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The potential of domestication through human controlled culture of some plants' species from wild habitats of the state of Sikkim, India

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Abstract

The plant species, growing in the cultivated land of Sikkim Himalaya, are enumerated to document the recent trend of domestication. This information can be utilized for the economic development of communities of Sikkim Himalaya relating to organic production.

This paper presented the notes on altitudinal ranges, flowering and fruiting period, local names etc. of domesticated plant species, which are growing as crops.

Keywords: Cultivar, domesticated crops, Sikkim Himalaya.

Introduction

The domestication of plant species from wild habitats is an old trend since the civilization started. Historically, there are many species grown in the different civilizations to cater the necessities. In the mountain ecology, the domestication of species was prevalent as it is bestowed with rich bioresources whereby the communities are living with. The selection process of species for the domestication is a unique ability to recognize the species at source. The indigenous communities of the Sikkim Himalayan region and adjoining areas have the potential to classify the species whether it is palatable or not. More than one community contributed to establish the

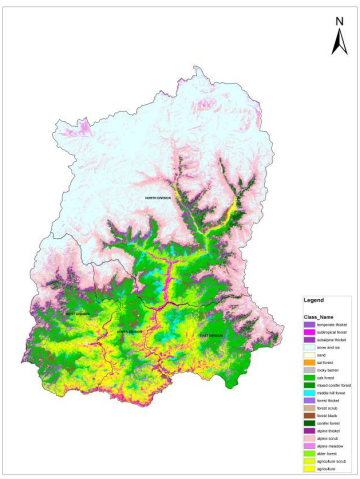

Figure 1: Sikkim

selection of species for the domestication in the courtyard of farming areas. Such wildly grown plants, which are presently domesticated in Sikkim Himalaya, are presented in this paper.

Physiographically, Sikkim, the study area, ranges altitudinal variation from 155 meters to 8586 meters. The major portion of the region is covered by pre-Cambrian rock and is much young. The north of Sikkim is encircled with the Tibetan plateaus and the rest parts of Sikkim is lower, open and fairly well cultivated areas. The coordinate of the study area, Sikkim, is from 27°33′N 88°30′E to 27.55°N 88.500°E.

Climatically, Sikkim experiences variation of temperatures from warm to freezing on the high mountains. Generally, the temperatures descends with the increase of altitude and receives average rainfall 500 mm with pre-monsoon during April and May due to the proximity to the Bay of Bengal. The hydro-meteorological factors influence the physical features and climate of the area.

Numerous researches conducted on the species of Sikkim (Hooker, 1872-1897; Hara, 1966, 1971; Thapa and Chettri, 1993; Srivastava and Kapaki, 1990; Sinha and Chauhan, 1997; Pradhan, 2020a) but a few literatures is available regarding the recent trend of domestication of the species.

Thus, this paper presented the enumerated list of the domesticated plants of Sikkim Himalaya.

Materials and Methods

Reconnaissance of the data obtained from the surveys of the state, Sikkim. Further, these valuable species are identified in Sikkim State Forest Herbarium, Forest (SSFH) referring the relevant literatures (Hooker, 1872-1897; King and Pantling, 1898; Grierson and Long, 1983; Hara, 1966, 1971), which were deposited in SSFH.

Results and Discussion

Since the crucial development of civilization, the species are domesticated which play profound role among hunter gathers to lead the agricultural societies. Several studies were undertaken across the large sections of societies of the world whereby these were found that several societies evolved through the domestication process (Ibarra *et al*., 2007; Flint-Garcia, 2013; Venkatesh *et al.,* 2015). However, the domesticated species of Sikkim Himalaya is thinly documented.

In general, most of the domesticated species of the wild habitats is the consequence of artificial selection based on the traits and adaptability.

