

Candidate Plus Tree Selection of *Buchanania lanzan* Tree in Central Region of Chhattisgarh

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ABSTRACT

Candidate plus tree selection is considered as an important and preliminary step in tree improvement program of a particular species. Plus tree selection is the first step to improve production and quality in forestry. In present study, 85 candidates plus trees of chironji showing good phenotype have been selected from different places covering three districts of central Chhattisgarh region viz., Mahasamund, Gariyabandh and Kabirdham following comparison tree method. The tree height, DBH, clear bole height and average crown diameter varied from 6.5 m-16.5 m, 10.50 cm-40.42 cm, 1.2 m-4.0 m and 2.1m-6.8 m respectively. The highest tree height found for CPT 2 as 16.5 m in Komakhan village, Mahasamund district. The highest tree diameter at breast height (DBH) was found (CPT 2) 40.42 cm in BK Bahra village, Mahasamund dis-

trict. The highest average crown diameter found was observed for CPT 14 and CPT 20 as 6.8 m in Neyur village Kabirdham district.

Keywords Plus tree, DBH, CPT, Crown diameter, Phenotype.

INTRODUCTION

Buchanania lanzan (Chironji) belongs to family Anacardiaceae is depleting with a very fast rate and presently categorized under the threatened species (registered in IUCN list). Therefore, conservation and sustainable use of this type of species is an important necessity for ecologically sustainable development, food security and development of socio-economically poor communities of the nation. These species play very important role in the socio-economic condition of tribal population of the state. Genetic Resources of Tropical Underutilized Fruits in India (Malik *et al.* 2012). Plants usually attain a height up to 18 m and a circumference of 1.5 m. Seedlings and plants show a wide range of variation and have a distinctive dark gray bark with a red blaze on the trunk (Rajput *et al.* 2018). It is dicot woody plants constitutes of leaves which are thickly coriaceous, broadly oblong, obtuse, reticulately veined, the nerves and veins impressed on the upper surface, base rounded, main nerves 10-20 pairs, petioles long. The inflorescences are hermaphrodites with well-developed panicles located on the terminal and lateral droop. The flowers are small, sessile, greenish-white in color, in the terminal and axillary pyramidal ferrugineo-pilose

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panicles and bisexual attaining a diameter of 6.11 mm. A single panicle bears about 3000-5000 flowers. When buds start growing externally, it takes 18-28 days to anthesis and around 3% fruit sets. Flowering starts in January to March on the well-developed panicles and fruits ripe in May–June for harvesting (Banerjee and Bandyopadhyaya 2015). The fruit is a drupe which is yellowish-red in color with a weight of 1.15 g consisting of 23.90°Brix TSS, 57.6% pulp and 48.70 mg/100 mg vitamin C (Singh *et al.* 2015). About 30.62% population of Chhattisgarh is tribal population and is dependent on the Non Timber Forest Produce (NTFP). *Buchanania lanzan* (Chironji) is one of the major non-wood forest products of Chhattisgarh. Chironji is a multipurpose tree, provides food, fodder, timber, medicines and gives monetary reward to tribal community of India as a mean of living by collection of Chironji fruits and selling it in the local markets. Chironji plantation is natural in the state and therefore very diverse in different places across the state.” Chironji is a life support and medicinally important tropical tree species and a significant source of livelihood for local tribal, it holds good proportions of antioxidants, essential nutrients and bioactive molecules. The seeds are the major source of regeneration of Chironji so highly heterozygous plant, which is cross pollinated, contributes genetic variation. Still there are no evidences for identified variety of this important minor fruit, Chironji throughout the country especially in the state of Chhattisgarh. From last few years, due to lack of suitable and efficient harvesting techniques and unawareness in tribes regarding its own unique properties, such as nutritional and therapeutic values may leads increased in deforestation has resulted in extinction of this important forest produce. Though these crops grow in wild and have been neglected, conservation, cultivation and promotion of these are very crucial for nutritional, medicinal and economic purposes.

Tree breeding is a key element in the improvement of production and timber quality in forestry. While plus tree selection is the first important step in an improvement program (Wilson 2005). Selecting plus trees in forestry has been widely applied mainly for the purpose of timber production, cone production, disease and insect resistance. In this study, a method to select plus trees for seed production is described

and named as a comparison tree method.

