

# LAND INVENTORIZATIION AT TARDI-BABHLAJ VILLAGES OF SHIRPUR TALUKA MAHARASHTRA STATE USING RS AND GIS

## ABSTRACT

Scientific evaluation of the land is essential in order to understand the suitability for agricultural and non-agricultural purposes and identification of capabilities and constraints of the land for various crops and their cultivation helps in appropriate and sustainable usage. In order to uplift the production, productivity as well as profitability from a farm land, the knowledge regarding various land resources and soil properties become pre-requisites. In this, direction, a land inventORIZATION was carried out using RS and GIS techniques. The prime objective was to carry out land evaluation studies based on land based on land capability classification and suitability of lands for commonly cultivated crops in the region. Soil morphological features, physical, physico-chemical and fertility properties of the land were analysed and the results indicated that the soils are good in inherent properties even with the slight variation in the morphological and physicochemical properties. Land evaluation based on Land Capability Classification (LCC) revealed that, all the blocks fall under Class-IV with some of the limitations like, erosion, texture and low organic carbon content in soils. Suitability of land to the crops indicated that there are limitations with respect to erosion, slope and soil fertility. Based on the obtained results, corrective measures especially increasing the organic matter through external application and few agronomic practices like, ridge and furrow planting, intercropping etc. were suggested for all the blocks to reduce the erosion losses improve the soil properties for higher productivity of the cultivated crops.

**Keywords:** *Soil Characterization, Soil Constraints, Land Capability, Remote Sensing and GIS*

## Introduction

Soil is a potential natural resource and a life supporting system which is being used to meet the basic necessities of food and fodder since time immemorial. As the population is growing year after year, pressure on land resources for more food production has been consistently increasing on account of limited production capacity of the soil owing to its inherent properties, agro-climatic conditions, usage and its managing practices. Information regarding spatial distribution, in-built properties, production potentiality, limitation/constraints and suitability of soils help in framing the strategies to achieve greater

and sustainable crop production.

Soil health management is gaining greater importance these days as a consequence of irrational use and poor management of soils in several agricultural, industrial and urban development activities. Appropriate management of soils in accordance to their inherent properties is essential in order to improve soil productivity as well as sustainability. In this context, soil quality has been a crucial consideration. Basically, soil quality consists of two components- i) soils' inherent properties defined by pedological processes and ii) an active fragment which comes under the influence by the user or manager of the soil. The interactions between chemical, physical and biological properties outline quality parameters of a particular soil and decide upon the performance of the functions viz., i) apportioning the rain water into runoff and/or infiltration at the soil surface; ii) water holding and release to plants or groundwater or as runoff; iii) retaining as well as release of mineral nutrients; iv) being a buffering agent to toxic compounds and v) resistance against water and wind erosion. Further, portioning of the soil quality parameters can be done as chemical properties- organic carbon content, C:N ratio, pH, available forms of nutrients and trace elements, acidic and saline conditions, CEC, etc. and physical indicators- texture, infiltration and bulk density (Carter., 1996). Soil characterization and land evaluation techniques like, land capability and crop suitability are becoming popular means for studying soils and managing soil health by using advanced tools such as RS and GIS (Naidu *et al.*, 2006; Najafian *et al.*, 2012 and Rajesh *et al.*, 2019). Use of these advanced techniques helps a soil scientist to decide upon the soil characters and assist in suggesting farmers with suitable soil management practices for higher productivity and maintain the soil health management (Bhandari *et al.*, 2013, Sys *et al.*, 1991).

Based on these considerations, a study was planned to understand the various soil properties of the land situated at Tardi and Babhlaj village boundaries to identify the potentiality as well as to improve the land by overcoming the constraints for use in various activities concerning agriculture and allied sciences based on sustainable practices for management of land resources and water.

## **MATERIALS AND METHODS**

Total land selected for this particular study was 111 acres which lies in two villages namely, Tardi and Babhlaj in Shirpur taluka of Dhule district, Maharashtra state, India. A preliminary survey of the land was carried out during the year 2019-20. The geographical position of the land lies between North latitude  $21^{\circ} 16'24.40''$  to  $21^{\circ} 16'18.63''$  and East longitude

75° 03'26.99" to 75° 04'24.66" (Figure 1). Average annual rainfall is 592 mm of which more than 85 percent is received during Southwest monsoon season (June-August). Generally, weather condition of the area is generally dry except during rainy season. Maximum recorded temperature of 46 °C and minimum of 8.9 ° C (DSR, 2021) in the area.

### **Soil sampling**

The entire study area was divided into 8 blocks based on the existing boundaries (Figure 2). Collection of soil samples was done at 0-20 cm depth. Adequate samples were collected from all the blocks and composite samples were prepared and analysed for various properties.

Soil samples were kept for drying at ambient temperature; using pestle and mortar samples were ground then sifted with 2 mm sieve. Analyses for various soil parameters carried out based on the standard procedures. pH and EC by potentiometric method. Physical parameters were estimated by Keens Cup Method (Keen and Rackowski, 1921). Chemical properties of the soil like organic carbon (OC), nitrogen, phosphorous, potassium, calcium, magnesium, cation exchange capacity etc. were analysed and calculated based on the procedures given by Piper (1966). The morphological data on soil slope, erosion, drainage, gravelliness and stoniness were collected through visual observation of the blocks as suggest by McGarry (2006).

The land evaluation techniques were drawn by using the climatic data, physical and fertility properties; crop suitability and land capability classes for each block were established following the criteria given by Sehgal (1995). A google earth image was used as a base map and Geo rectified using ArcGIS version 10.8 to prepare maps for crop suitability and land capability.

## **RESULTS**

### **Morphological features**

The soil type in all the Babhlaj blocks were Black cotton soils with clayey texture, Tardi South blocks were with black cotton soils with moderate clay content and Tardi North blocks were transitional soils with course texture. The profile in all blocks were well developed except, both Tardi North-1 and 2 blocks (Table 1).

The land was nearly level with less than 1 per cent slope in Babhlaj South blocks; there was very gentle slope (1-3%) in Tardi South blocks whereas, Tardi North blocks were observed

with gentle slope ranging from 3-5 per cent. Moderate erosion was observed in Tardi South-1, Tardi North-1 and Tardi North-2 blocks whereas, remaining blocks were observed with slight erosion. Soils in all the blocks were well drained. However, 10-20% gravelliness and less than 1% stoniness were recorded in Tardi North-1 and Tardi North-2 blocks, remaining blocks did not show any gravelliness or stoniness. The land topography in Tardi North-1 and Tardi North-2 were undulating; moderate topography was recorded for Babhlaj South-3 and Tardi South-1, 2 and 3 blocks but Babhlaj South-1 and 2 were observed to be almost levelled.

