Identification and delineation of potential castor growing areas in different agro eco sub regions of india

Article · June 2015

CITATION
1

READS
51

13 authors, including:

L.G.K. Naidu
The National Bureau of soil survey and Land Use Planning,
39 PUBLICATIONS **79** CITATIONS
SEE PROFILE

Dharumarajan s
National Bureau of Soil Survey and Land Use Planning
46 PUBLICATIONS **38** CITATIONS
SEE PROFILE

Lalitha Manickam
National Bureau of Soil Survey and Land Use Planning, Bangalore, India
30 PUBLICATIONS **95** CITATIONS
SEE PROFILE

Vasundhara Ramakrishnappa
National Bureau of Soil Survey and Land Use Planning
9 PUBLICATIONS **3** CITATIONS
SEE PROFILE

Identification and delineation of potential castor growing areas in different Agro-eco sub regions of India

L G K NAIDU, S DHARUMARAJAN, M LALITHA, R VASUNDHARA, V RAMAMURTHY, G P OBI REDDY[1], R S SINGH[2], B TAILOR[2], RAMESHWAR SINGH[2], U BARUAH[3], M PADMAIAH[4], G SURESH[4] AND K S VARAPRASAD[4]

ICAR-National Bureau of Soil Survey and Land Use Planning, Regional Centre, Bangalore-560 024, Karnataka

(Received: April, 2015; Revised: May, 2015; Accepted: June, 2015)

ABSTRACT

Castor (*Ricinus communis* L.) is one of the oldest cultivated crops in the world. Castor oil is having global importance specially in chemical industry because it is the only commercial source of a hydroxylated fatty acid. Castor also has tremendous future potential as an industrial oilseed crop because of its high seed oil content, unique fatty acid composition, potentially high oil yields, and ability to be grown under drought and saline conditions. Soils and prevailing climatic conditions across different Agro-Eco Sub Regions (AESR) of India were assessed and matched with crop requirement criteria to identify the potential castor growing areas. Potential castor growing areas comprise favourable soil depth (deep soils) with longer Length of Growing Period (LGP). Among the traditional castor growing areas, AESR 5.2, 7.3, 8.2 and 8.3 have potential to grow castor whereas in non-traditional castor growing areas, AESR 6.3, 6.2, 13.1, 15.4 and 17.1 are most potential for expanding castor cultivation. Relative yield and spread index of castor indicated that most of the potential areas identified in different AESRs fall in zone II and III, need special attention to increase productivity and area expansion programme. Site specific management strategies like selection of suitable variety matching with LGP and proper adoption of nutrient management will overcome the limitations observed in these zones.

Keywords: Castor, Crop growing environment, Land suitability, Length of growing period

Castor (*Ricinus communis* L.) is one of the ancient and important non-edible oilseed crops cultivated for centuries specifically for the oil found in its seed. Castor oil commonly comprises as much as 50-60% of the weight of the seed, making it one of the highest yielding oilseed crops (Weiss, 2000; Baldwin and Cossar, 2009). Cultivation of castor is largely confined to countries lying between 40° N and 40° S latitude. India blessed with ideal tropical conditions for castor crop and is one of the biggest producers of castor seed (62.4%) followed distantly by China (19.2%) and Brazil (12.7%) (DOD, 2012). The productivity of castor in India is also high as compared to other countries. In India, Gujarat ranks first both in area and production followed by Rajasthan, Telangana/Andhra Pradesh and Tamil Nadu. These five states alone contribute nearly 95% of the total area and production of castor (DOD, 2012). The oil content of the seed varies from 35-55% with the average of about 47%. The castor oil is widely used and has multiple applications in preparation of several industrial products *viz*., paints, varnishes, soaps, lubricants, pharmaceutical, textiles, nylon roap, etc.

Castor crop requires a moderately high temperature (20-26°C) with low humidity throughout the growing season to produce maximum yields. Castor is tolerant to drought and grows well in relatively dry and hot regions having a well distributed rainfall of 500-750 mm. Long and clear sunny days are desirable to produce higher yield. Extreme temperatures have a bearing on oil quality. At temperature of >35°C and below 15°C, oil and protein content gets reduced. It can be grown on almost all soils except heavy clays and those poorly drained and saline (Moshkin, 1986). Soils of slightly acid reaction (pH of 5.0-6.0) are preferred. The growth components *viz*., LAI and dry matter and seed yield of castor was increased significantly with increment in soil depth due to higher moisture and nutrient use efficiencies (Subba Reddy *et al.,* 2004). Satyavathi and Suryanarayan Reddy (2004) evaluated the soil-site suitability for six major crops in Telangana state and found that the major limiting factor for the growth of castor is soil pH (pH>7.5) which can be corrected by applying organic manures and gypsum.

In India, castor is grown under two contrasting environments *viz.,* irrigated intensive cultivation with high productivity in Gujarat and Rajasthan; and rainfed cultivation coupled with poor management and very low productivity in Andhra Pradesh, Karnataka, Tamil Nadu, Orissa, etc., which require location specific technologies. There exists a huge yield gap between Improved Technology (IT) and Farmers Practice (FP) of castor cultivation. This paper attempts to assess and identify suitable castor growing tracts based on prevailing soil and climatic conditions across castor growing

[1]ICAR-NBSS&LUP, Nagpur-440 033, Maharashtra; [2]ICAR-NBSS&LUP, Regional Centre, Udaipur-313 001, Rajasthan; [3]ICAR-NBSS&LUP, NER Centre, Jorhat-785 004, Assam; [4]ICAR-Indian Institute of Oilseeds Research, Rajendranagar-500 030, Hyderabad, Telangana

areas in the country and identify production constraints to suggest measures for improved production and productivity and identify potential new areas for crop area expansion.