MATERIALS AND METHODS

Selected forest area

In present study, 85 candidates plus trees of Chironji showing good phenotype have been selected from different places covering three districts of central Chhattisgarh region viz., Mahasamund, Gariyabandh and Kabirdham. The climate of central Chhattisgarh region, from where selection was made, is typically tropical, characterized by fairly hot summer, moderately cold winter and humid and warm monsoon. Most of the precipitation is received from south west monsoon, concentrated during the month of June, July and August.

Selection procedure

Different localities, where the Chironji found to grown naturally viz., BK Bahra, Komakhan village from Mahasamund district, Joba village from Gariyaband district and Neyur village from Kabirdham district. Falling in three districts of central Chhattisgarh region were extensively surveyed to identify the CPTs of selected tree species. Selection was made from sparse population of Chironji growing naturally around the forest area that were average or better in traits of interest. The CPTs were not selected too close to each other in order to avoid narrowing down of the genetic base due to relatedness or inbreeding. Aerial distance of at least 200-300 m between individuals was maintained.

The selection criteria for CPTs vary from species to species but many of the basic characteristics are quite considerable. The objective was that the selected individual should have good stem form, good growth characters, well-formed crown, natural pruning ability and free from pests and diseases. The individuals having diseases, dead branches, or attacked by any pathogen and pests were rejected in the initial stage of selection. Major economic characteristics considered for the CPT selection were the stem straightness, cylindrical clear bole, girth at breast height (GBH), tree height and branch angle.

Tree height was recorded based on ocular esti-

mation Girth at breast height (GBH) was measured at 1.37 m height from the base of tree using standard measuring tape and expressed in nearest centimeter. Clear bole height was recorded with measuring tape from tree base to the first live branch on the main stem and expressed in meter. Trees were not accepted with branch angle more than 90°. Degree of branch angle was judged subjectively by considering upper stem portion as base. Ability of candidate tree to shed its lower limbs (dead or alive) as compared to other tree was also judged subjectively. The data recorded

Study area

Site	District	Latitude/longitude
BK Bahra Komakhan	Mahasamund	21.0020388/82.4632
Joba	Gariyaband	20.5144/82.12578
Neyur	Kabirdham	22.45284/81.2692

were subjected to simple statistical analysis using excel work book.

RESULTS AND DISCUSSION

Morphological characters of selected plus trees of *Buchanania lanzan* naturally growing in Komakhan and BK Bahra village Mahasamund district Chhattisgarh

A total of 10 morphological superior trees (plus trees)

were selected from Komakhan village (Table 1) of Mahasamund Forest Division, Mahasamund. The total height of the selected plus trees varied from 8.0 m (CPT07) to 16.5 m (CPT02) from Komakhan village with mean of 13.8 m. Diameter at breast height was observed maximum 32.14 cm for CPT 8 and minimum in 13.68 cm for CPT 26 with mean of 21.48 cm. The clear bole height of the selected plus trees varied from 1.5 m for CPT 07 to 4.0 m for CPT10 with mean of 3.1 m. Crown height varied from 6.5 m for CPT 07 to 13.6 m for CPT 03 with mean of 10 m. Avg crown diameter varied from 3.2 m for CPT 07,10 to 4.8 m for CPT05 with mean of 3.87 m. Selected trees in the present study had fairly good straightness, compact crown and clear bole.

Association of different morphological characteristics of selected plus trees in present study, it was observed that the total height of the naturally occurring trees exhibited a positive and highly significant correlation with crown height, clear bole height. However, height displayed a negative and significant correlation with DBH was significant at ($p < 0.01$) (Table 2–8).

A total of 30 morphologically superior trees (plus trees) were selected from BK Bahra village of Mahasamund Forest Division, Mahasamund (Table 2). The total height of the selected plus trees varied from 6.8 m for CPT16 to 15.0 m CPT08 from with

Table 1. Morphological characters of selected plus trees of *Buchanania lanzan* naturally growing in Komakhan village Mahasamund district (CG).