### **Physical and physico-chemical properties**

Based on the samples collected, various physical properties and physico-chemical properties of soils were analysed and pertaining results are presented in Table 2. Bulk density in all the blocks ranged from 1.06 to 1.28 Mg/m<sup>3</sup> and particle density was found nearer to 2.65 Mg/m<sup>3</sup>. Porosity in Babhlaj South-2 was 45.59% whereas it was more than 50% in remaining blocks. Babhlaj South-2 block was recorded with 22.35% MWHC and rest of the blocks were found to be nearer and above 50%.

With respect to physico-chemical properties, the pH was neutral to slightly saline in the soils of the studied area with a range of 7.37 to 8.00. Similarly, electrical conductivity of the soils was also non-saline with a range of 0.16 to 0.27 dS/m. Organic carbon content was low in all the blocks ranging between 0.14 to 0.49%.

### **Chemical and fertility properties**

Among the fertility properties of the soil studied, available nitrogen content was low in all the blocks whereas, the range of available phosphorous and available potassium was medium to high (Table 3). Calcium and magnesium contents were approximately in the ratio of 2:1. Sodium content was found to be lower and ESP was less than 15 in all the blocks. The CEC was recorded more than 60 % in all the blocks.

### **Land capability classification and crop suitability**

Based on the land capability classification, the evaluated blocks were categorized under Class IV (Figure 3) with some limitations with respect soil physical properties (Tardi North-1 and 2) and further all the blocks were reported with fertility limitation.

Based on the crop suitability criteria, the blocks were evaluated for the major crops grown in the area. Tardi South-1, Tardi South-3, Tardi North-1 and Tardi North-2 blocks were

marginally suitable (S3) for sorghum crop whereas, remaining blocks were moderately suitable (S2). Further, fertility limitation (f) was reported in Babhlaj South-1, Babhlaj South-2, Tardi South-2 and Tardi South-3 blocks; erosion limitation (e) was reported in all the blocks except Tardi South-3. While studying maize suitability, Babhlaj South-3, Tardi South-2 and Tardi North-2 were found moderately suitable and remaining blocks were marginally suitable. Fertility limitation was reported across the blocks; however, Tardi North-2 was reported with slope (t) and erosion (e) limitations in addition.

Pearl millet suitability studies indicated that, Tardi South-1, Tardi North-1 and Tardi North-2 blocks were marginally suitable (S3) whereas, all the remaining blocks were moderately suitable (S2). However, all of the blocks were reported with erosion limitation (e) in common. Babhlaj South-3 and Tardi South-2 blocks were found highly suitable (S1) for pigeon pea cultivation; Tardi South-3 block was marginally suitable with fertility limitation. Rest of the blocks were moderately suitable (S2) with fertility limitation in common, Tardi North-1 and Tardi North-2 blocks were reported additionally with slope (t) and erosion (e) limitations.

With respect to suitability for cotton and groundnut, all the blocks were reported as marginally suitable (S3) with fertility limitations (f) in common further, erosion limitation was associated with Tardi South-1, Tardi North-1 and Tardi North-2 blocks for groundnut cultivation.

## **DISCUSSION**

### **Soil characterization**

The results on soil morphological features indicated that soil type in all the blocks was generally black cotton soil with moderate clayey to clayey texture. Slope of the land in all the blocks were nearly level to gentle slope; erosion was slight to moderate with well drained condition. Regarding gravelliness, all the blocks were classified non-gravelly but, Tardi North-1 and Tardi North-2 blocks were gravelly (10-20%) and stony (less than 1%) as suggested by Natarajan and Sarkar (2009).

Outcomes regarding physical properties of the soil indicated slight variation in the obtained values however, the range of values are not deviated from the acceptable ranges. Similarly, physico-chemical properties indicated that the soil chemical reaction was neutral to slightly saline; electrical conductivity was less than 1 dS/m indicating normal condition of the soil without any problems to the cultivated crops. However, organic carbon was found low in all

the soil samples which may be attributed to non-application of organic matter to the lands. Even though, there were variation in the calculated values for physico-chemical properties the obtained range indicate that the inherent characteristics of soil are in good condition.

The fertility properties showed that the available nitrogen was low in all the blocks however, the range of available phosphorous and available potassium was medium to high. Calcium and magnesium content were not in the range which causes soil salinity. Further, calcium and magnesium content was found almost in the ratio of 2:1 indicates stability in the soil reaction. Sodium content and ESP were found lesser than 5 and 15, respectively which are considered safe for cultivated crops. The CEC was recorded more than 60 in all of the blocks which might be attributed to higher content of 2:1 type of expanding clay minerals which positively correlate with CEC and the amount of exchangeable sodium in the soil in relation to total cations is determined by nature of the mineral/s, electrolyte concentration as well as the soluble-cations (Dasog and Patil, 2011).

#### **Land evaluation studies**

Land evaluation was carried out under land capability and crop suitability studies. Based on the land capability or limitation, eight classes have been designated for categorization of lands. Accordingly, the lands are categorized under Class-I to Class-IV when they are found suitable for common crop cultivation and are distinguished based on soil depth, degree of slope, erosion, etc. Class-V to Class-VIII lands categories are considered unsuitable for growing crops however, they are suggested for growing grasses, forestry or used for wildlife habitation and recreation (Klingebiel and Montgomery, 1961).

Based on land capability classification, all the blocks were categorized under class-IV (Figure 3) indicating the suitability of the lands for crop cultivation. However, all the blocks were reported with fertility limitations owing to low organic carbon content and Tardi North-1 and Tardi North-2 blocks were further observed with soil physical constraints as they were reported with coarse texture. Based on the crop suitability criteria, the blocks were evaluated for suitability to cultivate common crops like sorghum, maize, cotton, etc.

Sorghum requires clay loam to loam textured soils having good water holding capacity for obtaining higher yields. For higher productivity of maize, soils with loamy sand to clay loam texture, high organic matter and WHC, neutral to slight alkaline pH are considered good (Rajendra, 2012). Suitability studies for sorghum crop revealed moderately to marginally suitability of the lands. The major limiting factors were erosion and fertility and few of the

blocks were observed with both (Figure 4). Severe fertility (S3f) limitation was recorded in five of the blocks and three blocks were observed to be moderately (S2f) constrained with fertility, among which Tardi North-2 was further, recorded with slope and erosion limitations for maize cultivation (Figure 5).