MATERIALS AND METHODS

District and state wise area, production and productivity data of castor crop was compiled from available sources (DOD, 2012). The soil information for castor growing districts were abstracted from state soil survey reports published by National Bureau of Soil Survey and Land Use Planning (NBSS&LUP), Nagpur under soil resource mapping project of the country (Challa *et al.,* 1995; Natarajan *et al.,* 1996; Reddy *et al.,* 1996; Sarkar *et al.,* 1995; Shivaprasad and Seghal, 1996; Sharma *et al.,* 1994; Haldar *et al.,* 1997; Shyampura and Seghal, 1995; Sen *et al.,* 1999; Singh *et al.,* 2003). Castor growing districts map was over laid on agro-ecological sub regions map prepared by NBSS&LUP (Seghal *et al.,* 1992) to arrive at length of growing period of castor in different growing tracts of the country (Fig. 1). Land suitability assessment was carried out following FAO guidelines (FAO, 1976) and soil-site suitability criteria were developed for castor (Table 1). These criteria were used to group the castor growing areas into highly suitable (S1), moderately suitable (S2), marginally suitable (S3) and not suitable (N) based on kind and degree of limitations (Naidu *et al.,* 2006). The cultivars recommended for different regions were matched with length of growing period (LGP) of the area to know relative suitability of the variety for the region. Based on the secondary data, Relative Yield Index (RYI) and Relative Spread Index (RSI) were worked out as suggested by Kanwar (1972) to know the efficient districts for suggesting different strategies to improve the production of castor. RYI and RSI are calculated grouped into following four zones. Zone-I: High Yield and High spread (>90 RYI and >90 RSI), Zone-II: High yield and Low Spread (>90 RYI and <90 RSI), Zone III: Low yield and High spread (<90 RYI and >90 RSI) and Zone IV: Low spread and Low yield (<90 RYI and < 90 RSI).

Table 1 Land suitability criteria for castor

		Suitable			
		Highly	Moderately	Marginally	Not suitable
Length of growing period (days) for varieties	Early	>120	90-120	<90	
	Medium	>150	120-150	90-120	
	Late	>210	180-210	150-180	
Soil drainage	Class	Well drained	Moderately well drained	Imperfectly drained	Poorly drained
Texture	Class	L, Scl, Sil, Cl,Sl	Sicl, Sic, Sc	Ls,	S
Effective soil depth (cm)	cm	>75	50-75	25-50	<25
Coarse fragments (Vol %)	Vol %	Non gravelly	Upto 15	15-35	>35
pH	1:2.5	6.5-7.5	6.5-5.0	8.0-9.0	>9.0
			7.5-8.0	4.0-5.0	<4.0

Note: S: sand; L: loam; Ls: loamy sand; Sl: sandy loam; Scl: sandy clay loam; Sil: silt loam; Cl: clay loam; Sicl: silty clay loam; Sic: silty clay; Sc: sandy clay

RESULTS AND DISCUSSION

Agro climatic situations across castor growing region: The crop cultivation is spread in most of the climatic regions i.e., arid condition in Rajasthan and Gujarat; semi-arid climate in southern and central India; sub-humid climate in Orissa and Bihar; and humid to per-humid climate in Assam (Fig. 2). The rainfall varied from 242 mm in Pali (Rajasthan) to 3455 mm in Dhemaji (Assam). Similarly length of growing period varied from <60 days in Rajasthan to >300 days in Assam. Length of growing period (LGP) in southern region (Telangana including AP, Karnataka and Tamil Nadu) varied from 60-90 days, 90-120 days and 120-150 days, respectively. Castor crop suffer from moisture stress during maturity stage in southern region due to cultivation of medium duration cultivars under rainfed conditions. In central region (Maharashtra, Madhya Pradesh) crop growing period ranges from 120-150 days and 150-180 days, respectively. In western region (Gujarat and Rajasthan) crop growing period predominantly ranges from <60 days, 60-90 days and 90-120 days which is insufficient to grow castor successfully under rainfed conditions and hence the crop is grown under protective irrigations as per the need resulting in higher productivity in these two states. In eastern region (Odisha and Bihar states) the predominant LGP is 150-180 days and hence there is no moisture limitation for castor production. On the other hand, in north eastern region, LGP varies from greater than 270 days where there is no limitation of moisture for growing longer/perennial cultivars. In this region perennial cultivars are more suitable than short and medium duration cultivars.

