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Detailed LRI for Assessment of Land Capability and Land Suitability of Amarapura-2 Micro-Watershed Using RS and GIS

N.L. Rajesh^{1*}, U. Satishkumar², I. Shankergouda³, S.N. Bhat¹, K. Basavaraj¹,
H.V. Rudramurthy¹, K. Narayana Rao¹, V. Rajesh¹ and R. Meenkshi Bai¹

¹Department of Soil Science, ²Department of SWE, CAE, ³Director of Research, UAS, Raichur
- 584 104, Karnataka, India

**Corresponding author*

ABSTRACT

Keywords

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A detailed land resources inventory (LRI) of Amarapura-2 micro watershed was carried out at 1:8000 scale for deriving land capability and crop suitability classes. The micro watershed is located between 77° 8' to 17° 17' North latitude and 77° 10' to 17° 15' East longitude of Lingasaguru taluk, Raichur district, Karnataka State, India. Twenty four soil phase units with eight soil series were identified through detailed soil resource study. Land capability subclasses in the study area were IIIes and IVes with limitations of soil erosion, texture, soil drainage, soil fertility and topography. Land suitability for five major horticultural crops of the area were evaluated and found that only the soil phase unit "MRLfC2" was marginally suitable with limitation of rooting condition (S3r) for Sapota, Jamun, Gauva and Custard apple. Rest all 23 soil phase units were not suitable for all the five crops including Mango. Soil phase unit-wise crop plan with suitable interventions for maximising the yield of field crops, horticultural crops, vegetables, millets and pulses were developed which is a part of improved implementation program in Amarapura-2 micro-watershed under the World Bank funded Sujala-III project.

Introduction

There is a significant diversion of farmlands to non- agricultural uses, exerting further strain on the already shrinking land and water resources, affecting not only the productivity but also the sustainability of the resources. Wrong choice of crops, faulty agricultural practices, imbalance in use of fertilizer, lack of appropriate cropping pattern and choice of land use to exploit the full potentials of the resources by the farmer have greatly affected

the productivity of land resources. The problems of ever-increasing population and increased competition for a variety of demands have induced tremendous pressure on shrinking land resources. It is, therefore, essential to assess the potential of available land in terms of its capability for proper land use planning (Kharche and Gaikawad 1993). In view of this, a systematic study has been made to assess land capability for better land use adjustments according to FAO (1990), in Amarapura-2 micro-watershed for efficient

land utilization in North Eastern part of Karnataka state, India, under the World Bank funded Sujala-III watershed development program, which is being implemented by Watershed Development Department & Dept. of Horticulture, Govt. of Karnataka.

Materials and Methods

Amarapura-2 micro-watershed is located in Lingasugur taluk of Raichur district, Karnataka state and having total area of 519.33 hectares lies between 77° 8' to 17° 17' North latitude and 77°10' to 17°15' East longitude of 508 m above mean sea level (MSL). Semi-arid climate prevails on Amarapura-2 micro-watershed and it belongs to North Eastern Dry zone of Karnataka state. The average rainfall of this region is 560.87 mm with a large spatial and temporal variability. Mean maximum and minimum temperatures are 33.82°C and 21.16°C, respectively. The highest rainfall was received during the month of October (138 mm). The length of growing period, which indicates the availability of water for plant growth, is about 120 to 150 days in a year. It starts from 2nd week of August to 2nd week of November. The location of the study area furnished in Figure 1. Amarapura-2 is surrounded by Kalarhatti, Todki, Kalmalli and Chatra villages.

The detailed survey (at 1:8000 scale) of the entire micro-watershed was carried out in the year 2016, with the help of cadastral map (Fig. 2) overlaid on IRS LISS-IV merged Cartosat-1 imagery (2.5 m spatial resolution), through rapid traversing to cover up the soils at varying physiographic position. During the traverse, based on geology, drainage pattern, surface features, slope characteristics and land use, landforms and physiographic units were identified. The pedons were exposed and studied for their morphological properties following the standard procedure outlined (Anon., 1999). Soil series wise surface and

subsurface characteristics of the soil profile and also the fertility status were analysed (Table 1a and 1b) using standard analytical procedures (Jackson, 1958). These results were used as input parameters to classify the Land capability and Land suitability for various horticultural crops.