To obtain higher yields in pearl millet loamy sand to loamy soils having good drainage and without salinity or alkalinity are ideal. Cultivation of pigeon pea can be done on wide range of soils from sand to heavy clay loams with good drainage and medium heavy texture (Rajendra, 2012). However, in the present study, the lands were observed with only erosion limitation in all the blocks among which five were found moderately suitable and three were marginally suitable for pearl millet cultivation (Figure 6). Babhlaj South-3 and Tardi South-2 blocks were found highly suitable (S1) for pigeon pea cultivation without any limiting factors with respect to soil and climatic features. But, Tardi South-3 block was marginally (S3f) suitable with severe fertility limitations and remaining blocks were reported with moderate fertility, erosion and slope limitations for pigeon pea cultivation (Figure 7).

Cotton prefers a deep, friable soil with good fertility and higher water holding capacity. Whereas, ideal soils for groundnut cultivation are sandy and loamy soils with good drainage, with high organic matter having pH in the range of 5.5-7.0 (Rajendra, 2013). Even though soils in all the majority of blocks were black cotton with clayey texture, cotton crop was found marginally suitable with severe fertility (S3f) limitation (Figure 8). Land evaluation for suitability of groundnut crop revealed that, there were severe limitations with respect to fertility in all of the blocks; Tardi South-1, Tardi North-1 and Tardi North-2 blocks were further observed with erosion limitation (Figure 9).

Considering the land evaluation studies, following corrective measures are drawn against the identified limitation to improve the soil properties and increase crop productivity.

### **Identified limitations**

#### **1. Morphological constraints of the land**

- 1.1. Prone to erosion at moderate level (e)
- 1.2. Sloppy and Undulating lands (t)
- 1.3. Gravelly and stony land in patches

### **Corrective measures:**

- Construction of contour bund for sloppy lands to reduce the erosion losses

- Growing crops across and along the slope minimizes soil and water loss through erosion
- Soil and water erosion can be controlled by various agronomic measures like ridge and furrow system, broad bed furrow methods and intercropping methods.
- Collection of excess water and diverted to the streams and channels

## 2. Fertility constraints (f)

### 2.1. Low organic matter content and low level of available primary nutrients

#### Corrective measures:

- Growing and incorporation of green manure crops like, sun hemp (*Crotalaria Juncea*), *Sesbania* sp.
- Application of FYM manure at 25 t/ha before sowing of the crops.
- Summer ploughing should be done in order to expose the soil to high temperature by sun to kill pathogens, weed seeds and insect pests.

#### CONCLUSIONS

Based on the results obtained for various properties, the soils in all the blocks were reportedly good in inherent physical properties and chemical properties considering some of the variations in obtained values. However, the results drawn from these soil properties and land capability classification as well as crop suitability indicated that the lands in all of the blocks fall under Class-IV along with limitations *viz.*, soil physical characteristics like texture in Tardi 1 and Tardi 2 and it was also reported that all the blocks were constrained with soil fertility. Among the evaluated six of the commonly grown crops for suitability, only pigeon pea was reported with high suitability in Babhlaj South-3 and Tardi South-2 blocks. But, remaining blocks were reported to have some limitations like, erosion, slope and soil fertility for cultivating the crops.

## REFERENCES

- Bhandari, S., Jhadav, S.T and Suresh, K. (2013). Land capability classification and crop suitability assessment in a watershed using RS and GIS – A case study of watershed in Dehradun, Uttarakhand. In: 14<sup>th</sup> Esri India User Conference Proceedings; Dec 11-13; New Delhi, India.
- Dasog, G.S. and Patil, P. L. (2011). Genesis and classification of black, red and lateritic soils of north Karnataka. In: 76<sup>th</sup> Annual Convention of ISSS, Soil Science Research in North Karnataka; Dharwad Chapter of ISSS, University of Agricultural Sciences, Dharwad, India; p 1-10.
- District Survey Report – DSR. Government of Maharashtra, India. (2021). Available from: <https://cdn.s3waas.gov.in/s3a86c450b76fb8c371afead6410d55534/uploads/2021/02/2021021086.pdf>.
- Keen, B. and Raczkowski, H. (1921). The relation between the clay content and certain physical properties of a soil. *The J. Agric. Sci.* :11(4):441-449. doi: 10.1017/S0021859600004469.
- Klingebiel, A.A. and Montgomery, P. H. (1961). Land capability classification, Agriculture Handbook No. 210, Soil Conservation Service, U.S. Dept. of Agriculture.
- Mc Garry D. (2006). A Methodology of a Visual Soil - Field Assessment Tool “VS-Fast”-to support, enhance and contribute to the LADA programme, Draft 5. FAO, Rome. [http://www.fao.org/tempref/agl/emailconf/soilmoisture/t4\\_Mcgarry\\_3.pdf](http://www.fao.org/tempref/agl/emailconf/soilmoisture/t4_Mcgarry_3.pdf)
- Naidu, L.G.K., Ramamurthy, V., Challa, O., Hegde, R. and Krishnan, P. (2006). Manual Soil-site suitability criteria for major crops. NBSS Publ. No. 129, ICAR-NBSS & LUP, Publication, Nagpur, India.
- Najafiana, A., Dayani, M., Motaghianc, H.R. and Nadiana, H. (2012). Geostatistical Assessment of the Spatial Distribution of Some Chemical Properties in Calcareous Soils. *J. Integrative Agric.*, 11(10):1729-37. [https://doi.org/10.1016/S2095-3119\(12\)60177-4](https://doi.org/10.1016/S2095-3119(12)60177-4).
- Natarajan, A. and Sarkar, D. (2009). Field Guide for Soil Survey. ICAR-NBSS&LUP Publication, Nagpur, India.
- Piper, C.S.(1966). Soil and Plant Analysis, Hans Publishers, Mumbai, India.
- Rajendra, P. (2012). Text book of Field Crops Production- Food grain crops (Vol. I). Indian Council of Agricultural Research, Pusa, New Delhi, India.

Rajendra P. (2013). Text book of Field Crops Production- Commercial crops (Vol. II). Indian Council of Agricultural Research, Pusa, New Delhi, India.

Rajesh, N.L., Rajesh, V., Meenkshi Bai, R., Sathishkumar, U., Bhat, S.N. and Rudramurthy, H. V. (2019). Land resource inventory of Kalmali North-1 micro watershed to derive land capability and land suitability for field crops. *Int. J. Chem. Studies.*, 7(1):245-249. <https://www.chemijournal.com/archives/2019/vol7issue1/PartE/6-6-316-773.pdf>.