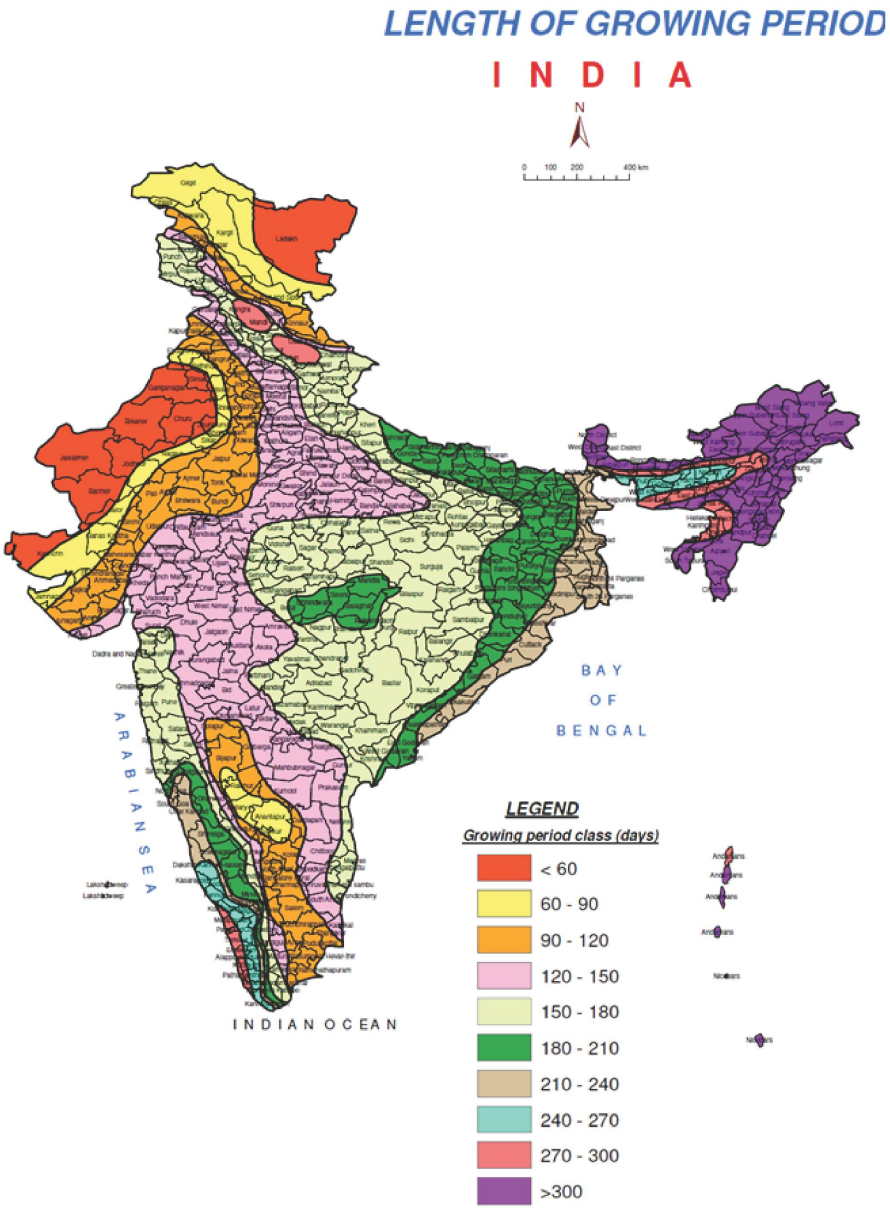

Fig.1. Length of growing period in different districts/states of India (Source: Seghal *et al*., 1992)