Likewise, the plant species of wild habitats, which are bought to the farming land of Sikkim and adjoining Himalaya for the cultivation, are unique and exceptional. Sikkim exhibits the rich ecosystem with species diversity delivers social, economic and environmental benefits to the communities. These communities are natural resources dependents who collect the food resources from the forests for sustainable livelihood. Thus, the traditional knowledge of communities extends support to select the species for the domestication. The region of the indigenous people is bestowed with rich bioresources so it is having imperative values connecting with earth, water, plants, animals, knowledge, traditions and stories. The recent trends of domesticated species of wild habitats of Sikkim are in use as vegetables and some are in use as ethnomedicine.

Nonetheless, the researches on the domestication of species is thinly documented in Sikkim (Pradhan, 2020a, 2020b) so the enumeration of domesticated plants was essential, in this regard.

Enumerated list of the domesticated species of wild habitat is presented.

(Abbreviations: Fl: Flowering Period; Fr.: Fruiting Period; L: Lepcha Language; N: Nepali Language)

1. ***Allium wallichii*** Kunth, Enum. Pl. 4: 443. 1843. Family: Amaryllidaceae; Local name: Sufyu (L); Himal ko Dungdungay (N).

Synonyms:

Allium bulleyanum Diels.; *Allium caeruleum* Wall.; *Allium feddei* H. Lév.; *Allium lancifolium* Stearn.; *Allium liangshanense* Z.Y. Zhu.; *Allium platyphyllum* (Diels) F.T. Wang & Tang.; *Allium polyastrum* Diels.; *Allium praelatitium* H. Lév.

This species is used as an ethnomedicine as well as an ingredient of food. Its vegetative form can be seen during April and remain till July that grows at altitudinal ranges of 6000-9000 ft. Plant height is 2.5-3.0 ft having elongated thick roots. A linear leaf is ca. 40 cm length and ca. 1.2 cm wide. Penduncle bears umbel inflorescence. Flower is with white perianth and light yellowish anther lobes. The

vegetative parts of plant use as the essence of the food. It is also used against cough, cold, sinusitis and migraine.

Fl.: July-August. **Fr.**: October-November.

Distribution: India: Sikkim: 7000 ft. - 9000 ft.; China; Bhutan; Myanmar; Nepal.

2. ***Amaranthus viridis*** L. Sp. Pl., ed. 2. 2: 1405. 1763. Family: Amaranthaceae; Local Name: Kayeam Bee (L).

Synonyms:

Euxolus viridis (Linnaeus) Moquin-Tandon.

It is ca. 70 cm tall and erect. Its vegetative form can be seen from April onwards. The young vegetative shoots are used as food. The roasted seeds are used to add the flavor to the soft drinks.

Fl.: June-August. **Fr.**: August-October.

Distribution: India: Sikkim: upto 7000 ft.

3. ***Arisaema speciosum*** (Wallich) Martius ex Schott & Endlicher, Melet. Bot. 17. 1832. Family: Araceae; Local Name: Sungtuk (L), Laruwa (N).

Synonyms:

Arum speciosum Wallich, Tent. Fl. Napal. 29. 1824;

A. eminens Schott; *A. speciosum* var. *eminens* (Schott) Engler.

Plant is 4-4.5 ft tall bearing leaf lamina 15-18 cm. long that grows well in shady place. It grows suitably upto 4900 ft. Its vegetative form starts from April onwards. The young vegetative shoots are used as food.

Fl.: April-June. **Fr.**: October-November.

Distribution: India: Sikkim: 4000 ft -6000 ft.; China, Bhutan, Nepal.

4. ***Himalayacalamus hookerianus*** (Munro) Stapleton. Family: Poaceae; Local name: Bowak (L), Pareng (N).

Synonyms:

Arundinaria hookeriana Munro

It is growing in the cultivated farm land for the production of young shoots. In some cases, it is found growing as a fence to the farmland that, in turn, uses as vegetable. It suitably grows from 5200 ft to 6000 ft. The young shoot of this species shoot out from April onwards till July.

Distribution: India: Sikkim: 5500 ft to 7500 ft.; China, Vietnam, Nepal, Bhutan.

5. ***Calamus flagellum*** Griffith ex Martius, Hist. Nat. Palm. 3: 333. 1853. Family: Poaceae; Local name: Ruubong (L), Pyakray/ Rabi Bet (N).