Sehgal, J. (1995). Land resource appraisal for land use planning to meet the challenges of 21<sup>st</sup> century. *J. Indian Soc. Soil Sci.* 143(4):504-28.

Sys, C., Van, Ranst, E. and Debaveye, J. (1991). Land Evaluation (Part 1) Principles in land evaluation and crop production calculations, Agricultural Publication-N<sup>o</sup> 7, Brussels, Belgium.

UNDER PEER REVIEW

**Table-1:** Morphological features of the land in different blocks.

Blocks	Area (acres)	Soil Type	Texture	Profile development	Slope	Erosion	Drainage	Gravelliness	Stoniness	Land type
<b>Babhlaj South-1</b>	28.44	Black soils	cotton Clayey	Well developed	< 1 %	Slight	Well drained	Nil	Nil	Almost levelled
<b>Babhlaj South-2</b>	9.22	Black soils	cotton Clayey	Well developed	< 1 %	Slight	Well drained	Nil	Nil	Almost levelled
<b>Babhlaj South-3</b>	13.50	Black soils	cotton Clayey	Well developed	< 1 %	Slight	Well drained	Nil	Nil	Moderate
<b>Tardi South-1</b>	24.90	Black soils	cotton Moderately Clayey	Well developed	1-3 %	Moderate	Well drained	Nil	Nil	Moderate
<b>Tardi South-2</b>	2.73	Black soils	cotton Moderately Clayey	Well developed	1-3 %	Slight	Well drained	Nil	Nil	Moderate
<b>Tardi South-3</b>	1.24	Black soils	cotton Moderately Clayey	Well developed	1-3 %	Slight	Well drained	Nil	Nil	Moderate
<b>Tardi North-1</b>	14.10	Transitional soils	Course textured	Not developed	well 3-5 %	Moderate	Well drained	10-20 %	< 1 %	Undulating topography
<b>Tardi North-2</b>	17.00	Transitional soils	Course textured	Not developed	well 3-5 %	Moderate	Well drained	10-20 %	< 1 %	Undulating topography
<b>Total</b>	<b>111.13</b>									

**Slope classes:** < 1%: Nearly level; 1-3%: Gently slope; 3-5%: Very gently slope.

**Table-2:** Physical and Physico-chemical properties

Blocks	Physical properties				Physico-chemical properties		
	BD $\pm$	PD $\pm$	Porosity ¥	MWHC ¥	pH	EC †	O.C.*
<b>Babhlaj South-1</b>	1.15	2.98	64.07	67.18	7.37	0.18	0.25
<b>Babhlaj South-2</b>	1.08	1.39	45.59	22.35	7.70	0.23	0.44
<b>Babhlaj South-3</b>	1.06	2.67	59.83	74.79	7.50	0.16	0.32
<b>Tardi South-1</b>	1.10	2.14	57.00	47.29	7.72	0.20	0.49
<b>Tardi South-2</b>	1.21	2.56	67.59	49.67	7.80	0.22	0.38
<b>Tardi South-3</b>	1.22	2.74	69.46	49.93	8.00	0.27	0.14
<b>Tardi North-1</b>	1.28	2.65	68.74	48.95	7.50	0.22	0.45
<b>Tardi North-2</b>	1.14	2.59	65.17	60.02	7.73	0.24	0.39

$\pm$  Mg/m<sup>3</sup>

¥ per cent (%)

† dS/m

\* Organic carbon (%)

**Table-3:** Chemical properties of the soils in different blocks

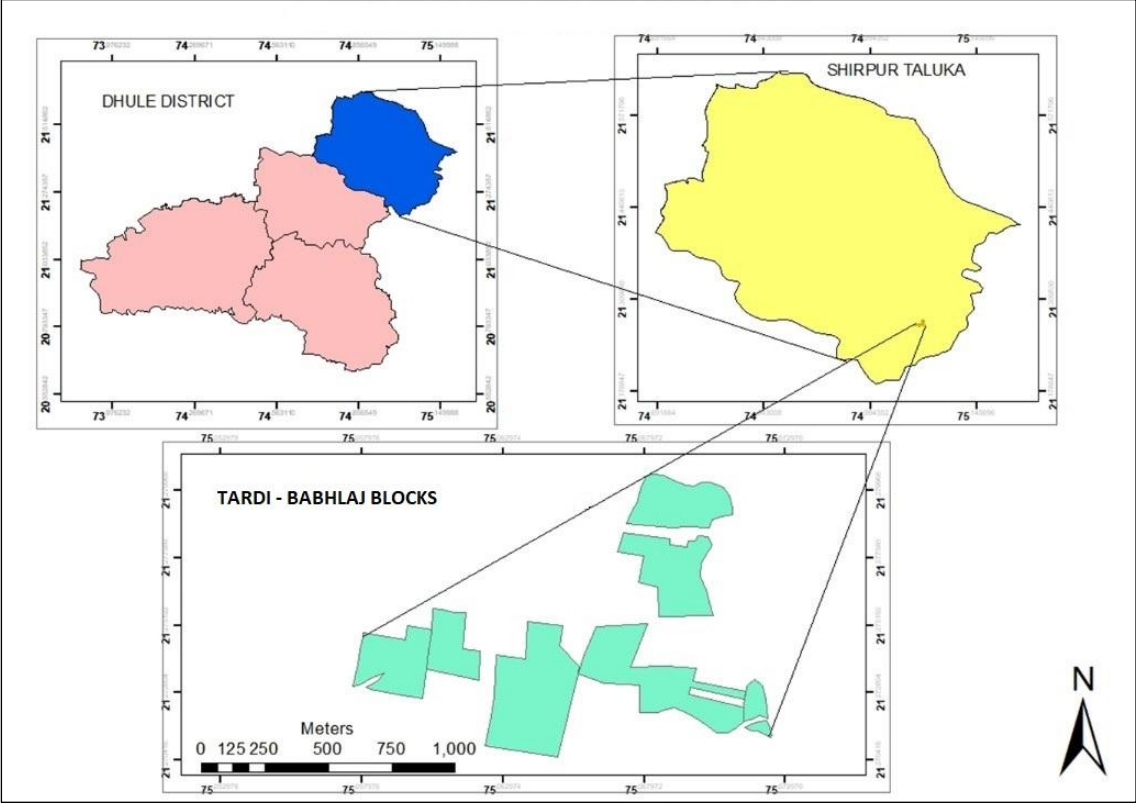
<b>Blocks</b>	<b>Available N †</b>	<b>Available P<sub>2</sub>O<sub>5</sub> †</b>	<b>Available K<sub>2</sub>O †</b>	<b>Na ‡</b>	<b>Ca §</b>	<b>Mg §</b>	<b>CEC</b>	<b>ESP</b>
<b>Babhlaj South-1</b>	118.77	54.04	385.28	1.76	34.17	13.17	85.64	2.06
<b>Babhlaj South-2</b>	211.87	70.95	483.84	1.82	33.00	12.00	92.72	1.96
<b>Babhlaj South-3</b>	154.08	88.63	376.32	1.45	35.25	12.00	84.40	1.71
<b>Tardi South-1</b>	237.55	68.61	291.20	1.46	39.67	5.17	73.92	1.97
<b>Tardi South-2</b>	182.98	48.42	302.40	1.30	31.25	6.00	67.23	1.94
<b>Tardi South-3</b>	67.58	100.34	295.68	1.30	31.00	6.50	66.85	1.94
<b>Tardi North-1</b>	216.68	54.00	403.20	1.70	35.00	3.25	78.20	2.17
<b>Tardi North-2</b>	187.79	95.19	362.88	1.42	39.25	13.75	88.85	1.61