Results and Discussion

Soil classification

Based on these soil-site properties of Amarapura-2 micro-watershed area was divided into different homogeneous units known as mapping/management units. Soil series identified under study were Bhogapur, Chatra, Chatra Tanda, Kalamalli, Kammarkhed, Kamarkhed tanda, Marali, and Vaykarnala (Fig. 3). These eight soil series obtained were found in three different landforms viz., upland, midland and lowland from very gentle sloping (1-3%) to gentle sloping (3-5%). The extent of area and distribution of these soil series were drawn and overlaid with cadastral map to get the parcel/survey number wise soil information.

Land capability classification

Land capability classification is an interpretive grouping of soils mainly based on the inherent soil characteristics, external land features and environmental factors that limits the use of the land (Anonymous, 1961). Morphological features of soil units (Table 1a and 1b) are matched with the criteria for land capability classification (Sehgal, 1996). The land capability classification of mapping units and their extent in watershed is presented in Figure 3. Based on soil properties, the soils of Amarapur-2 micro-watershed of Lingasugur taluk have been classified as III and IV and the area under IIIes and IVes was 63 ha and 195 ha, respectively with limitations of texture, drainage, fertility and topography.

Fig.1 Location map of the Amarapura-2 MWS

Fig.2 LISS IV merged Cartosat - I satellite imagery overlaid with cadastral map

Fig.3 Soil mapping units of Amarapura-2 MWS

Fig.4 Land capability classification of soils in Amarapura-2 MWS

Fig.5 Crop suitability for mango in Amarapura-2 MW

Fig.6 Crop suitability for sapota in Amarapura-2 MWS

Fig.7 Crop suitability for jamun in Amarapura-2 MW

Fig.8 Crop suitability for guava in Amarapura-2 MWS

Fig.9 Crop suitability for custard apple in Amarapura-2 MWS

Fig.10 Land management unit in Amarapura-2 village

Table.1a Soil series and respective profile characterization in Amarapura-2 MWS

Name of Soil series	Geology	Colour		Soil depth (cm)		Slope (%)	Landform	Texture		Structure		Consistency		Soil Reaction	Electrical Conductivity
		Surface	Subsurface	Surface	Sub surface			Surface	Sub surface	Surface	Sub surface	Surface	Sub surface	(1:2.5 Soil : water ratio)	(dSm ⁻¹)
Bhogapur	Granite	5YR 4/4	5YR5/6	0-12	19-30	15-25	Upland	SCL	SCL	1 fmsbk	2 sbk	sh, fr, ss, sp	vh, fi, vs, vp	Neutral	Non saline
Chatra	Granite	5YR6/1	5YR4/1	0-11	35-50	3-5	Upland	SCL	SCL	1 fmsbk	2 fmsbk	sh, fr, ss, sp	h, fr, vs, vp	Neutral	Non saline
Chatra Tanda	Granite	7.5YR6/4	7.5YR3/4	0-9	40-55	5-10	Upland	SL	SCL	1 fmsbk	2 fmsbk	sh, fr, ss, sp	vh, fr, vs, vp	Neutral	Non saline
Kalamalli	Granite	5YR4/4	5YR4/4	0-7	20-25	5-10	Upland	CL	C	1ffmgsbk	2 fmsbk	sh, fr, ss, sp	h, fr, vs, vp	Neutral	Non saline
Kammarkhed	Granite	10YR3/3	10YR2/2	0-11	25-35	3-5	Upland	SCL	SCL	1 fmsbk	2fmsbk	sh, fr, ss, sp	h, fr, s, vp	Slightly alkaline	Non saline
Kamarkhed tanda	Granite	7.5YR4/4	7.5YR4/4	0-12	20-30	5-10	Upland	SC	SCL	1 fmsbk	2 fmsbk	sh, fr, ss, sp	h, fr, vs, vp	Slightly alkaline	Non saline
Marali	Granite	10YR4/3	10YR3/2	0-11	45-65	3-5	Upland	CL	C	1 fmsbk	2 mcsbk	sh, fr, ss, sp	vh, fr, vs, vp	Slightly alkaline	Non saline
Vaykarnala	Granite	5YR4/4	5YR7/4	0-11	26-30	5-10	Upland	SC	SCL	1 fmsbk	2m sbk	sh, fr, ss, sp	h, fr, vs, vp	moderately alkaline	Non saline