CPT's	Site (District)	Height (m)	Clear bole height (m)	DBH (cm)	Clear bole : Total height ratio	Crown height (m)	Avg crown diameter
CPT 1	Komakhan (Mahasamund)	15.8	3.2	24.82	0.202	12.6	4.2
CPT 2		16.5	3.0	25.46	0.181	13.5	3.6
CPT 3		16.4	2.8	25.46	0.170	13.6	3.9
CPT 3		13.8	3.8	15.91	0.275	10.0	4.2
CPT 4		11.5	2.4	22.28	0.208	9.1	4.6
CPT 5		12.0	3.5	17.58	0.291	8.5	4.8
CPT 6		12.0	3.3	24.82	0.275	8.7	4.2
CPT 6		11.8	2.8	23.87	0.202	8.2	3.5
CPT 7		8.0	1.5	32.14	0.187	6.5	3.2
CPT 8		12.8	3.2	13.68	0.190	9.6	3.6
CPT 9	13.0	3.9	17.82	0.229	9.1	3.5	
CPT 10	14.6	4.0	14.00	0.227	10.6	3.2	
Mean		13.18	3.1	21.48	0.219	10.00	3.87

Table 2. Morphological characters of selected plus trees of *Buchanania lanzan* naturally growing in BK Bahra village Mahasamund district (CG).

CPT's	Site (District)	Height (m)	Clear bole height (m)	DBH (cm)	Clear bole : Total height ratio	Crown height (m)	Avg crown diameter
CPT 1		9.5	2.4	36.92	0.252	7.1	4.5
CPT 2		9.2	1.8	40.42	0.195	7.4	4.2
CPT 3		8.7	2.3	12.73	0.264	6.4	3.8
CPT 3		8.2	1.2	16.87	0.146	7.0	3.6
CPT 4		8.0	2.5	16.87	0.312	5.5	4.1
CPT 5		10	2.9	22.67	0.290	7.1	4.0
CPT 6		11.7	3.2	38.51	0.273	8.5	4.8
CPT 7		11.0	3.3	32.14	0.300	7.7	4.5
CPT 8		15.0	3.9	23.87	0.260	11.1	3.7
CPT 9		13.8	2.8	14.32	0.202	11.0	3.6
CPT 10		14.7	2.9	18.14	0.197	11.8	3.8
CPT 11		6.8	1.2	12.41	0.176	5.6	3.9
CPT 12		12.0	2.7	14.96	0.225	9.3	3.2
CPT 13		8.0	1.5	17.82	0.187	6.5	2.7
CPT 14		9.8	2.3	13.68	0.234	7.5	2.9
CPT 15		11.0	3.2	11.45	0.290	7.8	3.3
CPT 16		7.0	2.3	28.64	0.328	4.7	2.9
CPT 17		8.0	2.0	24.19	0.250	6.0	2.7
CPT 18	BK Bahra	9.7	3.2	23.55	0.329	6.5	2.8
CPT 19	(Mahasamund)	11.4	4.0	21.96	0.350	7.4	3.5
CPT 20		9.8	2.5	17.18	0.255	7.3	3.2
CPT 21		8.2	2.0	14.96	0.243	6.2	4.5
CPT 22		9.3	3.0	12.41	0.322	6.3	2.6
CPT 23		10.0	4.0	15.27	0.4	6.0	2.7
CPT 24		8.5	3.5	15.27	0.411	5.0	2.2
CPT 25		8.7	3.8	17.50	0.436	5.1	2.1
CPT 26		7.8	2.3	10.50	0.294	5.5	4.9
CPT 27		8.0	2.3	38.83	0.287	5.7	4.3
CPT 28		7.5	2.4	16.87	0.320	5.1	4.2
CPT 29		14.0	4.0	16.87	0.285	10	4.6
CPT 30		10.0	3.6	14.32	0.36	6.4	3.8
Mean		10.17	2.83	20.39	0.279	7.1	3.6

mean of 10.17 m. Diameter at breast height was maximum 40.42 cm for CPT2 and minimum in for CPT 26 (10.50 cm) with mean of (20.39 cm). The clear bole height of the selected plus trees varied from 1.2 m for CPT 3,11 to 4.0 m for CPT19 with mean of 2.83 m. Crown height varied from 4.7 m for CPT 15 to 11.8 m for CPT 10 with mean of 7.1 m. Average crown diameter varied from 2.1 m for CPT 25 to 4.8 m for CPT6 with mean of 3.6 m. Selected trees in the present study had fairly good straightness, compact crown and clear bole.