† Kg/ha

‡ cmol (P<sup>+</sup>)/Kg of soil

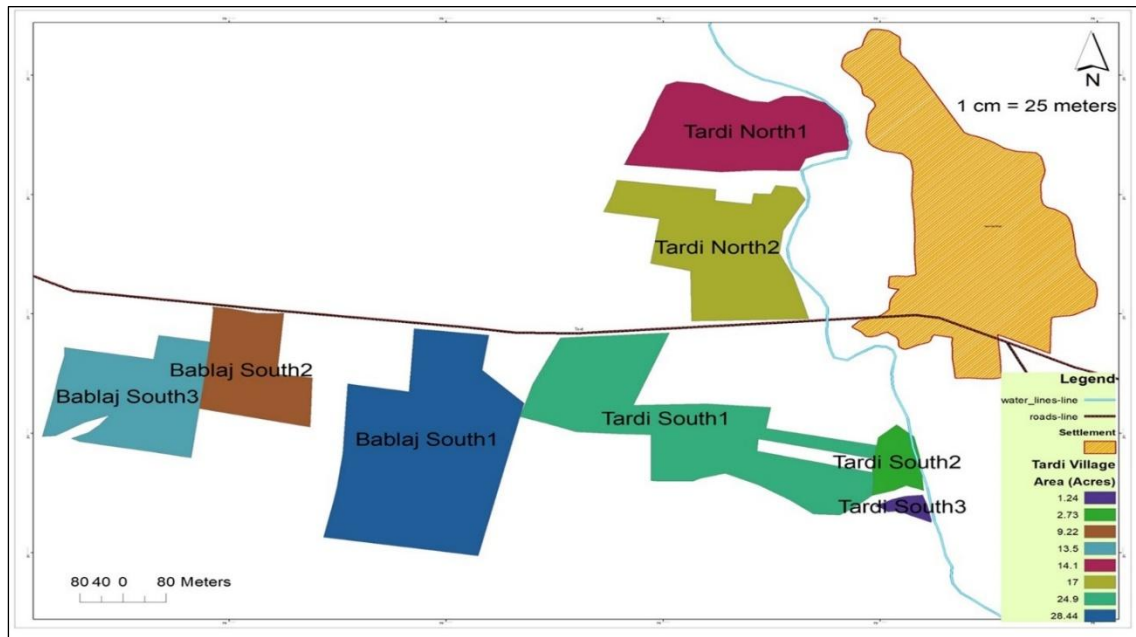
§ meq/100 gm of soil

**Fig.-1:** Geographical location of the land selected for the study



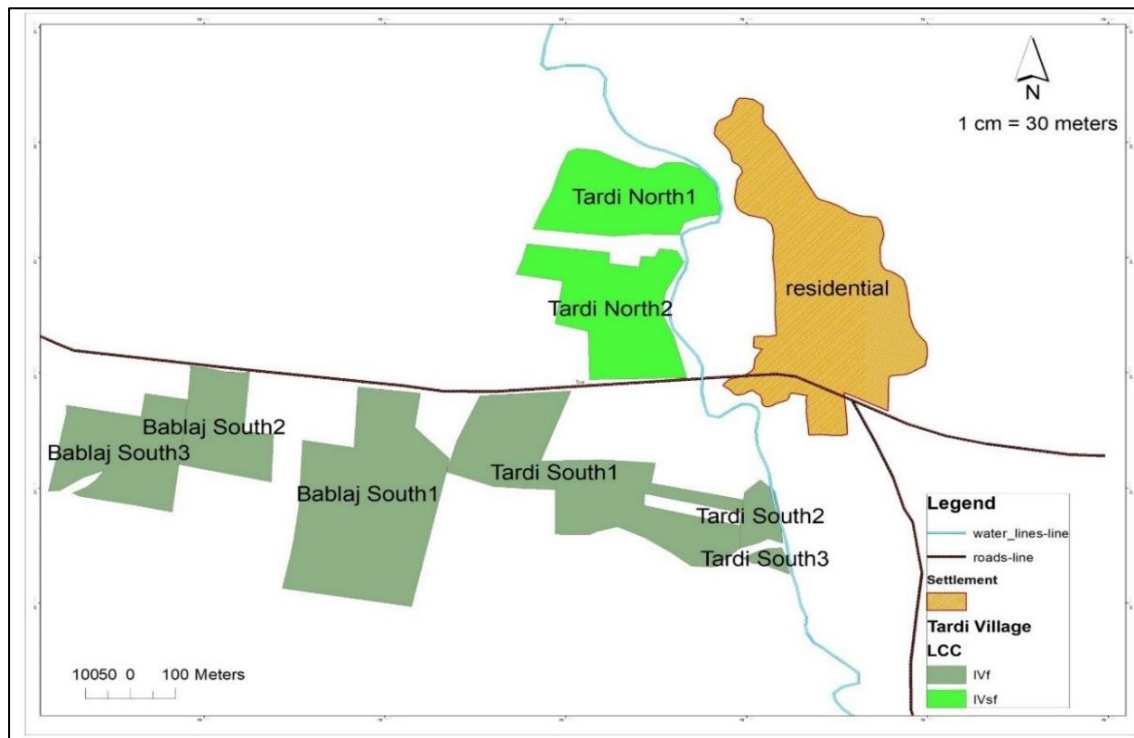
UNDER PEEK

**Fig.- 2:** On Site distribution of the blocks



UNDER PEER RE

**Fig.- 3:** Grouping of the blocks based on Land Capability Classification

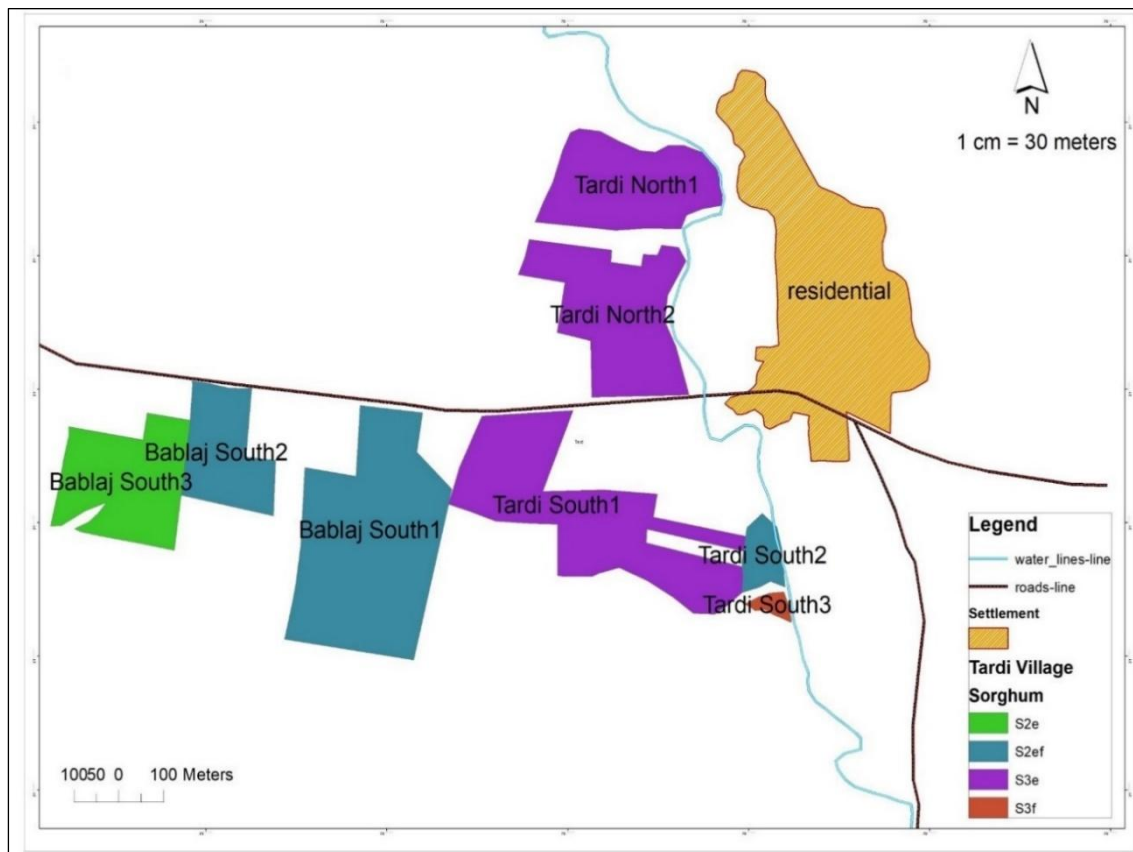


