimizing the production of farmers' choice of crops and enterprises on sustainable basis.

Identification of land use problems

Initial Participatory Rural Appraisal (PRA) exercises revealed that due to increased population pressure, more area particularly those that was not suitable to the cultivation of crops were brought under cultivation. This led to decreased forest resources and climate change and finally degradation of land productivity and low crop productivity (Fig. 4).

Land use dynamics

Before implementation of PLUP, the initial land use and land cover was studied (Fig. 5). Out of 280 ha geographical area, 180 ha was under crop cultivation and nearly 32 ha area was under scrub forest. Out of 180 ha, 58 per cent of the area was under cotton hybrids, 21.6 per cent under cotton hybrids + sorghum, 9.3 per cent under sorghum and 5.3 per cent under citrus + cotton hybrids + soybean system. As per the soil suitability evaluation, only 35 per cent area is suitable for cotton hybrids, 40 per cent for sorghum and soybean. But actual practice was to grow cotton hybrids in almost all types soils because of socio-economic compulsions and other factors as discussed above. Due to this the productivity of cotton hybrids was very low (8 q seed cotton /ha) as compared to potential yield of village (10-14 q/ha).

These reasons were explained to stakeholder and different plans were drawn to different land holdings. Participatory land use options implemented in different soils integrating farmer's perception and scientific land evaluation is presented in Table 2.