Synonyms:

Calamus flagellum var. *furvifurfuraceus* S. J. Pei & San Y. Chen;

C. flagellum var. *karinensis* Beccari; *C. karinensis* (Beccari) S. J. Pei & San Y. Chen; *C. polygamus* Roxburgh; *Palmijuncus flagellum* (Griffith ex Martius) Kuntze; *P. polygamus* (Roxburgh) Kuntze.

It's a climbing stem climbs upto 30 m. Fruits are ovoid brownish ca. 4 cm length and ca. 2.5 cm diameter, which are scaly grooved.

The fruits of plant are mostly sold in market which fetch good price. It is considered as one of the fruit item in the Himalayan region.

Fl.: July-August. **Fr.**: November-December.

Distribution: India: Sikkim: 4000 ft. to 6000 ft.; China, Bangladesh, Bhutan, India, Laos, Myanmar, Nepal, Thailand, Vietnam.

6. ***Calamus acanthospathus*** Griffith, Calcutta J. Nat. Hist. 5: 39. 1845. Family: Poaceae; Local name: Ruukup (L), Gauri (N).

Synonyms:

Calamus feanus Beccari; *C. feanus* var. *medogensis* S. J. Pei & San Y. Chen; *C. montanus* T. Anderson; *C. yunnanensis* Govaerts; *C.yunnanensis* var. *densiflorus* S. J. Pei & San Y. Chen;

C. yunnanensis var. *intermedius* S. J. Pei & San Y. Chen; *Palmijuncus acanthospathus* (Griffith) Kuntze; *P. montanus* (T. Anderson) Kuntze.

It is uniquely identified by the nodes and internodes. The climber climbs upto ca. 30 m. The shoot of this plant is used as vegetable and is available in the market of hilly region of Sikkim Himalaya.

Fl. and **Fr**.: May to November.

Distribution: India: Sikkim: 7000 ft-8500 ft.; China, Bhutan, India, Laos, Myanmar, Nepal, Thailand, Vietnam.

7. ***Camphylandra aurantiaca*** Baker, J. Linn. Soc., Bot. 14: 582. 1875. Family: Asparagaceae; Local name: Ree Sa perfyek (L), Himal ko Nakima (N).

Synonyms:

Tupistra aurantiaca (Baker) Wall. ex Hook. f.; *Rohdea aurantiaca* (Baker) N. Tanaka.

Plant is ca. 20-25 cm tall. The short rhizome of ca. 2 cm thick contains dense nodes. Leaves are linear, ca. 18 cm length and has spikes inflorescence whereon the densely packed flowers arrange with several sterile bracts. Its inflorescence is palatable that is bitter in taste. This inflorescence is used as vegetable as well as pickle.

Fl.: April-May. **Fr.**: August-September.

Distribution: India: Sikkim: 4500 ft. to 6000 ft.; China, Nepal, Bhutan, Nepal.

8. ***Chenopodium album*** L. Sp. Pl. 1: 219. 1753. Family: Amaranthaceae; Local Name: Generi (N).

Synonyms:

Atriplex alba (L.) Crantz; *Atriplex viridis* (L.) Crantz; *Anserina candidans* (Lam.) Montandon.

It is an annual herb and its height is ca. 2.5 ft. Its young aerial part is used as vegetable.

Fl.: May-July. **Fr.**: September-October.

Distribution: India: Sikkim: 1500 ft. to 5000 ft.; widely distributed across the world like China, Nepal, Vietnam, Bhutan and tropical areas.

9. ***Dioscorea bulbifera*** L. Sp. Pl. 2: 1033. 1753. Family: Dioscoreaceae; Local Name: Kuching (L), Ghetha (N).

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Synonyms:

Helmia bulbifera (Linnaeus) Kunth.

It is a perennial plant having bulbils in the leaf axils of the twining stems and the tubers in the ground. The tubers and bulblets are used as palatable food by boiling.

Fl.: July-October. **Fr.**: August-November.