Association of different morphological characteristics of selected plus trees in present study, it was observed that the total height of the naturally occur-

ring trees exhibited a positive and highly significant correlation with crown height, clear bole height and mean crown diameter $p < 0.01$ (Table 6).

Morphological characters of selected plus trees of *Buchanania lanzan* naturally growing in Joba village Gariyaband district (CG)

A total of 15 morphological superior trees (plus trees) were selected from Joba village (Table 3). The total height of the selected plus trees varied from 6.5 m (CPT07) to 13.4 m (CPT02) from Joba village of Gariyaband Forest Division with mean of 9.1 m. Diameter at breast height was observed maximum in 24.19 cm for CPT 2 and minimum in 12.73 cm for

Table 3. Morphological characters of selected plus trees of *Buchanania lanzan* naturally growing in Joba village Gariyaband district (CG).

CPT's	Site (District)	Height (m)	Clear bole height (m)	DBH (cm)	Clear bole : Total height ratio	Crown height (m)	Avg crown diameter
CPT 1	Joba (Gariyaband)	10.0	3.2	18.14	0.150	6.8	3.2
CPT 2		8.0	2.0	24.19	0.237	6.0	3.5
CPT 3		13.4	3.9	17.50	0.194	9.5	3.6
CPT 3		6.8	2.0	13.36	0.176	4.8	2.9
CPT 4		10.8	3.0	18.14	0.185	7.8	3.5
CPT 5		11.2	3.6	12.41	0.205	7.6	2.7
CPT 6		8.6	2.3	12.09	0.186	6.3	3.6
CPT 6		8.9	2.4	11.45	0.134	6.5	2.4
CPT 7		7.6	1.3	12.73	0.171	6.3	2.8
CPT 8		7.9	2.1	19.09	0.265	5.8	3.4
CPT 9		9.8	2.5	13.68	0.255	7.3	3.3
CPT 10		10.3	4.0	17.50	0.252	6.3	4.2
CPT 11		8.5	2.3	12.73	0.270	6.2	2.2
CPT 12		9.3	2.2	29.92	0.236	7.1	3.3
CPT 13		9.8	2.7	13.78	0.275	7.1	2.5
CPT 14	7.3	2.5	17.50	0.164	4.8	2.6	
CPT 15	6.5	2.2	12.73	0.204	4.3	2.8	
Mean		9.1	2.6	16.29	0.209	6.5	3.08

CPT 7,11,15 with mean of 16.29 cm. The clear bole height of the selected plus trees varied from 1.2 m for CPT 3,6,14 to 4.0 m for CPT10 with mean of 2.6 m. Average crown height varied from 4.3 m for CPT 15 to 9.5 m for CPT 03 with mean of 6.5 m. Average crown diameter varied from 2.2 m for CPT 11 to 4.2

Table 4. Morphological characters of selected plus trees of *Buchanania lanzan* naturally growing in Neyur village Kabirdham district (CG).

CPT's	Site (District)	Height (m)	Clear bole height (m)	DBH (cm)	Clear bole : Total height ratio	Crown height (m)	Avg crown diameter
CPT 1		8.5	2.0	15.59	0.235	6.5	6.5
CPT 2		8.0	1.8	16.87	0.225	6.2	5.2
CPT 3		7.8	2.2	14.00	0.282	5.6	5.8
CPT 3		9.6	2.6	14.64	0.270	7.0	5.4
CPT 4		11.0	2.5	12.09	0.227	8.5	4.1
CPT 5		10	3.0	13.36	0.3	7.0	4.0
CPT 6		12.0	3.2	35.01	0.266	8.8	4.8
CPT 7		10.4	3.3	37.87	0.317	7.1	4.5
CPT 8		14.8	3.3	26.10	0.222	11.5	6.3
CPT 9		13.3	2.8	17.82	0.210	10.5	6.4
CPT 10		14.7	2.9	15.91	0.197	11.9	6.2
CPT 11		7.8	1.2	30.23	0.153	6.6	5.8
CPT 12		13.0	2.7	28.64	0.207	10.3	5.1
CPT 13		8.0	2.3	14.64	0.287	5.7	5.3
CPT 14		12.3	2.3	22.28	0.181	10.0	6.8
CPT 15		10.6	3.2	23.87	0.301	7.4	4.5
CPT 16		9.0	2.3	18.46	0.255	6.7	4.8
CPT 17		11.2	2.0	18.14	0.178	9.0	4.3
CPT 18		12.3	3.2	24.82	0.260	9.1	5.9
CPT 19		11.3	3.0	20.37	0.265	8.3	7.2
CPT 20		11.0	2.0	14.64	0.181	9.0	6.8
CPT 21		10.3	3.0	17.82	0.291	7.3	7.5

Table 4. Continued.