Fig.1 Study area- location of Kokarda village

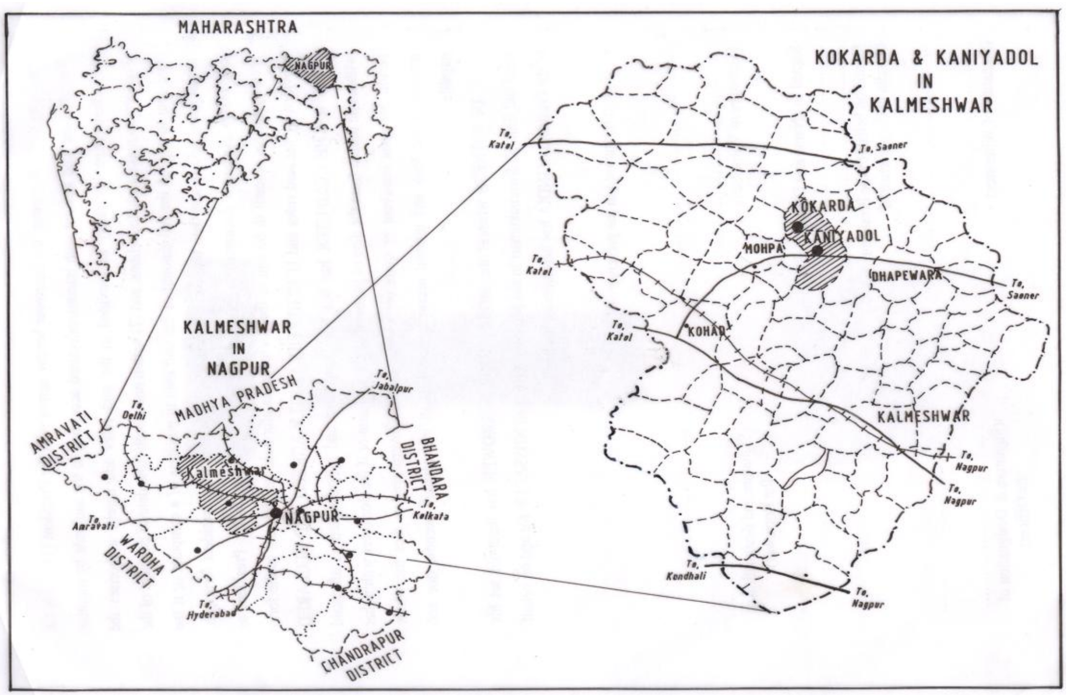

Fig.2 Problem analysis- Land use and land degradation

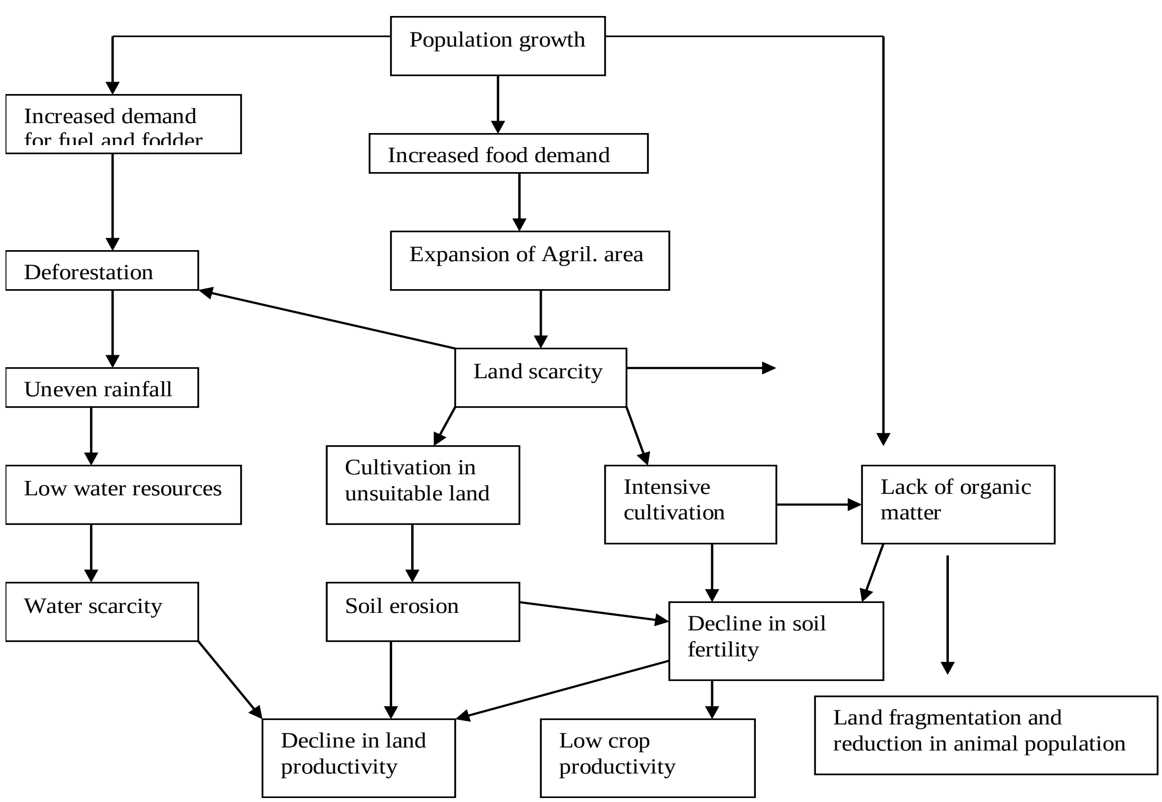