Distribution: India: Sikkim: upto 2300 m. China, Bhutan, Cambodia, Japan, Korea, Myanmar, Thailand, Vietnam; Africa, Oceania.

10. *Dioscorea glabra* Roxb. Fl. Ind. ed. 1832. 3: 804. 1832. 'Punzok Buk'. Family: Dioscoreaceae; Punzok Buk (L); Ban Tarul (N).

Synonyms:

Dioscorea glabra var. *longifolia* Prain & Burkill; *D. hongkongense* Uline ex R. Knuth; *D. nummularia* Roxburgh (1832).

The white cylindrical tuber is an essential item in the cultural aspect of the community. It is used during the festival, Magasagrati of Nepali community. The tubers are used as vegetable.

Fl.: September to December. Rhizome harvesting Period: December-March.

Distribution: India: Sikkim: ca. 700 ft. upto 6000 ft. Bhutan, Cambodia, India, Indonesia, Laos, Malaysia, Myanmar, Thailand, Vietnam.

11. *Dioscorea pentaphylla* L. Sp. Pl. 2: 1032. 1753. Family: Dioscoreaceae; Byagur (N), Kushok (L).

Synonyms:

Dioscorea changjiangensis F. W. Xing & Z. X. Li; *D. codonopsidifolia* Kamikoti.

The stem of climber plant bears thorns measuring ca. 3 mm long. It has petiolate, ovate and palmate leaves having 3-7 leaflets. The size of the bulb is c. 10-30 cm. Rhizome is c. 15-25 cm diameter and c. 15-25 cm long.

The rhizome is the palatable part that uses as vegetable.

Fl.: August- September. **Fr**.: January-February.

Distribution: India: Sikkim: ca. 700 ft. upto 6000 ft.; Bangladesh, India, Indonesia, Japan, Laos, Malaysia, Myanmar, Nepal, New Guinea, Philippines, Vietnam; Africa, Australia, Pacific Islands.

12. *Diploknema butyracea* (Roxb.) H.J. Lam. Bull. Jard. Bot. Buitenzorg, sér. 3. 7: 186. 1925. Family: Sapotaceae; Local Name: Yelpot (L), Cheurifal (N).

Synonyms:

Bassia butyracea Roxburgh, Asiat. Res. 8: 477. 1808.

Tree is upto 25 m tall. It bears ovoid-globose to oblong fleshy exocarp fruit. The fruits of this plant fetch good market in the Himalayan region. The bark of *Diploknema butyracea* (Roxb.) Lam. is used as antihelmintic for treating animals. Its harvesting period is August to September and available at the altitudinal ranges of 1200 -5000 ft.

Fl.: January-April. **Fr.**: June-August

Distribution: India: Sikkim: upto 5000 ft.; Bhutan, Nepal, China.

13. *Eryngium foetidum* L. Sp. Pl. 1: 232. 1753. Family: Apiaceae; Lcoal name: Ausu (L), Bhotay dhanya (N).

Synonyms:

Eryngium antihystericum Rottler.

Plant is ca. 8-40 cm tall from a basal rosette. It has taproot fusiform with fibrous roots having cylindrical flowers head and ovoid to globose fruit. It is one of the traditional spices.

Fl.: April-May. **Fr.**: April- December.

Distribution: India: Sikkim: naturally growing at the elevation of 4500 ft.; China, Bhutan, Nepal.

14. *Fagopyrum dibotrys* (D.Don) Hara. Fl. E. Himal. 69. 1966. Family: Polygonaceae; Local Name: Punzok Khurhu (L); Jungali Phapar (N).

Synonyms:

Polygonum dibotrys D. Don, Prodr. Fl. Nepal. 73. 1825;? *Fagopyrum acutatum* (Lehmann) Mansfeld ex K. Hammer; *Fagopyrum cymosum* (Treviranus) Meisner; *F.*

megaspartanium Q. F. Chen; *F. pilus* Q. F. Chen;? *P. acutatum* Lehmann; *P. cymosum* Treviranus; *P. labordei* H. Léveillé & Vaniot; *P. tristachyum* H. Léveillé; *P. volubile* Turczaninow.