IV: Land capability class (LCC) IV.

S: Constraints regarding physical properties

f: Constraints regarding chemical (fertility) properties

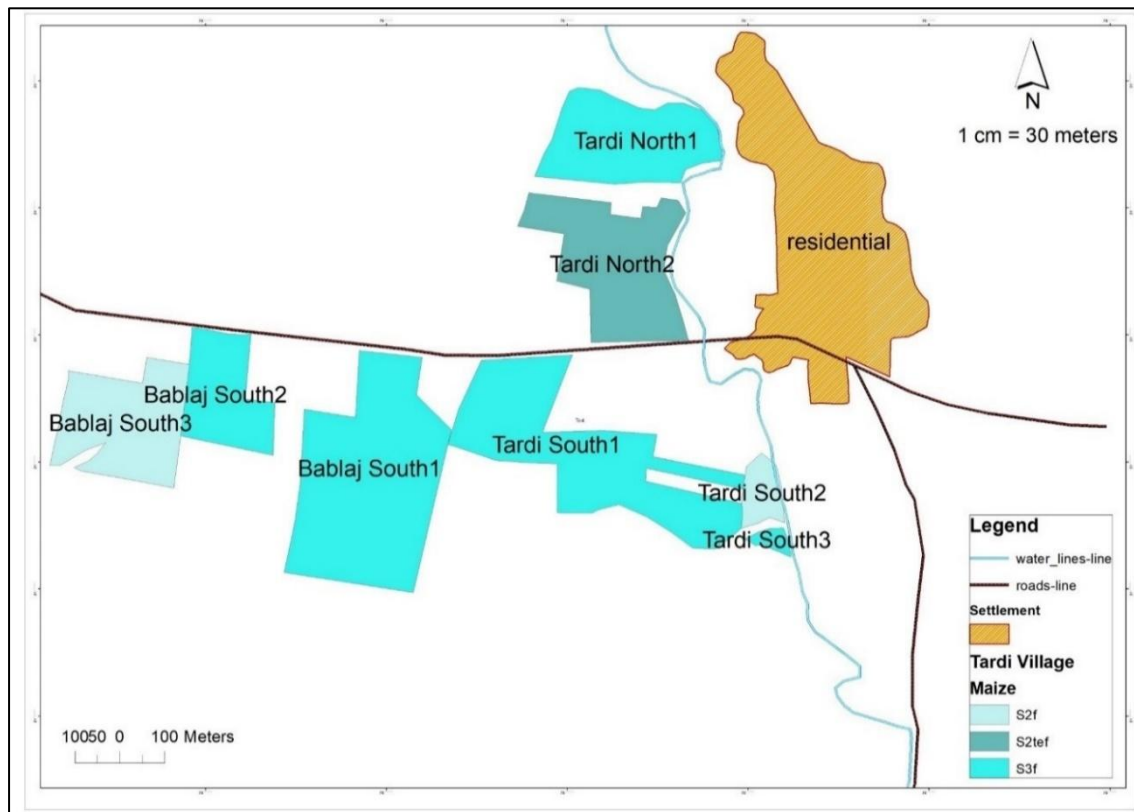
**Fig.- 4:** Sorghum suitability map



S2: Moderately suitable  
S3: Marginally suitable  
e: Erosion constraint  
f: Fertility constraint