Fig.3 Soil suitability map of Kokarda

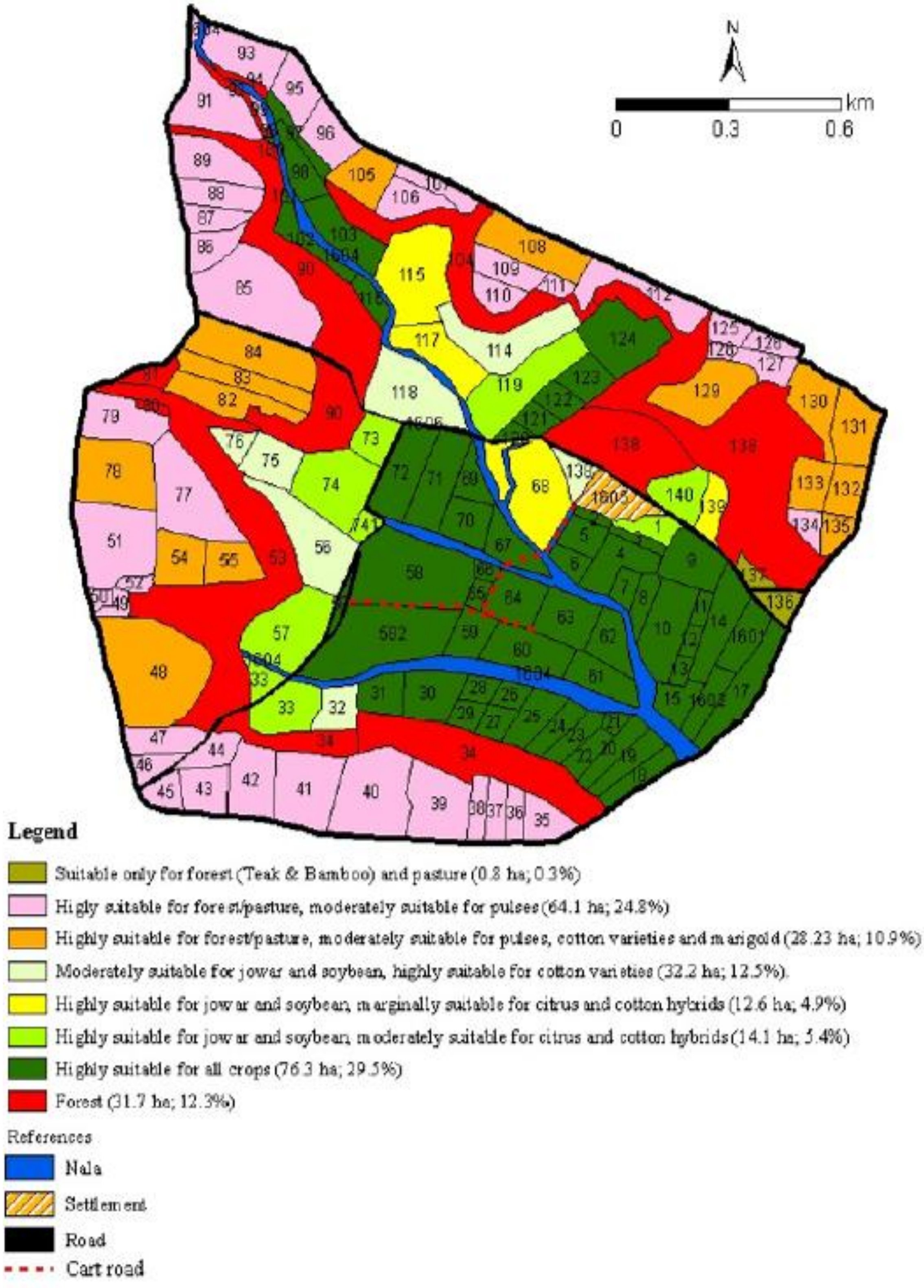

Fig.4 Perception and implementation of scientific soil-site suitability in the watershed