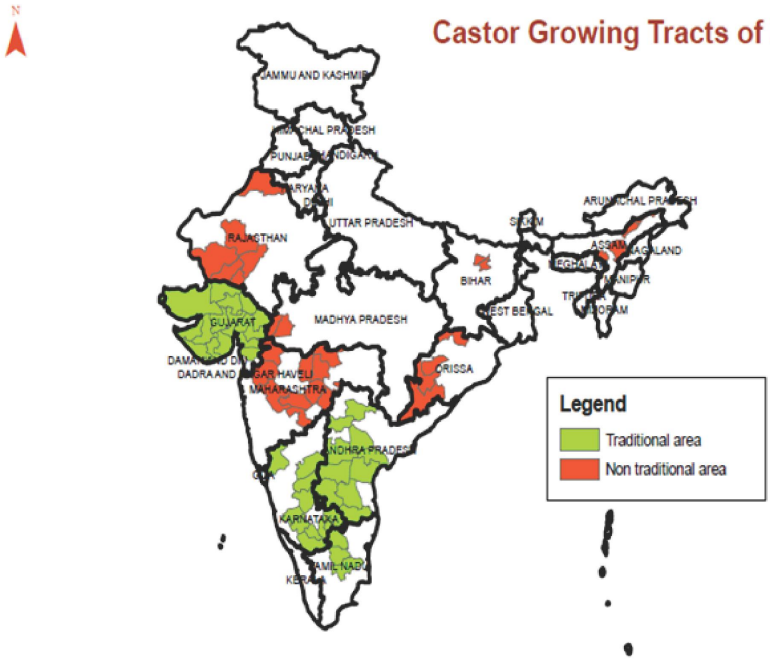

Fig. 2. Castor growing tracts of India

Relative yield and spread index: The analysis of relative yield and spread index carried out in the study gave an opportunity to identify efficient districts for area expansion or productivity improvement of castor in the country. Jamnagar district was found to have highest RYI and RSI followed by Mehsana, Gandhinagar and Banaskantha (Table 4). The districts of Narmada and Porbandar showed high RYI (120-150) and less RSI (90-120) whereas Patan and Ahmadabad districts showed low RYI (90-120) and high RSI (>200). Relative spread index of Amreli, Bhavnagar and Dhoad districts was found to be very low. The districts having low RYI and high RSI belonged to Zone III. The RYI of Sirohi, Barmer and Jalore is 60 to 90, Kurnool, Pali, Mahabubnagar having 30-60 and Namakkal, Prakasam, Rangareddy very low RYI (<30) whereas the relative spread index is greater than 200. In this Zone, Koraput and Medak districts were found with very low yield index (<30). The districts having low RYI and low RSI belongs to Zone IV. Ahmednagar, Buldana, Dhule, Dharmapuri, Dhar, Trichy, Nanded and Beed districts showed very low RYI (<30) and RSI (<30). The strategy in Zone II districts could be oriented towards area expansion by extension activities and awareness programmes whereas zone III districts should be targeted to increase the productivity by recommending short duration varieties and adoption of suitable agronomic measures. The districts with low RYI and RSI under Zone IV needs special strategies to improve the productivity and area expansion based on soil and agro-climatic situations.

Land suitability assessment in traditional castor growing areas

Gujarat: Total area under castor cultivation in the state is 6.27 lakh ha. The dominant castor growing districts in Gujarat are Banaskantha, Mehsana, Patan and Ahmadabad. District wise major soils, rainfall and prevailing growing period are presented in Table 2. In these four major districts, average rainfall ranges from 535 mm in Patan to 702 mm in Ahmadabad with LGP ranging from 60-90 days in Banskantha and Patan; 90-120 days in Mehsana and Ahmadabad. In general, the major soils occurring in these districts are very deep, well drained, calcareous coarse loamy soils followed by very deep, well drained fine loamy soils. The existing soil conditions are highly favourable whereas prevailing crop growing period (60-90 & 120 days) is insufficient to support long duration varieties. Based on climatic limitation these four districts were categorized as marginally suitable with severe limitation of shorter growing period for castor cultivation.

Telangana/Andhra Pradesh: The total area under castor cultivation was found to be 1.79 lakh ha in the erstwhile combined state of Andhra Pradesh. The major castor growing districts are Mahabubnagar, Nalgonda, Rangareddy in Telangana state; Kurnool and Prakasam districts in Andhra Pradesh. The Mahabubnagar district receives an average rainfall of 792.3 mm with LGP of 120-150 days whereas Prakasam district receives an average rainfall of 542.4 mm with LGP of 90-120 days. In general, the major soils occurring in these two districts are shallow to deep, well drained (with some limitations of drainage in Nalgonda Dist.), red clayey soils followed by moderately deep well drained red clayey soils. Overall, soils have no/slight limitation while LGP has moderate limitation for growing successful crop.

Karnataka: The total area under castor cultivation is 0.18 lakh ha. Major castor growing districts are Tumkur, Hassan, Chitradurga and Mysore. District wise major soils, rainfall and prevailing length of growing period are described in Table 2. In these four districts, average rainfall ranges from 638 mm in Chitradurga to 879 mm in Hasan with LGP ranging from 90-120 days in Chitradurga; 90-180 days in Tumkur; 120-150 days in Mysore and 150-180 days in Hassan. Based on soil and agro-climatic conditions it has been grouped under marginally to unsuitable with strong limitations of growing period and problem of drainage, texture and salinity.

Tamil Nadu: Namakkal, Salem, Erode and Dharmapuri are the major castor growing districts of which Namakkal and Dharmapuri are important ones. District wise soils and length of growing period details are presented in Table2. Namakkal district receives an average rainfall of 775 mm with LGP of 150-180 days. In Dharmapuri average rainfall is slightly higher (852 mm) with same LGP as that in Namakkal district. The major soils occurring in these districts are moderately deep, well drained, calcareous gravelly loam soils followed by moderately shallow, well drained, red loamy soils. Based on soils and agro-climatic conditions the district has been categorized as marginally to moderately suitable for castor with strong limitations of rooting depth and sub-soil gravelliness.

Non-Traditional castor growing areas

Rajasthan: Rajasthan is emerging as an important castor growing state with an area of 1.95 lakh ha. Major castor growing districts are Barmer, Jalore, Ganganagar and Hanumangarh. District wise major soils, rainfall and crop growing period are presented in Table 3. The districts of Ganganagar and Hanumangarh receive an average rainfall of 253.7 mm with LGP of <60 days where as Jalore receive about 385.8 mm rainfall with LGP of 60-90 days The major soils occurring in the district are deep, well drained, sandy soils followed by moderately deep, well drained, sandy soils. Prevailing soil and agro-climatic conditions are marginally unsuitable for castor production with strong limitations of shorter growing period and sandy soils. Despite unfavourable growing conditions the crop acreage is on the increasing side as the crop is raised under protective irrigation under drip irrigation leading to higher productivity.

Maharashtra: The current total area under castor cultivation in the state is around 0.11 lakh ha. Major castor growing districts are Beed and Buldhana. District wise major soils, rainfall and prevailing crop growing period details are presented in Table 3. Two districts receive an average rainfall of 726 mm; LGP of 90-120 days and 764mm; LGP of 120-150 days, respectively in Beed and Buldhana districts. The major soils occurring in these districts are deep, well drained, cracking clay followed by very shallow, moderately well drained, clayey soils. Soil and prevailing agro-climatic conditions in the district are marginally to unsuitable for castor due to strong limitations of shallow rooting depth and heavy texture.

