International Journal of Bio-resource and Stress Management 2018, 9(3):451-455 Full Research Crossref

Doi: HTTPS://DOI.ORG/10.23910/IJBSM/2018.9.3.1846g *Natural Resource Management*

Soil-Site Suitability for Finger Millet Crop in Kumarband Sub-watershed Area of Dang District, Gujarat

S. T. Shirgire#*, Amaresh Das and Rajkishore Kumar

Dept. of Soil Science and Agricultural Chemistry, N.M.C.A. Navsari Agricultural University, Navsari (396 450), India
#*Present* ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune (410 505), India

Corresponding Author

S. T. Shirgire
e-mail: sunilshirgire22@gmail.com

Article History

Article ID: AR1846g
Received in 24th September, 2017
Received in revised form 22nd April, 2018
Accepted in final form 27th May, 2018

Abstract

The seventeen representative pedons were evaluated for their suitability to finger millet in the soils of different elevation having gently slope (flat plains) to higher degree of sloppy land i.e. at lower <300 m msl (P13 to P17), middle 300-350 m msl (P6 to P12) and upper piedmont >350 m msl (P1 to P5) (higher degree of slope) of Kumarband sub watershed area in the Dang district of Gujarat. The soils of study area were neutral to slightly alkaline in reaction and low to medium in organic carbon. The study suggests that soils at lower elevation finger millet crops were moderately suitable (S_2), while in soils of middle elevation finger millet are marginally suitable (S_3) except pedon 9 (P_9) i.e. not suitable finger millet cultivation . In case of upper elevation, finger millet was marginally suitable (S_3) but soils of surrounding area of pedon 4 (P_4) are not suitable finger millet cultivation because of higher degree of slope, soil texture, soil depth, stoniness, erosion and soil drainage are the major limitations. Results showed that the suitability classes can be improved if the correctable major limitations of soil erosion of hilly sloppy area were the only option to control the limitations which make them moderately sustainable to suitable class through soil amelioration measures.

Keywords: soil-site suitability, Finger millet, elevations, limitations, potential

1. Introduction

The process of land suitability classification is the evaluation and grouping of specific areas of land in terms of their suitability for defined use. The main objective of the land evaluation is the prediction of the inherent capacity of land unit to support a specific land use for long period of time without deterioration. The topographic characteristics, climatic conditions and soil quality of an area are the most important determinant parameters of the land suitability evaluation. Land suitability evaluation is the process of estimating the potential of land for land use planning (Sys et al., 1991). Several workers have worked out the suitability of soils for various crops such as cotton (Sehgal, 1991; Mandal et. al., 2002), wheat (Sharma, 1999), sorghum (Pakhan et al., 2010), rubber (Kharche et al., 1995) and mustard (Gandhi and Savalia, 2014). However, such in-formation on soils of Kumarbandh Sub watershed in Dang district of Gujarat in India is very scanty hence, the present study was undertaken to evaluate soil-site suitability for finger millet crop in Gujarat.

2. Materials and Methods

The study area lies between latitude 20°43′75′′ and 21°39′ 89′′ North, and the meridians of longitude 73°34′89′′ and 73°36′79′′East in south-west part of Dang district, Gujarat, India. The average rainfall of last ten years (Figure 1) was found to be 2227 mm with an average of 68 annual rainy days.

The wettest month is July with precipitation of around 500 to 700 mm. The maximum and minimum annual temperature of last ten years was noted to be 29.16 °C and 20.47 °C, respectively. The mean maximum temperature is the highest in the month of May. The entire sub watershed falls under *hyperthermic* temperature regime i.e. the mean annual soil temperature is above 29 °C with an *ustic* moisture regime i.e. a regime between *aridic* and *udic* regime. The relative humidity is the minimum during January and February and it reaches to minimum during the monsoon months and maximum during summer months. In order to get clear idea about the soil resources, to study soil characteristics and to evaluate the land suitability characteristics of sub watershed, two hundred and twenty one surface samples for generating information on fertility and chemical properties of soils of Kumarbandh sub watershed. Apart from surface samples, seventeen soil profiles were dug out depending on landforms in three elevations having gently slope (flat plains) to higher