UNDER PEER

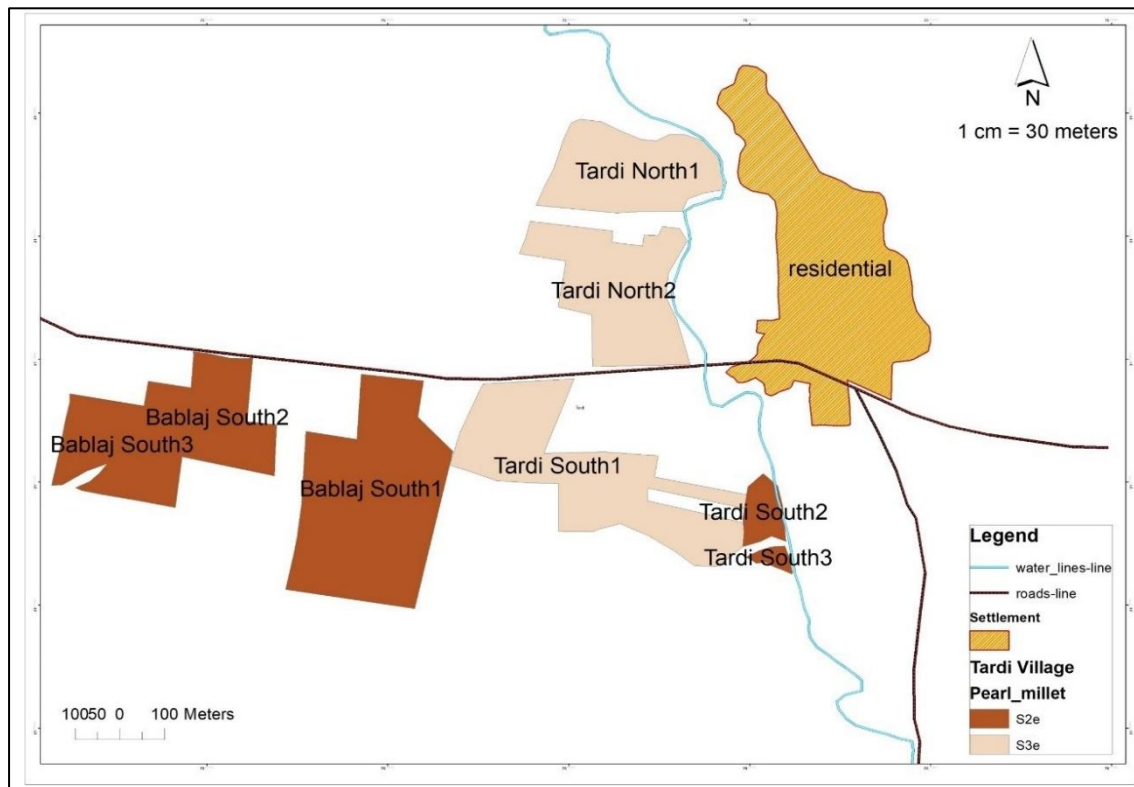
**Fig.- 5:** Maize suitability map



S2: Moderately suitable  
S3: Marginally suitable  
t: Slope constraint  
e: Erosion constraint  
f: Fertility constraint