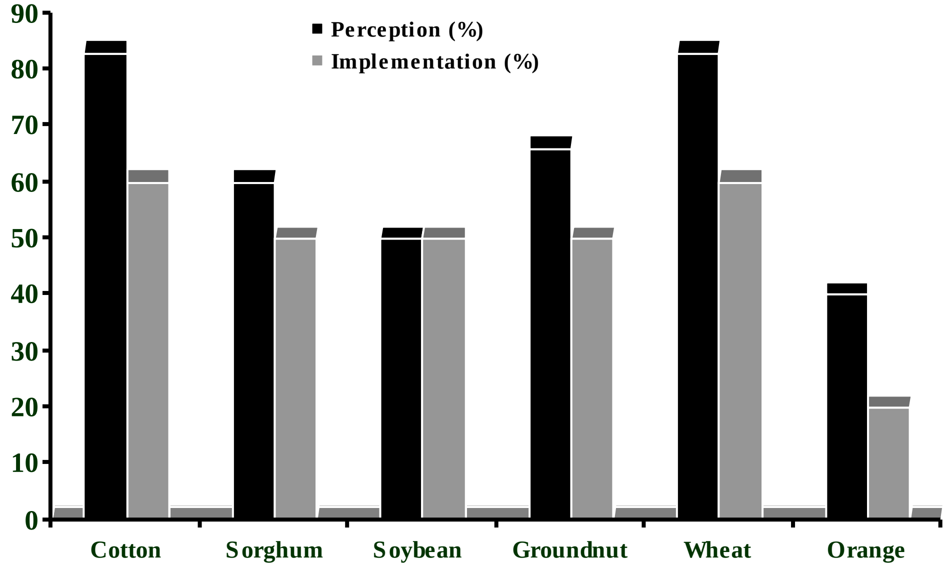

Fig.5 Land use land cover map of Kokarda village before implementation of PLUP

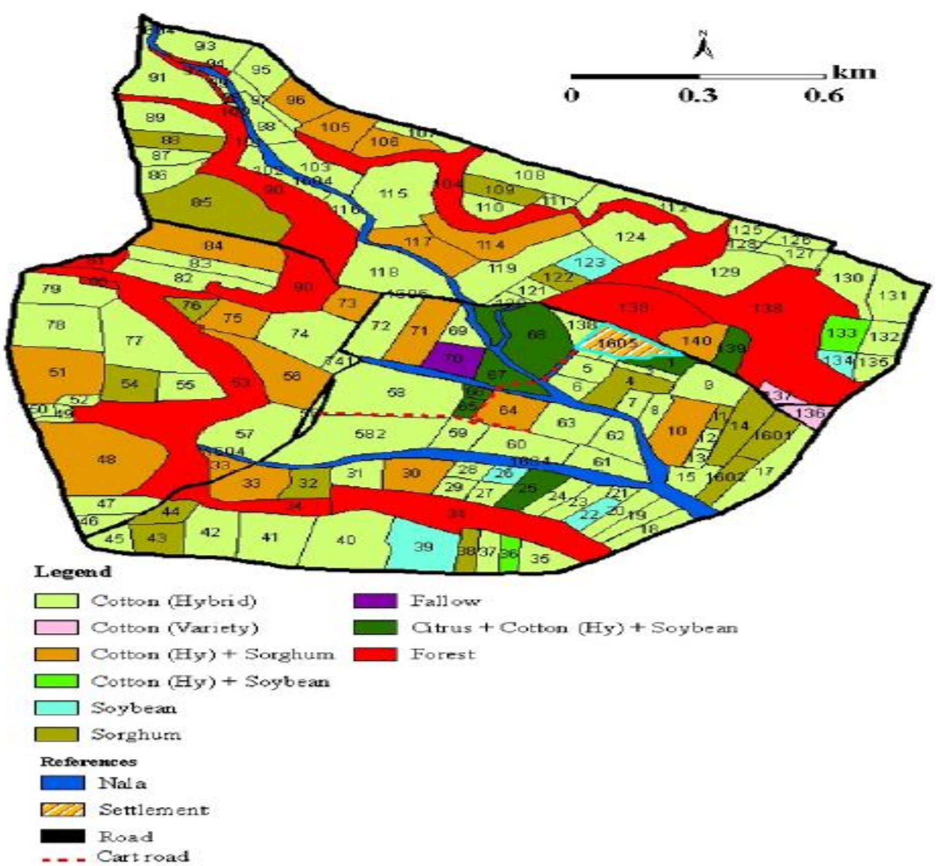

Fig.6 Land use land cover map of Kokarda village after implementation of PLUP

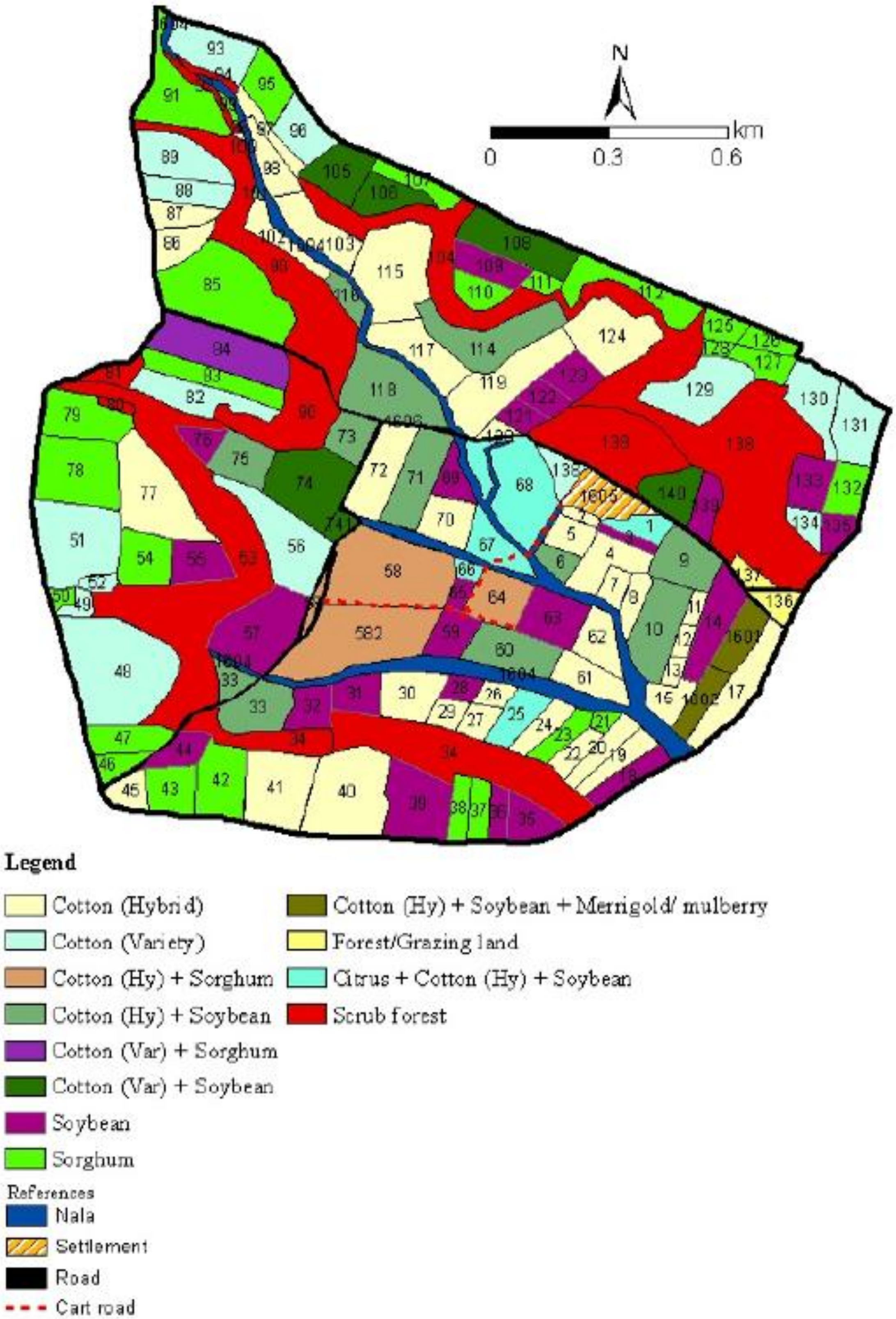

Table.1 Characteristics of soils of Kokarda village

Soil series	Characteristics	Effective soil depth (cm)	Major land use/ constraints	Some soil physico-chemical properties (ranges) through depths					LCC*	Irriga-bility sub class	Productivity potential	Soil taxonomy (subgroup)
				Clay (%)	OC (%)	CEC cmol (+)/kg	$CaCO_3$ (%)	pH				
Kokarda-1 (Dongari soil)	Shallow, brown, loamy, excessively drained soils on hills and plateau (1-15%)	15	- Sorghum, cotton, pigeonpea - very low WHC, low response to crops and management practices	33.5	0.50	25.5	-	6.8	IVes	4st	Very low	Lithic Ustorthents
Kokarda-2 (Bardi soil)	Moderately deep, dark brown, clayey, well-drained soils on plateau (1-8%)	50	-Cotton, pigeonpea, sorghum - Low to medium WHC	52.6-59.5	0.76-1.07	34.8-38	-	6.5-6.6	IIIes	2st	Medium	Typic Haplustepts
Kokarda-3 (Pathari soil)	Shallow, dark brown, clayey, excessively drained soils on escarpment (15-50%)	22	-Natural vegetation -Very shallow soils with low WHC	38.5-45.5	0.85-1.56	34.5-39.2	-	6.6-6.8	IVes	6st	Very low	Typic Ustorthents