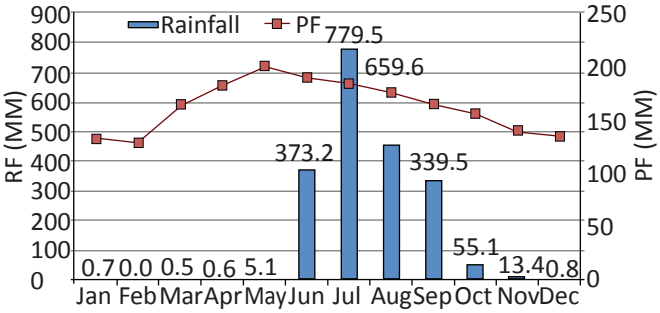

Figure 1: Hydrograph of sub watershed area of Dangs district (1994-2014)

degree of sloppy land i.e. at lower (P_{13} to P_{17}), middle (P_6 to P_{12}) and upper piedmont (P_1 to P_5) (higher degree of slope) and were examined by following standard procedures (Soil Survey Staff, 2014). These pedons were evaluated for their suitability using limitation method regarding number and intensity of limitations. Soil suitability for rice crop growing area was evaluated following FAO guidelines (FAO, 1976). Various criteria suitable for finger millet cultivation given by Sys et al. (1991) and Shivprasad et al. (1998) are presented in Table 1, which involves formulation of climatic and soil requirement of the crop as highly suitable (S1) , moderately suitable (S2), marginally suitable (S3) and not suitable (N1)

Table 1: Soil Site suitability criteria (crop requirements) for finger millet

Soil- site characteristics		Highly Suitable S_1	Moderately suitable S_2	Marginally suitable S_3	Not suitable N_1
Climate regime	Mean Temp. in growing Season °C (c)	28-34	25-27, 35-38	39-40, 20-24	>40, <20
	Total rainfall (mm)	750-900	600-750	450-600	<450
Land characteristics	Length of growing period (Days) (c)	>100	90-110	60-90	<60
	Soil Drainage class (w)	Well drained; moderately Well drained;	Imperfectly drained somewhat excessively drained	Poorly drained; excessively drained	
Nutrient availability	Texture class (s)	L, sil, sl,cl,sicl,scl	Sic,c, sc	Ls, s, c>60%	
	pH (1:2.5) (f)	5.5-7.5	7.6-8.5;4.5-5.4	8.6-9.5;4.0-4.4	<4.0
Rooting condition (s)	Effective soil depth (cm)	75	51-75	25-50	<25
	Coarse fragments Vol %	15	15-35	35-50	>50
Soil toxicity (n)	Salinity (ECe dS/m)	<1.0	1.0-2.0	2.0-4.0	
	Sodicity (ESP %)	<10	10-15	15-25	>25
Erosion hazards(t)	Slope (%)	<3	3-5	5-10	>10

3. Results and Discussion

The soil-site suitability for different land uses is very important for suitable and alternate land use planning. Land suitability for different crops and land quality ratings are those as suggested by NBSS & LUP (1994) for Finger millet. The soil-site suitability evaluations based on comparison of land qualities and crop requirements for finger millet crop are presented in Table 1 and Table 2. The inferences drawn based on the land qualities and suitability (Table 4) ratings are described as per elevations following sub heads as under.

3.1. Upper elevation

Pedon-1: The soils associated with the pedon-1, 3 and 5(P_1, P_3 and P_5) were rated marginally suitable (S_3) for finger millet (Table 4) on account of limitations imposed by topography, stoniness, depth and soil texture for finger millet, (Table 3). The soil conservation measures are only the option to control the major limitation of soil erosion in hill slope area which make them unable to be upgraded from current moderately sustainable (S_2) state from marginally(S_3) to moderately suitability class (S_2).

Pedon-2: The soils of the pedon-2 (P_2) were (Table 4) were rated marginally suitable (S_3) for finger millet on account of limitations (Table 3) imposed by topography, stoniness and. All the above limitations need to be corrected to get satisfactory production these crops.

Pedon-4: The soils of the pedon-4 (P_4) were found not suitable (N_1)for finger millet (Table 4), on account of limitations imposed by higher degree of slope, marginal available moisture capacity, soil texture, soil depth, stoniness and soil drainage (Table 3). Because of higher degree of slope, suitability of these soils for the above crops cannot be improved by any means. However, the soils would be suitable for growing grasses and development of pastures and forest plants.