Madhya Pradesh: The districts of Jabua and Dhar in Madhya Pradesh receive an average rainfall of 855-956 mm with LGP of 120-150 days. The major soils occurring in these districts are moderately deep, well drained, clayey soils followed by extremely shallow, somewhat excessively well drained, loamy soils. Soil and agro climatic conditions in these districts are moderately to unsuitable for castor production due to shallow rooting depth

Bihar: An average rainfall of 1069 mm is received in Begusarai and Samastipur districts (1234mm) in Bihar with LGP of 180-210 days in both the districts. The major soils occurring in the district are very deep, well drained, fine loamy soils followed by very deep, moderately well drained, fine loamy soils. Soil and agro-climatic conditions in the district are highly to moderately suitable for castor production.

Odisha: The Kalahandi district receives an average of 1330 mm rainfall; Koraput district with an average rainfall of 1567 mm experience LGP of 180-210 days in both the districts. The major soils occurring in the district are deep, somewhat excessively and well to imperfectly drained, gravelly fine loamy soils followed by moderately shallow, well drained, gravelly clayey soils. The prevailing soil and agro-climatic conditions in the districts are marginally to moderately suitable with limitation of drainage. In Koraput, soils are marginally suitable to not suitable for castor production with limitations of gravelliness and steep slopes.

Table 2 Land suitability assessment for castor in different districts of traditional castor growing areas

District	AESR	Depth	Texture	Drainage	RF(mm)	LGP (days)	Suitability
Gujarat							
Banaskantha	2.3	Very deep	Coarse loamy	Well drained	549.4	60-90	S3-N
Mehsana	4.2	Very deep	Coarse loamy	Mod. well drained	618.7	90-120	S3
Patan	2.3	Very deep	Coarse loamy to Fine loamy	Well drained	535	60-90	S3
Ahmadabad	6.1	Moderately deep	Cracking clay	Well to mod. well drained	702	90-120	S3
Amreli	5.1	Moderately shallow	Cracking clay	Well drained	574	90-120	S3
Anand	5.2	Very deep to deep	Fine loamy	Well drained	874.8	120-150	S2
Bharuch	5.2	Very deep	Cracking clay	Mod. well drained	944.7	120-150	S2-S3
Bhavnagar	5.1	Moderately shallow to deep	Cracking clay	Well drained	593.2	90-120	S2-S3
Dhoad	5.2	Shallow	Loamy to clayey	Well drained	873.4	120-150	S3
Gandhinagar	4.2	Very deep	Coarse loamy to fine loamy	Well drained	800	90-120	S3
Jamnagar	2.4	Shallow to moderately deep	Clayey	Well drained	479.4	60-90	S3
Junagadh	5.1	Moderately shallow	Fine to fine loamy soils	Well drained	749.2	90-120	S3
Narmada	5.2	Shallow	Clayey	Well drained	1068	120-150	S3-N
Panchmahal	5.2	Moderately deep to very deep	Fine to coarse loamy	Well drained	941	120-150	S2
Porbandar	2.4	Very deep	Cracking clay	Imperfectly drained	529	60-90	S3
Telangana/ Andhra Pradesh							
Mahbubnagar	7.2	Deep to mod. deep	Clay	Well drained	792.3	120-150	S2-S3
Nalgonda	7.2	Deep to mod. deep	Clay	Imperfectly drained to well drained	762	120-150	S3-S2
Kurnool	7.1	Shallow	Clay	Somewhat excessively drained	606.9	90-120	S3
Prakasam	7.3	Shallow to mod. deep	Clay	Well drained	542.4	90-120	S3-S2
Anantapur	3	Mod. deep (SK)	Clay	Well drained	583	<90/90-120	S3-N
Adilabad	6.2	Shallow to very shallow (SK)	Clay to loamy	Well drained	1070.9	120-150	S3-S2
Medak	7.2	Deep	Cracking clay	Moderately well drained	953.4	150-180	S3-N
Rangareddy	7.2	Very shallow to very deep	Clay	Excessively drained to moderately well drained	783	120-150	S3-N
Warangal	7.2	Mod. deep to very shallow	Loam	Well drained to imperfectly drained	994	150-180	S3-N
Chittor	8.3	Mod.deep	Clay	Well drained	926	180-210	S2
Kadapa	7.1	Shallow	Loamy	Excessively drained	747.6	90-120	S3
Guntur	7.3	Mod. deep to deep	Clay to loamy	Well drained	889.1	120-150	S3-S1
Karnataka							
Tumkur	8.2	Deep	Clay	Well drained	806.2	150-180	S2-S3
Hassan	8.2	Deep	Clay	Mod. well drained to imperfectly drained	878.9	150-180	S3
Chitradurga	8.2	Very deep to shallow	Clay to cracking clay	Mod. well drained to well drained	638	90-120	S3-N
Mysore	8.2	Moderately deep to very deep	Clay to cracking clay	Well drained	809.7	120-150	S3
Belgaum	6.4	Very deep to very shallow	Cracking clay to loamy sand	Well drained	1303	<90/90-120	S3
Bellary	3	Very deep to deep	Clay	Mod. well drained	519	<90/90-120	S3-N
Bangalore rural	8.2	Deep to very deep	Clay	Well drained	824	150-180	S2
Chamrajnagar	8.2	Moderately shallow- very deep	Clay	Well drained	811	90-150	S3
Chikmagalur	19.2	Deep	Clay	Mod. well drained to well drained	1762	>240	S2-S3
Davangere	6.4	Very deep to mod. deep	Clay	Well to moderately well drained	639.9	120-150	N-S2
Haveri	6.4	Moderately shallow	Loamy to clay	Well drained	769.2	150-180	N-S3
Kolar	8.2	Deep to very deep	Clay	Well drained	661.4	120-150	S2
Koppal	3	moderately deep to very shallow	Clay	Well drained	572	<90	S3-N
Mandya	8.2	Deep	Clay	Well to moderately well drained	688.5	120-150	S3-N
Raichur	6.1	Deep to moderately deep	Clay	Well drained	661.3	150-180	S2-N
Ramnagar	8.2	Deep	Clay	Moderately well drained	844.8	150-180	S1-S2
Tamil Nadu							
Namakkal	8.3	Shallow to moderately shallow	Loamy	Well drained	775	150-180	S3-S2
Dharmapuri	8.3	Moderately deep to moderately shallow	Clay	Well to somewhat excessively	852	150-180	S2
Salem	8.3	Moderately shallow to shallow	Clay	Well drained	966	150-180	S2-S3
Erode	8.3	Shallow to very shallow	Loamy	Well drained	795	150-180	S3-N
Trichy	8.3	Deep to moderately shallow	Clay to cracking clay	Moderately well to well drained	869	90-120	S2-S3