Kokarda-4 (Dongari soil)	Moderately deep, dark brown, clayey skeletal, well-drained soils on escarpment (15-30%)	44	-Forest land - Low to medium WHC	54.5-60.5	1.28-1.72	40.5-44.2	-	6.7-6.9	IVes	6st	Very low	Lithic Ustorthents
Kokarda-5 (Dongari soil)	Shallow, brown to dark brown, clayey, well drained soils on pediment (3-30%)	11	-Sorghum, Pigeonpea, gram, wheat, vegetables - Very low WHC	37.5	0.53	34.5	12.2	8.0	IIIes	3s	Low	Lithic Ustorthents (cal.)
Kokarda-6 (Bardi soil)	Moderately deep, brown, clayey, well drained soils, on pediment (1-8%)	36	-Sorghum, cotton, pigeonpea -Low WHC	36.5-47.5	0.58-0.69	33.3-44.2	4.2-4.6	7.8-7.9	IIIes	3s	Low	Typic Haplustepts (cal.)
Kokarda-7 (Bardi soil)	Deep, brown to dark brown, clayey, well to moderately drained soils on pediment (1-8%)	60	-Sorghum, cotton, wheat, vegetables, orange - Low to medium WHC	42.5-50.5	0.56-0.75	41.2-48.7	10.7-14.1	8.1-8.4	IIIes	3es	Low	Typic Haplustepts (cal.)
Kokarda-8 (Halki kanhar)	Very deep, very dark brown, clayey, moderately to well drained soils on piedmont (1-8%)	97	-Cotton, sorghum, pigeonpea, wheat, gram, vegetables, orange -Medium to high WHC	53.5-59	0.69-0.82	50.6-55.4	8.4-17.3	8.1-8.5	II s	2s	Medium	Vertic Haplustepts (cal.)
Kokarda-9 (Bhari kanhar)	Very deep, dark brown to very dark brown, clayey, moderately to well drained soils, on piedmont (1-3%)	150	-Cotton, sorghum, pigeonpea, wheat, gram, vegetables, orange, sugar cane -Medium to high WHC	53.0-71.5	0.24-0.89	45.6-56.9	13.5-18.0	8.2-8.8	II d	2d	Medium	Typic Haplusterts (cal.)