Note: sh – slightly hard, ss – slightly sticky, sp – slightly plastic, fr – friable, fi – firm, vs – very sticky, v p – very plastic, h – hard, m – medium, sbk –subangular blocky, abk-angular blocky, c – coarse, S-sand, C-clay, L-loam

Table.3 Proposed crop plan for Amarapura-2 micro-watershed

Proposed Land Use Class	Soil Map Units	Survey Number	Field Crops	Horticulture Crops	Suitable Interventions
LMU 1	BHGcF3g2S2R1, BHGhE3g2S2R1, BHGhF3g2S2R1, CHTcD3g1S1, CHTcD3g2S2, CHThD3g1S1, KALhD3g1S1, Unmanaged	Kalmalli: Kalarhati26/10,26/8,26/11,26/6,26/9,25/9,26/1,26/2,26/3,35/5,29/2,23,36,40,53,54,55,65,68,74	Open scrub with thorny bushes, less than 10% canopy	Nil	Open scrub with thorny bushes, less than 10% canopy
LMU 2	CHRhD3g1, CHRhD3g1S1, KMTiD3g1, VKRcC3g2S2R1, VKRcD3g2S2, VKRcD3g2S2R1, VKRhC3g2S2R1, VKRhD3g2S2R1, VKRiD3g2S2R1, Unmanaged	Kalmalli:27,31,32,33,25,20/1,26/4, Todki:31/434/1	All minor millets and pulses	Nil- as the soil depth is very shallow, root zone depth limitation	Cultivation on raised bunds and ridge furrows, with mulches and drip irrigation system. Drip irrigation with suitable soil and water conservation measures.
LMU 3	KALiC2g1, KALcC2g1, CHTcC2g1, Moderately managed	Todki 21,24,29,30, 32, 33, 62, 66, 72,73, 20/2,26/5,	All minor millets and pulses	Nil- as the soil depth is very shallow, root zone depth limitation	Cultivation on raised bunds and ridge furrows, with mulches and drip irrigation System. Drip irrigation with suitable soil and water conservation measures.
LMU 4	CHRCc2g1S1, CHRhC2g1S1, KMRcC2g1, KMRfC2, Moderately managed	Todki:16, 21, 22,23, 25, 30, 20/1,20/2,22/1,22/2,26/7,17/1,26/2, 24/2	Soil crop; Green gram, red gram, black gram, til, sorghum, other minor short duration crops	Fruit crops: Mango, sapota, Guava, Lime Jamun, Tamarind, Jackfruit, Fig. Veg: Beans, Bhendi, Drumstick, Clusterbean, Curryleaf, Coriander <i>etc.</i> Flower: Lilly, Merigold.	Cultivation on raised bunds and ridge furrows, with mulches and drip irrigation system. Drip irrigation with suitable soil and water conservation measures.
LMU 5	MRLfC2 g0, moderately managed	Thoodki, 67	Sole crop; sorghum, Bajra, Navni, green gram, cotton, red gram, Bengal gram, <i>etc.</i> major crop is red gram and cotton followed by sorghum	Guava, custard apple, Tamarind, sapota, jamun, Ber, Veg: Onion, Tomato, Brinjal, Chilli, Bhendi, lab lab, coriander, and green leafs, curry leaf. Flowers- Gaillardia, marigold, Chrysanthemum, lilly	Deep and wider size furrows, Drip irrigation with suitable soil and water Conservation measures Cultivation on raised bunds with mulches and drip.

Table.1b Soil fertility status of Amarapura-2 MWS

Parameters	Low	Medium	High
	Area (ha)		
Organic carbon (%)	129 (24.88%)	295 (56.79%)	-
Nitrogen (kg/ha)	494 (95.14 %)	-	-
Phosphorus (P ₂ O ₅ kg/ha)	221 (97.34%)	329 (63.43%)	-
Potassium (K ₂ O kg/ha)	494 (75.11 %)	-	-
Sulphur (Kg/ha)	154 (21.61%)	329 (63.43 %)	-
Calcium (meq/100 g of soil)	-	-	497 (94.14 %)
Magnesium (meq/100 g of soil)	-	-	497 (94.14 %)