Note: S1: Highly suitable, S2: Moderately suitable, S3: Marginally suitable, N: Not suitable

Table 3 Land suitability assessment for castor in different districts of non-traditional castor growing areas

District	AESR	Depth	Texture	Drainage	RF (mm)	LGP (days)	Suitability
Rajasthan							
Barmer	2.1	Deep	Sandy	Excessively drained	281.8	<60	S3-N
Jalore	2.3	Very deep	sandy	Excessively drained	385.8	60-90	S3
Ganganagar	2.1	Deep	Coarse loamy	Well drained	322.3	<60	S3-N
Hanumangarh	2.1	Very deep	Coarse loamy to sandy	Well drained	253.7	60-90	S3
Jothpur	2.1	Deep to mod. deep	Sandy to fine loamy	Excessively drained	326.8	<60	S3-N
Pali	2.3	Moderately shallow to very deep	Fine loamy to coarse loamy	Well drained	242	60-90	S3
Sirohi	2.3	Very shallow to deep	Loamy to fine loamy	Well drained	769.2	60-90	N-S3
Maharashtra							
Ahemednagar	4.2	Deep to moderately shallow	Cracking Clay	Moderately well	568.7	90-120	N-S2
Beed	6.1	Very shallow to shallow	Cracking Clay	Somewhat excessively to well drained	726	90-120	N-S2
Buldana	6.3	Deep to very shallow	Cracking Clay	Moderately well to well drained	764.1	120-150	S3-N
Akola	6.3	Deep to very shallow	Cracking Clay	Moderately well to well	801.7	120-150	N-S3
Amravati	6.3	Deep to very shallow	Cracking Clay	Moderately well	870.5	120-150	S2-N
Dhule	6.2	Deep to very shallow	Clayey to loamy	Moderately well to somewhat excessively	614.7	120-150	S2-N
Nanded	6.2	Shallow to very shallow	Clayey to loamy	Well drained	991.5	120-150	S3-N
Madhya Pradesh							
Dhar	5.2	Moderately deep to extremely shallow	Loamy to clay	Well drained to somewhat excessively	955.6	120-150	N-S2
Jabua	5.2	Shallow to moderately deep	Loamy to clay	Somewhat excessively to well drained	855.5	120-150	S3-S2
Bihar							
Begusarai	13.1	Very deep	Fine loamy	Well to mod. well drained	1069	180-210	S1-S2
Samastipur	13.1	Very deep	Fine loamy	Well to mod. well drained	1234	180-210	S1-S2
Orissa							
Koraput	12.1	Deep to moderately shallow	Fine loamy	Somewhat excessively to poorly drained	1567.2	180-210	S3-N
Kalahandi	12.1	Moderately deep to very deep	Fine loamy to fine	Well to imperfectly drained	1330.5	180-210	S3-S2
Assam							
Dhemaji	15.4	Very deep	Coarse loamy to fine loamy	Well drained	3435	>300	S1
Karbialong	17.1	Very deep	Coarse loamy to fine loamy	Well drained	1205	270-300	S1-S2
Lakimpur	15.4	Deep to moderately deep	Coarse loamy to fine soils	Well drained	2967	>300	S1

Note: S1: Highly suitable, S2: Moderately suitable, S3: Marginally suitable, N: Not suitable

Assam: The important districts of castor cultivation are Karibalong, Dhemaji and Lakimpur in Assam. An average rainfall of 1205 mm with LGP of 270-300 days; 3435 mm and LGP of >300 days; 2967 mm with LGP of >300 days have been recorded in Karibalong, Dhemaji and Lakimpur districts respectively. The major soils occurring in the district are very deep, well drained, coarse loamy soils followed by very deep, well drained, fine loamy soils. Prevailing soil and agro climatic conditions in the district are highly suitable for castor production. Despite favourable climatic conditions, the castor cultivation is limited for rearing eri-silkworms by utilizing leaves of castor for feeding the larvae of eri-silk worm. The crop is not utilized for seed purpose. There is scope for increasing area and productivity of crop.