*LCC- Land capability class.
Names in parenthesis are local name

Table.2 Mutually agreed land use options for different soils based on farmer's perception and scientific land evaluation

Present land use	Farmer's perception on present LUP	Suggested land use	Farmer's perception on suggested LUP	Mutually agreed land use management for cotton (Demonstration)
<u>Moderate deep to deep soils</u> 1. Cotton hybrids grown with a spacing of 100 x 100 cm	1. Low yield 2. High flower and boll drop 3. High cost of production	1. Cotton hybrids on deep, medium deep soils with recommended spacing of 90 x 90 cm and Integrated nutrient management (INM) practice	1. Acceptable since it resembles the current practice	1. Growing of cotton hybrids with 3'X3' spacing on medium and deep soils and INM
2. (a) High yielding varieties of sorghum grown with recommended seed rate but late sowing		2. (a) Timely sowing of HYV or hybrids with recommended seed rate	2.(a) Non availability of shoot fly resistant varieties and hybrids	2. (a) Timely sowing of sorghum hybrids with recommended seed rate on medium and deep soils
(b) High yielding varieties of sorghum grown with recommended seed rate and plant protection (Shoot fly) for late sowing		(b) For late sowing use shootfly resistant varieties or use higher seed rate to maintain the plant population or follow recommended plant protection with application of carbofuran	(b) Timely sowing is very difficult because of non availability of labour and bullock pairs	(b) Growing of sorghum variety/hybrids with higher seed rate in late sown condition
3. High yielding varieties of soybean with low plant population and poor nutrient application		3. Optimum seed rate and integrated nutrient management	3. Lack of knowledge on seed treatment with biofertilizers	3. Use of optimum seed rate, application of 75% recommended dose of fertilizers and seed treatment of rhizobium and phosphate solublizing bacteria
4. Citrus orchards with cotton and soybean inter cropping without drainage system and low nutrient application (20 kg FYM /tree)		4. (a) Citrus orchards on moderate deep soils with 50 kg FYM +600:200:100 g NPK/tree (b) Citrus orchards on deep soils with drainage system + 50 kg FYM +600:200:100 g NPK/tree	4. Non-availability of FYM	4. Application of 5 kg Vermicompost + 20 kg FYM in the months of November and May
5. Most of the area is fallow during *rabi* (winter) few farmers grow for gram and wheat using protective irrigation		5. In deep soils gram can be grown with residual moisture and wheat with 4-5 protective irrigations	5. Low ground water table of wells limited area can be put use in rabi. If water resources improved, wheat, vegetables and gram can be grown	5. Soil and water conservation (nallah bunding and percolation tank) measures to improve the well recharge capacity to bring more area under crops in rabi especially under wheat and