3.2. Middle elevation

Pedon-6 (P_6), 10(P_{10}) and 11(P_{11}): The soils associated with the

Table 2: Soil-site suitability evaluation and land qualities of the different pedons in sub watershed area of Dan district

Pedons	Climate regime	Land characteristics			Nutrient availability				Effective rooting depth	Soil toxicity		Erosion hazards
		Moisture availability		Soil Drainage								
	Rainfall (mm)	AWC	LGP		Texture	pH	OC (%)	CEC (Cmol (p+) kg^{-1})		Salinity (ECe)	Sodicity (ESP)	Slope (%)
Upper Elevation												
P_1	2228	12.72	120	Well Drained	c	5.9	0.68	26.76	80	0.014	6.67	5-8
P_2	2228	9.60	120	Well Drained	l	6.2	0.72	25.37	56	0.015	5.28	5-8
P_3	2228	8.35	120	Well Drained	sc	5.7	0.95	24.01	70	0.051	5.64	5-10
P_4	2228	11.97	120	Excess.Drained	c	6.3	1.01	29.96	65	0.043	4.94	15-25
P_5	2228	9.72	120	Well Drained	l	5.9	0.91	23.10	70	0.077	3.42	5-10
Middle Elevation												
P_6	2228	14.96	120	Mod. Drained	c	6.2	0.41	26.51	40	0.074	4.21	3-5
P_7	2228	13.16	120	Well Drained	sc	6.9	1.08	32.15	55	0.49	7.92	9-10
P_8	2228	15.51	120	Well Drained	c	5.7	2.15	24.70	75	0.051	3.42	5-10
P_9	2228	6.65	120	Mod.Drained	l	6.2	1.7	31.22	50	0.057	3.49	10-15
P_{10}	2228	13.10	120	Mod.Drained	sc	6.4	0.59	32.78	30	0.045	1.89	3-5
P_{11}	2228	12.32	120	Well Drained	cl	6.1	0.87	31.62	30	0.051	1.61	3-5
P_{12}	2228	13.84	120	Well Drained	cl	5.8	0.95	24.90	85	0.053	5.48	5-8
Lower Elevation												
P_{13}	2228	10.17	120	Mod.Drained	l	6.7	1.64	36.86	107	0.047	7.7	3-5
P_{14}	2228	11.96	120	Mod.Drained	c	6.2	1.26	32.99	120	0.061	8.9	3-5
P_{15}	2228	13.13	120	Imp. to Mod. Drained	c	6.3	0.60	36.61	110	0.053	8.5	1-3
P_{16}	2228	12.76	120	Imper. to Mod. Drained	c	6.2	0.57	34.75	45	0.067	5.2	3-5
P_{17}	2228	10.61	120	Imper. to Mod. Drained	sic	6.2	0.66	22.89	69	0.064	6.6	1-3

P_6, P_{10} and P_{11}, were found moderately suitable (S_2) for finger millet (Table 4). Satisfactory production these crops could be achieved along with soil conservation measures in these moderately sloppy areas of middle elevations, as they have limitations of topography, stoniness, depth and soil texture for finger millet (Table 3). Appropriate soil conservation measures in the soils of hill slope area were the only option to control the major limitation of soil erosion which make them unable to be upgraded from moderately sustainable (S_2) to highly suitability class (S_1) for finger millet.

Pedon-7 and 8: The soils associated with the pedon-7, 8 and 12 ($P_{7,}$ P_8 and P_{12}) (Table 4) came under the rating of marginally suitable (S_3) finger millet on account of limitations imposed by that of topography, soil texture, stoniness and depth for finger millet(Table 3). The suitability classes clearly indicated that all the constraints need to be corrected to get satisfactory production of different crops.

Pedon-9: The soils of the surrounding area of pedon-9 (P_9) were (Table 4) found non-suitable (N_1) for finger millet due to major limitations of marginal slope, soil moisture available during crop growing period, soil texture and soil depth(Table 3).

3.3. Lower elevation

Pedon-13, 14 and 15: The soils associated with pedon-13, 14 and 15 (P_{13}, P_{14} and P_{15}) and its surroundings area were (Table 4) observed moderately suitable (S_2) owing to limitations of soil texture, drainage and coarse fragments which are to be corrected to get satisfactory crop production for finger millet (Table 3).