CPT's	Site (District)	Height (m)	Clear bole height (m)	DBH (cm)	Clear bole : Total height ratio	Crown height (m)	Avg crown diameter
CPT 22	Neyur (Kabirdham)	12.0	4.0	18.78	0.333	8.0	5.6
CPT 23		10.0	4.0	30.55	0.4	6.0	5.4
CPT 24		9.0	3.5	28.64	0.388	5.2	4.2
CPT 25		8.9	3.6	33.42	0.404	5.3	4.6
CPT 26		10.0	3.0	32.46	0.3	7.0	4.3
CPT 27		9.0	2.0	27.05	0.222	5.7	5.6
CPT 28		8.0	2.1	26.41	0.262	5.9	5.2
CPT 29		14.0	3.0	22.28	0.214	11	4.6
CPT 30		12.0	3.6	20.69	0.3	8.4	5.4
Mean			10.63	2.76	22.36	0.262	7.82

m for CPT10 with mean of 3.08 m.

Association of different morphological characteristics of selected plus trees in present study, showed that the total height of the naturally occurring trees exhibited a positive and highly significant correlation with crown height, clear bole height and mean crown diameter $p < 0.01\%$ (Table 7).

Morphological characters of selected plus trees of *Buchanania lanzan* naturally growing in Neyur village Kabirdham district (CG)

A total of 30 morphological superior trees (plus trees) were selected from Neyur village (Table 4) under Kabirdham Forest Division. The total height of the selected plus trees varied from 7.8 m for CPT03 to

Table 5. Correlation coefficient among different traits of selected plus tree of *Buchanania lanzan* Komakhan village Mahasamund district. ** Correlation is significant at the 0.01 level (2-tailed).

	Height	Clear bole height	DBH	Crown height	Mean crown diameter
Height	1				
Clear bole height	0.41	1			
DBH	-0.31	-.714	1		
Crown height	0.943**	0.14	-0.06	1	
Mean crown diameter	0.06	0.00	-0.16	0.00	1

14.8 m for CPT08 with mean of 10.63 m. Diameter at breast height was observed maximum in 37.87 cm for CPT 7 and minimum in for CPT 4 12.09 cm with mean of 22.36 cm. The clear bole height of the selected plus trees varied from 1.2 m for CPT 11 to 4.0 m for CPT 22 with mean of 2.76 m. Crown height varied from 5.2 m for CPT 24 to 11.9 m for CPT 10 with mean of 7.82 m. Avg crown diameter varied from 4.2 m for CPT 25 to 6.8 m for CPT14 with mean of 5.42 m.

Association of different morphological characteristics of selected plus trees in present study, showed that the total height of the naturally occurring trees exhibited a positive and highly was significantly correlated with clear bole height was significant at 0.05% ($r = .378$). Total height of tree highly significant correlation with crown height was

Table 6. Correlation coefficient among different traits of selected plus tree of *Buchanania lanzan* BK Bahra village Mahasamund district. **Correlation is significant at the 0.01 level (2 tailed).

	Height	Clear bole height	DBH	Crown height	Mean crown diameter
Height	1				
Clear bole height	.573**	1			
DBH	.031	-.080	1		
Crown height	.922**	.272	.015	1	
Mean crown diameter	0.275	-0.172	0.227	0.352	1

Table 7. Correlation coefficient among different traits of selected plus tree of *Buchanania lanzan* Joba village Gariyaband district. ** Correlation is significant at the 0.01 level (2 tailed).

	Height	Clear bole height	DBH	Crown height	Mean crown diameter
Height	1				
Clear bole height	0.757**	1			
DBH	0.070	0.032	1		
Crown height	0.950**	0.636	0.186	1	
Mean crown diameter	0.302	0.314	0.352	0.265	1

significant at 0.01% ($r=.925$) (Table 8).