UNDER PEEK

**Fig.- 6:** Pearl millet suitability map



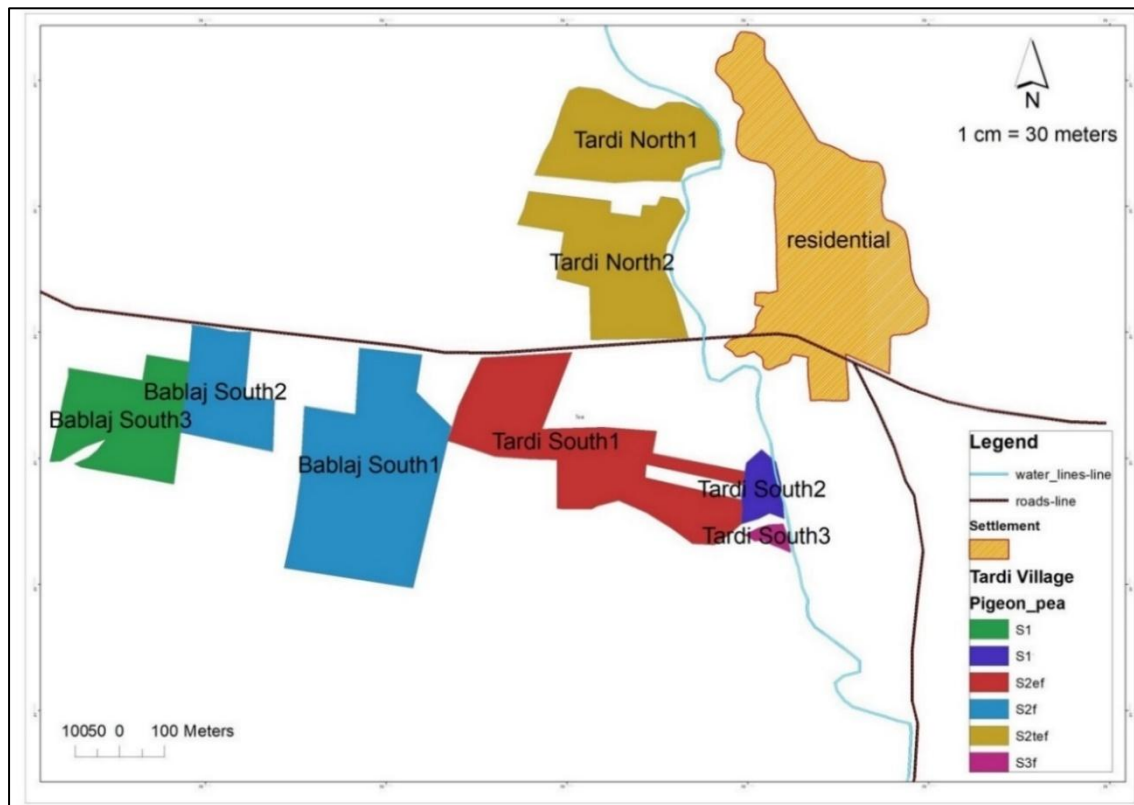
S2: Moderately suitable

S3: Marginally suitable

e: Erosion constraint

UNDER PEER

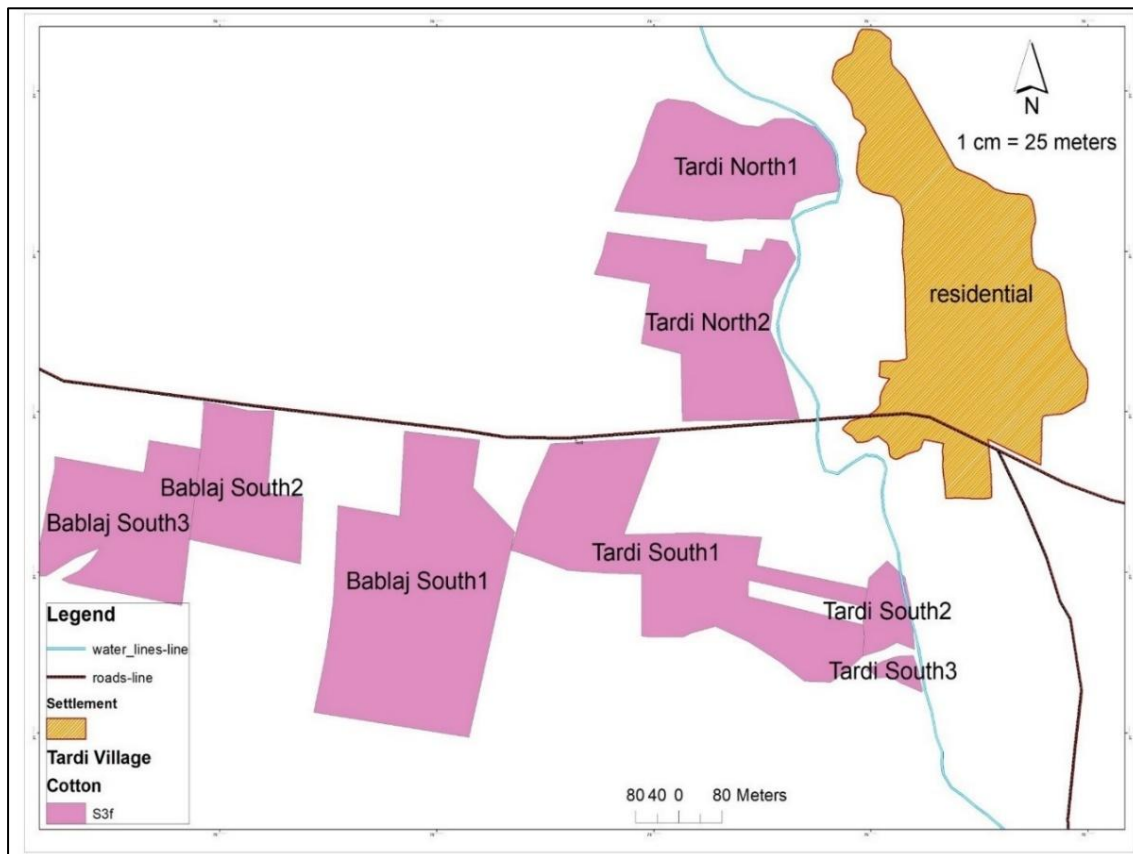
**Fig.- 7:** Pigeon pea suitability map



S1: Highly suitable  
 S2: Moderately suitable  
 S3: Marginally suitable  
 e: Erosion constraint  
 f: Fertility constraint  
 t: Slope constraint

UNDER PEEK

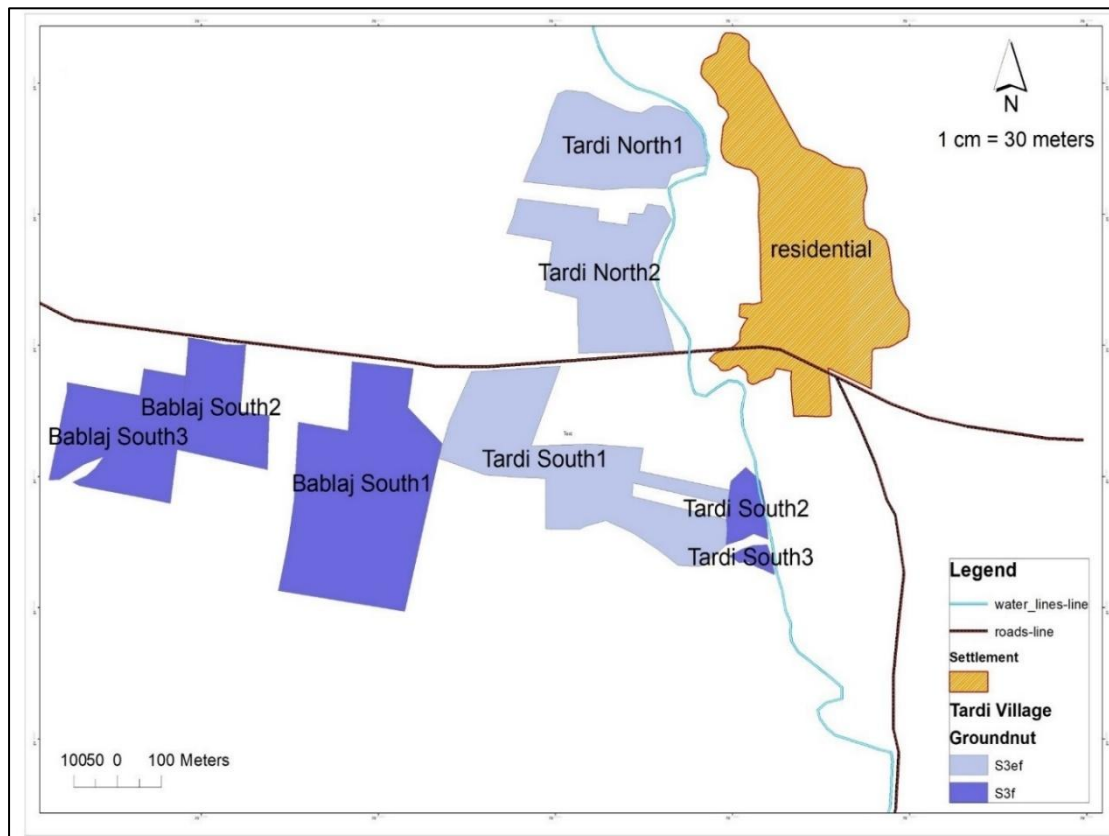
**Fig.- 8:** Suitability map for cotton



S3: Marginally suitable  
f: Fertility constraint

UNDER PEEL

**Fig.- 9:** Suitability map for groundnut



S3: Marginally suitable  
e: Erosion constraint  
f: Fertility constraint

UNDER PEER