Pedon-16 and 17: The soils of the pedon-16 and 17 (P_{16} and P_{17}) were (Table 4) moderately suitable (S_2) for finger millet on

Table 3: Soil-site Suitability for Finger millet crop in the study area

Pedon no.	Temp. in growing Season (c)	Land Characteristics		Nutrient Availability		Rooting Conditions (s)		Soil toxicity (n)		Erosion hazards (t) Slope (%)
		Length of Growing Period (c)	Soil Drainage (w)	Texture (s)	pH (f)	Effective Rooting Depth	Coarse fragments	Salinity (ECe)	Sodicity (ESP)	
Upper Elevations										
P_1	S_1	S_1	S_1	S_2	S_1	S_2	S_3	S_1	S_1	S_3
P_2	S_1	S_1	S_1	S_1	S_1	S_2	S_3	S_1	S_1	S_3
P_3	S_1	S_1	S_1	S_2	S_1	S_2	S_3	S_1	S_1	S_3
P_4	S_1	S_1	S_3	S_2	S_1	S_2	N_1	S_1	S_1	N_1
P_5	S_1	S_1	S_1	S_1	S_1	S_2	S_3	S_1	S_1	S_3
Middle elevations										
P_6	S_1	S_1	S_1	S_2	S_1	S_3	S_3	S_1	S_1	S_2
P_7	S_1	S_1	S_1	S_2	S_1	S_2	S_3	S_1	S_1	S_3
P_8	S_1	S_1	S_1	S_2	S_1	S_2	S_3	S_1	S_1	S_3
P_9	S_1	S_1	S_1	S_1	S_1	S_2	S_3	S_1	S_1	N_1
P_{10}	S_1	S_1	S_1	S_2	S_1	S_3	S_3	S_1	S_1	S_2
P_{11}	S_1	S_1	S_1	S_1	S_1	S_3	S_3	S_1	S_1	S_2
P_{12}	S_1	S_1	S_1	S_1	S_1	S_1	S_3	S_1	S_1	S_3
Lower elevations										
P_{13}	S_1	S_1	S_1	S_1	S_1	S_1	S_3	S_1	S_1	S_2
P_{14}	S_1	S_1	S_1	S_2	S_1	S_1	S_3	S_1	S_1	S_2
P_{15}	S_1	S_1	S_2	S_2	S_1	S_1	S_3	S_1	S_1	S_1
P_{16}	S_1	S_1	S_2	S_2	S_1	S_2	S_3	S_1	S_1	S_2
P_{17}	S_1	S_1	S_2	S_2	S_1	S_2	S_3	S_1	S_1	S_1

Source: Shivprasad et al. (1998); S_1: Highly Suitable; S_2: Moderately Suitable; S_3: Marginally Suitable; N_1: Not Suitable

Table 4: Limitation levels of the land characteristics and land suitability class for Finger millet

Pedon No	Family of soil	Soil-site suitability class for Finger millet
Upper elevations		
P_1	Sandy Loam-Skeletal, Mixed, Hyperthermic, Lithic Haplustalf	S_3 st
P_2	Sandy Clay Loam-Skeletal, Mixed, Hyperthermic, Lithic Haplustepts	S_3 st
P_3	Sandy Clay Loam-Skeletal, Mixed Hyperthermic, Lithic Rhodustalf	S_3 st
P_4	Sandy Clay Loam-Skeletal, Mixed Hyperthermic, Fluventic Haplustepts	N1 wt
P_5	Loamy-Skeletal, Mixed, Hyperthermic, Lithic Haplustepts	S_3 st
Middle elevations		
P_6	Loamy-Skeletal, Mixed, Hyperthermic, Lithic Haplustepts	S_2 st
P_7	Sandy Clay Loam-Skeletal, Mixed Hyperthermic, Lithic Rhodustalf	S_3 st
P_8	Loamy-Skeletal, Mixed, Hyperthermic, Lithic Haplustalf	S_3 st
P_9	Sandy Clay Loam-Skeletal, Mixed, Hyperthermic, Lithic Haplustepts	N_1 st
P_{10}	Sandy Clay Loam-Skeletal, Mixed, Hyperthermic, Lithic Haplustepts	S_2 st

Continue....