Evaluation of varietal and agronomic recommendations: In the coordinated castor research project significant achievement has been made in development of improved varieties and hybrids of short and medium duration coupled with biotic stress resistance/tolerance. There is a need for development of production technologies to provide ecological optimum conditions through tailored agronomic practices for different agro-ecological situations and varietal groups. Choice of varieties and fertilizer management plays a major role in improving crop yield and productivity. The varietal recommendation across different states (Table 5) indicated that popular varieties and hybrids which are currently grown in different states have longer duration than the crop growing period prevailing in the area. In Gujarat and Rajasthan, effective LGP is less than 60-90 and 120 days whereas the popular varieties grown in these states have

longer duration of 110-240 days. This indicates that castor production in Rajasthan and Gujarat needs supplemental irrigation for successful growing under rainfed conditions. In Orissa, Bihar, most of the varieties grown may not have moisture limitation due to longer growing period. In Assam where crop growing period is more than 270 days necessiate good perennial varieties. The present long duration varieties are utilized for rearing eri-silk worms. Dual purpose cultivars need to be identified/developed for the region. There is a mismatch between varieties recommended with LGP of the areas in all the states needs site specific varietal recommendations. There is an urgent need to breed short duration varieties available to suit southern states.

Crop nutrition /nutrient management in castor plays an important role in production of either sole crops or intercrops or sequential castor based cropping systems. Scheduling crop nutrition in terms of method of application, time of application and sources of nutrients to be applied has a bearing on crop productivity under rainfed and irrigated cultures. Castor is highly responsive to applied fertilizers. In recent years widespread potassium and sulphur deficiencies are observed across the country. The research results under AICRP (Castor) helped in developing location-specific nutrient recommendations and amply demonstrated the need for inclusion of K and S nutrients in fertilizer recommendation apart from N and P applications. Castor crop perform better in drought situations with application of K, improved oil content was realized through sulphur nutrition. Of late, the crop is responding to micronutrient applications especially to foliar application of $ZnSO_4$ @ 0.5% twice at 50 and 90 DAS under rainfed conditions. Hence, the soil test based site-specific nutrient management is the need of the hour instead of blanket application of nutrients for realizing higher productivity and profitability of castor.

Table 4 Relative yield index and relative spread index of castor

	Relative Yield index						
	Zone I					**Zone III**	
Relative Spread index	>200	200-150	150-120	120-90	90-60	60-30	<30
	>200	Jamnagar	Mehsana Gandhinagar Banaskantha	Patan Ahemadabad	Sirohi Barmer Jalore	Kurnool Pali Mahabubnagar	Namakkal Prakasam Rangareddy Nalgonda
	200-150		Ramnagar Panchmahal Bharuch Anand			Jodhpur Warangal Mysore	
	120-150		Junagadh Bangalore rural		Tumkur	Kadapa Hassan Kalahandi	Koraput
	90-120		Narmada Porbandar	Hanumangarh		Mandya	Medak
	Zone II					**Zone IV**	
	60-90				Chamraj-nagar Koppal Chitradurga	Guntur	
	30-60		Amreli		Chikmag-alur	Adilabad Anantapur Raichur	Jabua, Amravati Salem ,Karbialong Erode
	<30		Bhavnagar Dhoad		Bellary Samastipur Haveri Davangere Belgaum Kolar Begusarai	Ganganagar Akola Chittor Dhemaji Lakimpur	Ahemednagar Buldana,Dhule Dharmapuri Dhar,Trichy Nanded,Beed

In conclusion, relative yield and spread index indicated that districts falling in zone II (high yield & low spread) and III (low spread & high yield) need special attention to increase productivity and area expansion programme. Based on prevailing soil and climatic conditions in different AESRs of traditional castor growing areas, Anand and Panchmahal of AESR 5.2, Guntur (AESR-7.3), Chitoor, Dharmapuri and Trichy (AESR-8.3) and Tumkur, Bangalore rural, Kolar and Ramanagar (AESR-8.2) have been identified as potential districts for augmenting castor production. In non-traditional areas, Amravati (6.3), Dhule (6.2), Begusarai and Samastipur (13.1), Dhemaji and Lakimpur (15.4) and Karbialong (17.1) have been identified as most potential districts. Traditional castor growing areas have shorter crop growing period as compared to presently grown varietal crop duration. Therefore there is need to breed short duration castor cultivars matching with the length of growing period especially under rainfed conditions. Non-traditional areas like Orissa, Bihar and Assam have favourable growing environments where long and perennial cultivars/for eri culture and seed (dual purpose) can be developed and promoted. Soil-test based site specific nutrient management schedule involving integrated use of major (N,P,K), secondary (S) and micro nutrients (Zn) suiting to different soil types are to be developed.