				vegetables
<u>Shallow soils</u> 1. Cotton hybrids grown with 100 x 100 cm spacing 2. High yielding varieties of soybean with low plant population and poor nutrient application 3. (a) High yielding varieties of sorghum grown with recommended seed rate but late sowing (b) High yielding varieties of sorghum grown with recommended seed rate and plant protection (Shoot fly) for late sowing	- Do-	1. Early maturing cotton varieties on shallow soils with 60 x 60 cm (closer) spacing to induce earliness 2. Optimum seed rate and integrated nutrient management 3. (a) Timely sowing of HYV or hybrids with recommended seed rate (b) For late sowing use shootfly resistance varieties or use higher seed rate to maintain the plant population or follow recommended plant protection with application of carbofuran	1. Non availability of 60 cm markers for sowing of variety 2. Flower and boll drop is more due to restricted aeration and increased humidity at lower spacing 2. Lack of knowledge on seed treatment with biofertilizers 3. (a) Non availability of shoot fly resistant varieties and hybrids (b) Timely sowing is very difficult because of non availability of labour and bullock pairs	1. Growing of cotton variety on shallow soils with 60 x 60 cm or 45 x 45 cm spacing and opening of broad bed and furrow 2. Use of optimum seed rate, application of 75% recommended dose of fertilizers and seed treatment of rhizobium and phosphate solublizing bacteria 3. (a) Timely sowing of sorghum hybrids with opening of furrow after every seven rows (b) Growing of sorghum variety/hybrids with higher seed rate in late sown condition 4. Alternate land uses like planting of mulberry where assured irrigation facilities are available or growing of marigold flower or coriander for culinary purpose
<u>shallow soils with coarse texture and lower profile water holding capacity</u> 1. High yielding varieties/local varieties of sorghum grown with recommended seed rate but no plant protection 2. Cotton hybrids/ varieties grown on stony shallow soils (N_2: Not suitable)	1. Low yield 2. low plant population 3. Non economical 4. Poor fodder quality	1. (a) Timely sowing of HYV or hybrids with recommended seed rate (b) For late sowing use shootfly resistance varieties or use higher seed rate to maintain the plant population or follow recommended plant protection viz., use of carbofuran application 2. N_2 soils should be put to use for pasture and agro forestry to reduce erosion and improve soil fertility	1. First preference is cotton and soybean as these crops more remunerative than sorghum 2. Accepted for testing	1. Growing of sorghum variety/hybrids with plant protection measures to control shoot fly in late sown condition 2. Growing of Sorghum on N_2 soils

Table.3 Average yield of crops for pre and post PLUP period in Kokarda Villages

CROPS	Average yield (Kg/ha)		Per cent increase
	Pre project	Post project	
Rainfed			
Sorghum	1540	2170	40.9
Cotton Variety	500	700	40.0
Hybrid	810	1080	33.3
Soybean	1020	1340	31.4
Pigeon pea	600	750	25.0
Ground nut	925	1150	24.3
Local fodder sorghum	2500	10,000	400
Irrigated			
Wheat	1500	1730	15.3
Gram	650	965	48.5
Brinjal	14000	16000	14.3
Orange	21,500	26,500	23.2

The analysis of changes in land use after four years of implementation indicated that the area under crop cultivation increased from 180 ha to 197 ha (Fig. 6) by bringing current fallow and other pasture land under agro-forestry cultivation. The area under cotton hybrid, cotton hybrid + sorghum and citrus has been declined from 104 to 55 ha, 38.8 to 11.9 ha and 9.6 to 6.8 ha, respectively.

Whereas, area under cotton varieties (which can be grown on shallow soils, not suitable for hybrid cotton), cotton hybrids + soybean, cotton varieties + sorghum, cotton varieties + soybean, soybean and sorghum increased from 0.8 to 23.9 ha, 1.72 to 12.9 ha, 0 to 8.2 ha, 0 to 8.8 ha, 6.1 to 29.3 ha and 16.6 to 37.7 ha, respectively. The area under soybean and sorghum fluctuated alternatively depending on market prices.

Evaluation of PLUP

Each land use plan was evaluated for its productivity, economic viability and farmer's acceptance after the crop cycle and modifications were made while implementing the plan if stakeholder found it difficult to implement the agreed land use plans.

The increase in productivity of different crops following the implementation of PLUP ranges from 14 to 48 per cent (Table 3). The yield levels of dryland as well as irrigated crops increased. This indicates that the PLUP created awareness and build the knowledge base among the stakeholders to use available natural resources more appropriately for improving the productivity.

Impact analysis of different land use management practices over different crops indicated that timely sowing of sorghum is being practiced by 90 per cent of the stakeholders and consequently the shoot fly incidence in sorghum reduced from 59 to 29 percent. Similarly, in cotton the adoption of *Azotobacter* seed treatment increased from 5 to 36 per cent and farmers practicing reduced spacing for cotton variety (45 x 45 cm) increased to 12 per cent. In soybean, the number of farmers adopting optimum seed rate has rised to 75 per cent, *rhizobium* and Phosphate solubilizing Bacteria (PSB) use has been increased to 90 and 30 per cent, respectively. This increased adoption of technologies shows the direct impact on improvement of stakeholder's livelihood and acceptance. Adoption of scientifically feasible, economically viable and stakeholder agreed technologies with soil suitable land uses contributed for increased productivity of crops.