Pedon No	Family of soil	Soil-site suitability class for Finger millet
P_{11}	Sandy Clay -Skeletal, Mixed, Hyperthermic, Fluventic Haplustepts	S_2 st
P_{12}	Sandy Loam-Skeletal, Mixed, Hyperthermic, Typic Haplustalf	S_3 t
Lower elevations		
P_{13}	Fine Loamy Mixed Hyperthermic, Typic Ustorthents	S_2 st
P_{14}	Sandy Clay Loam-Skeletal, Mixed, Hyperthermic, Typic Haplustepts	S_2 st
P_{15}	Loamy-Skeletal, Mixed, Hyperthermic, Fluventic Haplustepts	S_2w st
P_{16}	Sandy Loam-Skeletal, Mixed, Hyperthermic, Lithic Haplustepts	S_2w st
P_{17}	Clay Loam-Skeletal, Mixed, Hyperthermic, Typic Haplustepts	S_2 wst

Source: Shivprasad et al (1998); S1: Highly Suitable; S2: Moderately Suitable; S3: Marginally Suitable; N1: Not Suitable; w: Wetness; s: texture Physical characteristics; t: erosion hazard

account of limitations of moderate slope and coarse fragments for finger millet (Table 3). Various soil conservation measures were the only option to control the major limitation of soil erosion of hilly sloppy area which make them unable to be elevated from moderately sustainable (S_2) status to highly suitability class (S_1) for finger millet

Based on agro climate, landform, physical and chemical conditions prevailing in the sub watershed, at lower elevation (<350 m msl) existing finger millet crop fall in S_2 (moderately suitable) class indicating very good scope to grow these in soils of lower elevation. However, in middle elevation (350-400 m msl) finger millet comes under class S_3 (marginally suitable at this elevation mainly because of shallow depth and high slope as constraints). In case of upper elevation (>400 m msl), finger millet were found to be suited marginally as they fall in S_3 class of crop suitability.

4. Conclusion

The soils of study area were neutral to slightly alkaline in reaction and low to medium in organic carbon. In soils at lower elevation crops like rice and finger millet are moderately suitable (S_2), while in soils of middle elevation finger millet are marginally suitable (S_3) except in surrounding area of pedon 9 (P_{10}). In case of upper elevation, finger millet was marginally suitable (S_3) except pedon 4 (P_4). Corrective measures can be used to improve the suitability for finger millet crop cultivation.

5. References

FAO, 1976. A Framework for Land Evaluation, Soils bull. No. 32, Food and Agriculture Organization, Rome.

Gandhi, G and Savalia, S.G., 2014. Soil-site suitabilityevaluation for mustard in calcareous soils of Girnar toposequence in Southern Saurashtra region of Gujarat. Journal of Oilseed Brassica 5, 128–133 (2014).

Kharche, V.K., Sehgal, J.L., Challa, O., 1995. Evaluation of soil-site conditions for suitability of rub-ber. Agropedology 5, 69–78.

Mandal, D. K., Kandare, N.C., Mandal, C. and Challa, O., 2002. Assessment of quantitative land evaluation methods and suitability mapping for cotton growing soils of Nagpur district. Journal of the Indian Society of Soil Science 50, 74–80.

NBSS and LUP (1994). Proc. National meeting on soil-site suitability criteria for different crops. Feb. 7-8, 1994 held at NBSS and LUP (ICAR), New Delhi.

Pakhan, A.D., Chatterji, S., Sen, T.K., Venugopalan, M.V., Patil, S. and Challa, O., 2010. Use of different techniques in evaluation of suitability of shrink-swell soils of Nagpur district, Maharashtra for rainfed Sorghum. Journal of the Indian Society of Soil Science 58, 117–124.

Sehgal, J.L., 1991. Soil-site suitability evaluation for cotton. Agropedology 1, 49–63.

Shivaprasad, C.R., Reddy, R.S., Sehgal, J., Velayutham, M., 1998. Soils of Karnataka for optimizing land use. NBSS Publications 47, 15.

Soil Survey Staff, 2014. Keys to Soil Taxonomy 12th edition, National Resource Conservation Centre, USDA, Blacksburg, Virginia.

Sys, I.C., Vanrasant, B., Debavye, J., 1991. Land evaluation, Part 2. Method of land evaluation. Agriculture Pub. No. 7, Belgium.