Table 5 Length of growing period (LGP) castor cultivars grown in different states and their duration

State	District	LGP (Days)	Varieties/Hybrids recommended and its duration (days)
Telangana/	Mahabubnagar	120-150	GCH-4 (110-240)
Andhra Pradesh	Nalgonda	120-150	DCH-177 (90-180)
	Kurnool	90-120	DCH-519 (105-110)
			PCH-111 (120-180)
	Prakasam	120-150	
Karnataka	Tumkur	150-180	Jyothi (90-150)
	Hassan	150-180	GCH-4 (110-240)
	Chitradurga	90-120	DCH-177 (90-180)
Tamil Nadu	Erode	150-180	YRCH-1(90-180)
	Namakkal	150-180	GCH-7 (210-260)
	Salem	150-180	GCH-4(110-240)
Gujarat	Banaskantha	60-90	GCH-7 (210-260)
	Jamnagar	60-90	GCH-4 (110-240)
	Meshna	90-120	Avani
Rajasthan	Sirohi	60-90	GCH-7 (210-260)
	Jalore	60-90	GCH-4 (110-240)
	Jodhpur	<60	RHC-1 (180)
Assam	Dhemaji	>300	Local
	Karbialong	270-300	
	Lekimpur	>300	
Orissa	Koraput	180-210	DCH-177 (90-180)
	Kalahandi	180-210	Local
Bihar	Begusarai	180-210	Local
	Samastipur	180-210	

REFERENCES

Baldwin B S and Cossar R D 2009. Castor yield in response to planting date at four locations in the south central United States. *Industrial Crops and Products*, **29**: 316-319.

Challa O, Vadivelu S and Sehgal J 1995. Soils of Maharashtra for Optimising Land Use. National Bureau of Soil Survey and Land Use Planning, Nagpur.

DOD 2012. *Status Paper on Oilseed Crops.* Directorate of Oilseeds Development, Ministry of Agriculture, Department of Agriculture & Cooperation, Himayatnagar, Hyderabad. 184 pp.

FAO 1976. A Framework for Land Evaluation, *In: Soils Bulletin* 32, pp 17-22, Food and Agriculture Organisation, Rome.

Haldar A K, Srivastava R, Thampi C J D, Singh D S, Seghal J and Velayutham M 1997. Soils of Bihar for Optimising Land Use, Publication 50b, National Bureau of Soil Survey and Land Use Planning, Nagpur, 70 pp.

Moshkin V A 1986. *Castor*, Oxonian Press Pvt. Ltd., New Delhi.

Naidu L G K, Ramamurthy V, Challa O, Hegde, Rajendra and Krishnan P 2006. *Manual on Soil-Site Suitability Criteria For Major Crops,* National Bureau of Soil Survey and Land Use Planning, Nagpur, 118 pp.

Natarajan A, Reddy P S A and Seghal J 1996. Soil Resource of Tamil Nadu for Land Use Planning, Publication 56b, National Bureau of Soil Survey and Land Use Planning, Nagpur, pp 6-11.

Reddy R S, Shivaprasad C R and Harindranath C S 1996. Soil Resources of Andhra pradesh for Land Use Planning, Publication 69b, National Bureau of Soil Survey and Land Use Planning, Nagpur. pp 61-63.

Sarkar D, Thampi C J and Sehgal J 1995. *Soils of Orissa for Optimising Land Use*, Publication 66, National Bureau of Soil Survey and Land Use Planning, Nagpur. pp 19-43.

Satyavathi P L A and Suryanarayan Reddy M 2004, Soil-site suitability for six major crops in TeIangana region of Andhra Pradesh. *Journal of the Indian Society of Soil Science*, **52**: 220-225.

Sen T K, Chamuah G S, Seghal J and Velayutham M 1999. Soils of Assam for Optimising Land Use, Publication 66b, National Bureau of Soil Survey and Land Use Planning, Nagpur. 43 pp.

Sehgal J, Mandal D K, Mandal C and Vadivelu S 1992. Agro-ecological Regions of India. National Bureau of Soil Survey and Land Use Planning, Nagpur.

Sharma J P, Shyampura R L and Seghal J 1994. Soils of Gujarat for Optimising Land Use, Publication 29b, National Bureau of Soil Survey and Land Use Planning, Nagpur, 73 pp.

Shivaprasad C R and Seghal J 1996. Soils of Karnataka for Optimising Land Use, Publication 47 b, National Bureau of Soil Survey and Land Use Planning, Nagpur, pp 7-14.

Shyampura R L and Seghal J 1995. Soils of Rajasthan for Optimising Land Use, Publication 51b, National Bureau of Soil Survey and Land Use Planning, Nagpur, 68 pp.

Singh S P, Jagat Ram, Walia C S, Sachdev C B, Dhankar R P, Rana K P C, Seghal J, Velayutham M and Gajbhiye K S 2003. Soils of Uttar Pradesh for Optimising Land Use, Publication 68b, National Bureau of Soil Survey and Land Use Planning, Nagpur, 91 pp.

Subba Reddy G, Maruthi V, Vanaja M and Sree Rekha M 2004. Influence of soil depth on productivity of rainfed castor and cluster bean in sole and intercropping systems. *Indian Journal of Agricultural Research*, **38**: 79-86.

Weiss E A 2000. Castor. *In: Oilseed Crops,* Weiss E A (Ed.), Blackwell Science, Malden, MA, pp. 13-51.