Land use in the study area is very dynamic. Economic situation of the farmer, short-term family needs, level of perception or understanding about land resources and risk management strategies, social status, fragmentation of land, proximity of land, migration (labour) and market forces decides the land use. The introduction of village based participatory land use planning has made it possible for the villagers to practice proper land use management on their farms. Land use changed even more favourably than farmer's preference by demonstrating mutually agreed land use plans. Productivity level of rainfed crops increased in the range of 24-40 per cent whereas, in irrigated situation between 14- 48 percent. Improved production at farm level is now realized as a result of practicing soil suitable crop selection, soil and water conservation measures coupled with application of required inputs (organic and inorganic fertilizers). PLUP enhanced the livelihood of people by improving cash flow and conserving the natural resources of the village. Although this exercise was operational for five years, the degree of change of attitude by the villagers towards adopting participatory land use planning is considered satisfactory.

Acknowledgement

Authors thank all the participating farmers for sharing their valuable experience and providing information for this paper. The financial help rendered through the World Bank funded National Agricultural Technology project (NATP) for conducting this study is gratefully acknowledged.

References

Ameler, B. D., Betke, H. Eger, C. Ehrich, U. Hoesle, A. Kohler, C. Kosel, A. V. Lossau, W. Lutz, U. Muller, T. Schwedersky, S. Seidemann, M. Siebert, A. Trux and W. Zimmermann. 1999. Land use planning Methods, Strategies and Tools. GTZ.

De Haan, J. and M.van Ittersum, 1999. Introductory module Quantative Analysis of Agro-ecosystems (QUASI-intro): onderwijselement F350-323.Wageningen University and Research center.

Dhanorkar, B.A., Arti koyal, D.S. Mohekar, L.G.K. Naidu, R.S. Reddy and Dipak sarkar. 2013. Soil resource assessment for crop planning in Medak district, Andhra Pradesh. *Agropedology* 23(1), 23-29

Fagerstrom, M.H.H., I. Messing and Z.M. Wen. 2003. A participatory approach for integrated conservation planning in a small catchment in Loess Plateau, China-Part I. Aproach and methods. *Ctena*. 54: 255-269.

FAO. 1993. Guidelines for land use planning. p. 36. FAO development series1 FAO, Rome.

Hoanh, C.T. and R. Roetter. 1998. Towards decision support systems for land use planning. In: Eds. R. Roetter, C. T. Hoanh and P. S. Teng. A system approach to analyzing land use options for sustainable rural development in south and southeast Asia. Pp. 6-13. IRRI Discussion Paper series.

Naidu, L.G. K., Ramamurthy, V., Chall, O., Hegde, R. and P. Krishanan. 2006. Manual soil-site suitability criteria for major crops. NBSS Publ. No.129, NBSS &LUP, Nagpur, 118 pp.

Oltherten, T.M.P. 1999. Participatory approaches to planning for community forestry. Results and lesson from case study in Asia, Africa and ltin America. Forest, tree and people programme-Forestry department.

Patil, P.L., L. Vinay and G.S. Dasog. 2011. Land evaluation of Bhanapur micro-watershed in Northern Dry Zone of Karnataka. *Agropedology* 21(2), 10-16.

Ramamurthy, V., N.G. Patil, Bankar, W.V., K.S. Gajbhiye and M.V. Venugopalan, 2000. Land use planning: Farmers' perception and priorities–A case study. Paper submitted for National Syposium on Perspectives and policies for land use planning, held at NBSS&LUP from 27th Dec., 2000

Soil Survey Division Staff. 2000. Soil Survey Manual, USDA Hand Book No.18 (Indian print)

Swathvong, S., 2003. Participatory land use management planning in biodiversity conservation areas of Lao PDR. Acta-University-Agriculturae- Sueciae-Silvestria, 2003, No. 267, 44pp, +Papers I-V.

Velayutham, M., Ramamurthy, V. and M. V. Venugopalan, 2001. Agricultural Land Use Planning- from theoretical perspectives to participatory action plan in the Indian context. *The Land*. 6(4): 45-60

How to cite this article:

Ramamurthy, V. 2018. Participatory Land Use Planning to Enhance Rural Livelihoods in Eastern Maharashtra Plateau of Central India. *Int.J.Curr.Microbiol.App.Sci.* 7(04): 867-880.
doi: https://doi.org/10.20546/ijcmas.2018.704.094