Perennial plant is ca. 5.5 ft. tall with black brown rhizome. It has terminal or auxiliary, corymbose inflorescence and has achenes blackish brown seeds. Its young shoots are used as vegetable.

Fl.: April-October. **Fr.**: September-November.

Distribution: India: Sikkim: 5000 ft. to 6500 ft.; China, Bhutan, Myanmar, Nepal, Vietnam.

15. *Guizota abyssinica* (Linnaeus f.) Cassini in F. Cuvier, Dict. Sci. Nat. 59: 248. 1829. Family: Asteraceae; Local Name: Phelingay (N).

Synonyms:

Anthemis mysorensis DC., *Bidens ramtilla* Wall., *Buphthalmum ramtilla* Buch.-Ham. ex Wall., *Guizotia oleifera* (DC.) DC

Plant is annual that grows upto 6 ft. tall. The eatable part, achene fruit, is a triangular black fruit with thin pericarp.

Fl.: August to September. **Fr.**: September- October

Distribution: India: Sikkim: Tropical region to 4000 ft.; Nepal, Bhutan.

16. *Mangifera sylvatica* Roxb. Fl. Ind. 2: 438. 1824. Family: Anacardiaceae; Local Name: Punzok Ambipot (L), Chuche Aanp (N).

Tree is upto ca. 20 m tall having branchlets dark brown and glabrous. It has drupe oblique fruit that has apex elongated into a curved beak, thin mesocarp and large endocarp.

Fl.: April-May. **Fr.**: June-August.

Distribution: India: Sikkim: upto 4000 ft.; Bangladesh, Bhutan, Cambodia, Myanmar, Thailand.

17. *Nasturtium officinale* R.BR. W. T. Aiton, Hortus Kew. 4: 110. 1812. 'Khaney Bee'. Family: Brassicaceae; Local name: Khaney Bee (L), Simrayo (N).

Synonyms:

Sisymbrium nasturtium-aquaticum Linnaeus, Sp. Pl. 2: 657. 1753; *Rorippa nasturtium-aquaticum* (Linnaeus) Hayek.

Herb is perennial, rhizomatous and aquatic plant. Its young leafy part is used as vegetable and is available at market of Sikkim. The user believed that the plant is nutritious with potential of curing diseases like hypertension, anemia etc.

Fl.: April to September. **Fr.**: September- October.

Distribution: India: Sikkim: upto 6000 ft.; Bhutan, Nepal.

18. *Pandanus furcatus* Roxb. Family: Pandanaceae; Local name: Suhu roo boar (L).

Synonyms:

Barrotia diodon Gaudich.; *Pandanus crassipes* Wall. ex Balf. f. *Pandanus diodon* (Gaudich.) Martelli.; *Pandanus horridus* Reinw. ex Blume.; *Pandanus nepalensis* H.St.John.; *Pandanus spinifructus* Dennst.; *Rykia furcata* (Roxb.) de Vriese.

It is also called Himalayan Screw Pine. The plant is ca. 17 m tall and has branched aerial roots. It has long dark green leaves, c. 5 m long and c. 10 cm wide. The inner cortical and pith portion of its stem are used as vegetables.

Fl.: December-January. **Fr.**: April-May.

Distribution: India: Sikkim: upto 4000 ft. Nepal, Bhutan.

19. *Paris polyphylla* Sm. Rees, Cycl. 26: Paris no. 2. 1813. Family: Araceae; Local Name: Satuwa (N).

Synonyms:

Daiswa polyphylla (Sm.) Raf.

In the recent time, the species is domesticated in Sikkim for both medicinal as well as vegetable uses. The useful part of *Paris polyphylla* Sm. is the rhizome.

Fl.: August-September. **Fr.**: October-November.

Distribution: India: Sikkim: 5000-6500 ft. Bhutan, Laos, Myanmar, Nepal, Thailand, Vietnam.

20. *Perilla frutescens* (Linnaeus) Britton, Mem. Torrey Bot. Club. 5: 277. 1894. Family: Lamiaceae; Local name: Nuhum (L), Silam (N).