DISCUSSION

Selection of good phenotype on the basis of desired traits is the preliminary steps for mass scale multiplication program and genetic improvement of any tree species. Plus, tree selection among even-aged stands is a basic tool for tree improvement. With the intensification of forest farming, tree improvement programs have become an integral part of the forest management. The plus trees selected through minimum selection standards method, therefore form the base for any breeding program. A careful selection of plus trees is necessary through which efforts should be made for the maximum use of genetic variations. Such trees can be used either for progeny testing, vegetative multiplication or directly as seed sources. In the present investigation, 85 CPT's of *Buchanania lanzan* were selected from three districts of central Chhattisgarh region.

The data with regard to candidate plus trees (CPT's) of *Buchanania lanzan* selected from three districts of central Chhattisgarh region via. Conducting an extensive survey, the tree height, DBH, clear bole height and average crown diameter varied from 6.5 m-16.5 m, 10.50 cm-40.42 cm, 1.2 m-4.0 m and 2.1 m-6.8 m respectively. Similarly, the traits based on apparent growth, clear bole and stem straightness and the traits of priority were selected in different tree species viz., *Pongamia pinnata* (Kaushik *et al.* 2011)

Table 8. Correlation coefficient among different traits of selected plus tree of *Buchanania lanzan* Neyur village Kabirdham district. *Correlation is significant at the 0.05 level (2 tailed). ** Correlation is significant at the 0.01 level (2 tailed).

	Height	Clear bole height	DBH	Crown height	Mean crown diameter
Height	1				
Clear bole height	0.378*	1			
DBH	0.008	0.315	1		
Crown height	0.925**	0.027	-0.109	1	
Mean crown diameter	0.144	-0.171	-0.237	0.257	1

Plus tree selection has been carried out in a number of tree species for different end uses. Fifty-three candidates plus trees (CPTs) of *Pongamia pinnata* were selected from different locations in Orissa, India, on the basis of their seed and pod characteristics to identify suitable seed source with high oil content for production of quality planting seedlings for use in afforestation programs (Sahoo *et al.* 2011).

Similarly, candidate plus tree selection was reported in *Madhuca indica* which were evaluated for various seed germination and seedling traits following progeny testing (Wani and Ahmad 2013).

In present study selected of plus trees from naturally occurring *Buchanania lanzan* based on different morphological characteristics in central region of Chhattisgarh. It was observed that the total height of the naturally occurring trees exhibited a positive and highly significant correlation with crown height, clear bole height and mean crown diameter was significant at 0.01% in Mahasamund and Gariyaband district. In Kabirdham district it was observed that the total height of the naturally occurring trees exhibited a positive and highly significant correlation with clear bole height was significant at 0.05% ($r=.378$). Total height of tree was significantly by correlated with crown height was significant at 0.01% ($r=.925$). Similar finding reported that Daneva *et al.* (2018) selected plus tree from the naturally occurring *Alianthus excels* on the basis of phenotypic assessment of desirable characters of economic interest they reported the height of the tree has as a positive and

highly significant correlation with clear bole height, girth at breast height (GBH), height of crown. It was observed that height had positive and highly significant association with height of crown ($r=0.990$) and girth at breast height ($r=0.865$) of the tree. Singh *et al.* (2019) selected plus tree from naturally occurring *Prosopis cineraria* based on the desirable characters of economic interest. They reported highly significant and positive correlation between age and other morphological characters viz., height, clear bole height and GBH.

CONCLUSION

In the present investigation, 85 CPT's of *Buchanania lanzan* were selected from three districts (Mahasamund, Gariyaband and Kabirdham) of central Chhattisgarh region. The data with regard to candidate plus trees (CPT's) of *Buchanania lanzan* selected from three districts of central Chhattisgarh region. The tree height, DBH, clear bole height and crown diameter varied from 6.5 m-16.5 m, 10.50 cm-40.42 cm, 1.2 m-4.0 m and 2.1m-6.8m respectively. The highest tree height was measured for CPT 2 16.5 m in Komakhan village, Mahasamund district. The highest tree diameter at breast height (DBH) was measured for CPT 2 40.42 cm in BK Bahra village, Mahasamund district. The highest average crown diameter was measured for CPT 14 and for CPT 20 6.8 m in

Neyur village Kabirdham district.

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