Table.2 Crop suitability characteristics of Amarapura-2 MWS for land evaluation

Profile unit	Mango	Sapota	Jamun	Guava	Custard apple
BHGhF3g2S2R1	N	N	N	N	N
CHRhC2g1S1	N	N	N	N	N
KMTiD3g1	N	N	N	N	N
KMRcC2g1	N	N	N	N	N
VKRcC3g2S2R1	N	N	N	N	N
CHRcC2g1S1	N	N	N	N	N
KALcC2g1	N	N	N	N	N
MRLfC2	N	S3r	S3r	S3r	S3r
VKRhD3g2S2R1	N	N	N	N	N
KALhD3g1S1	N	N	N	N	N
VKRcD3g2S2	N	N	N	N	N
KALhD3g1S1	N	N	N	N	N
KMRfC2	N	N	N	N	N
VKRhD3g2S2R1	N	N	N	N	N
CHRhD3g1S1	N	N	N	N	N
BHGcF3g2S2R1	N	N	N	N	N
VKRhC3g2S2R1	N	N	N	N	N
KALiC2g1	N	N	N	N	N
BHGhE3g2S2R1	N	N	N	N	N
CHThD3g1S1	N	N	N	N	N
CHTeC2g1	N	N	N	N	N
KALcC2g1	N	N	N	N	N
VKRiD3g2D3S2R1	N	N	N	N	N
CHTeD3g1S1	N	N	N	N	N
CHTeD3g2S2	N	N	N	N	N
VKRcD3g2S2R1	N	N	N	N	N
CHThD3g1S1	N	N	N	N	N
BHGhE3g2S2R1	N	N	N	N	N
CHRhD3g1	N	N	N	N	N

Among all the eight series, Bhogapur series, Chatra series and Vaykarnala series were classified under capability class III and most of the crops like green gram, sorghum, pearl millet and guava are moderately suitable and on other hand stream bank series were classified into IV land capability class due to severe limitation of erosion (Fig. 4). Similar findings were also reported by (Leelavathi *et al.*, 2004).

Soil-site suitability evaluation for crops

The optimum requirements of a crop are always region specific. Climate and soil-site parameters play significant role to maximize the crop yields. The soil-site properties from the study area (Table 1a and 1b) were matched with soil-site suitability criteria for different crops (Sehgal, 1966).

Land suitability of horticultural crops

The optimum requirements of a crop are always region specific. Climate and soil-site parameters play significant role in maximizing the crop yields (Sys *et al.*, 1991).

Based on degree of limitations of soil fertility, climatic regime and land quality the soil site suitability criteria of Amarapura-2 micro-watershed classified for horticultural crops (Table 2).

Mango (*Mangifera indica* L.)

In most parts of the Amarapura-2 village poor soil characteristics like very shallow depth, poor drained soils, sandy loam to sandy clay loam soils, gently sloping and severe eroded characters observed.

Hence, the sustainability assessment for mango in Amarapura-2 village showed that 494 ha (95.14%) area not suitable for mango production (Fig. 5).

Sapota (*Manilkara zapota* L.)

The suitability assessment for Sapota in Amarapura-2 village showed that only 7 ha (1.46) area found marginally suitable with limitations to rooting conditions. About 486 ha (93.6%) area not suitable for Sapota production due to sensitive to poor drainage, presence of free CaCO₃, high soil pH, extreme gravel and stoniness presence in soils of Amarapura-2 Village (Fig. 6).

Jamun (*Syzgyium kumini* L.)

The suitability assessment for Jamun in Amarapura-2 showed that 486 ha (93.6%) area not suitable for growing Jamun (Fig. 7). About 7 ha (1.5%) area marginally suitable with limitation to rooting conditions.

Guava (*Psidium guajava* L.)

The suitability assessment for Guava in Amarapura-2 showed that 486 ha (93.68%) area not suitable for growing Guava (Fig. 8). About 8 ha (1.46%) area marginally suitable for guava production with limitation to rooting conditions.

Custard apple (*Annona reticulata*)

Amarapura-2 showed that 486 ha (93.68%) area not suitable for growing Custard apple (Fig. 9). About 7 ha (1.46%) area marginally suitable for custard apple production with limitation to rooting conditions. Similar findings were also reported for Mango, Sapota, Jamun, Guava, Custard apple by Maheshkumar *et al.*, (2017).

Proposed crop plan for Amarapura-2 micro-watershed

After assessing the land suitability for five horticultural crops, a proposed crop plan has been prepared for field crops and horticultural

crops with suitable management interventions to maximize the production in Amarapura-2 micro-watershed. The proposed crop plan is presented in Table 3.

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