Synonyms:

Perilla albiflora Odash.; *Perilla albiflora* Odash; *Perilla ocymoides* L.; *Melissa cretica* Lour. ; *Melissa maxima* Ard. ; *Mentha perilloides* Lam.

Plant is ca.0.3-2 m tall that has light gray-deep brown nutlets. These light grey seeds are used an ingredient for the preparation of traditional foods.

Fl.: Aug-September. **Fr.**: October-December.

Distribution: India: Sikkim: upto 5500 ft. Bhutan, Cambodia, Indonesia, Japan, Korea, Laos, Vietnam.

21. *Ribes glaicale* Wall. in Roxburgh, Fl. Ind. 2: 513. 1824. Family: Grossulariaceae Local name: Kimbu (N).

Plant attains ca. 2-3 m tall with glabrous branchlets and receme inflorescence. Leaves are serrate and narrowly ovate with pinkish petiole. Its subglobose red fruit is sour in taste. It is used as one of the fruit items.

Fl.: April-June. **Fr.**: July-September.

Distribution: India: Sikkim: 4000-7000 ft. Bhutan, Myanmar, Nepal.

22. *Solanum incanum* L., Sp. Pl. 188. 1753. Family: Solanaceae; Local name: Sohor Pot (L), Bee (N).

Synonyms:

Solanum bojeri Dunal; *Solanum campylacanthum* Hochst.; Solanum delagoense Dunal; *Solanum lichtensteinii* Willd.; *Solanum panduriforme* E. Mey

Plant is ca. 3.5 ft. tall. It bears fruits ca. 3 cm long and 2 cm diameter. Fruits are used as vegetable.

Fl.: November-March. **Fr.**: March-August

Distribution: India: Sikkim: upto 5500 ft. Iran, Syria, Egypt, Ethiopia, Sudan, Arabia, Pakistan, Nepal, Bhutan.

23. *Heracleum nepalense* D. Don, Prodr. Fl. Nepal. 185. 1825. Family: Apiaceae; Local Name: Sangbyen (L), Chimping (N).

Synonyms:

Heracleum nepalense var. *bivittatum* C. B. Clarke; *Tetrataenium nepalense* (D. Don) Mandenova.

Plant is about 2 m high having cylindrical root. It has solitary stem with long petiolate, broad ovate to lanceolate leaves. Fruit is obovoid.

It is used for the aroma of the pickles and is also used in the traditional foods.

Fl.: June-August. **Fr.**: September-October.

Distribution: India: Sikkim: 5500 ft to 7000 ft. Bhutan, Myanmar, Nepal.

24. *Phlogacanthus curviflorus* (Wall.) Nees. Wallich, Pl. Asiat. Rar. 3: 99. 1832. Family: Acanthaceae; Local Name: Titey (P).

Synonyms:

Justicia curviflora Wallich.

Shrub is ca. 5 ft. tall. Its inflorescence is used for making traditional delicious foods like Wachipa and Bomchipa of Rai community. It is bitter in taste. The fresh and dried flowers of *Phlogacanthus curviflorus* (Wall.) Nees. are bought to the market for sale.

Fl.: March-April. **Fr.**: April-May

Distribution: India: Sikkim: upto 5500 ft.; Bhutan, Laos, Myanmar, Thailand, Vietnam.

25. *Phytolacca* acinosa Wall. Fl. Ind., ed. 1832. 2: 458. 1832. Family: Phytolaccaceae; Local Name: Zadim (L), Jaringo (N).

Synonyms:

Phytolacca esculenta Van Houtte; *P. pekinensis* Hance.

Plant attains 2-4 ft. tall and bears thick fleshy roots. Leaves are petiolate, ovate to lanceolate. Its inflorescence is spike with fleshy berry fruit embedded with black

reniform, compressed seeds. Young Leaves and stems are used as vegetative from April to August.

Fl.: June-August. **Fr.**: September to October.

Distribution: India: Sikkim: upto 5500 ft.; Bhutan, Japan, Korea, Myanmar, Vietnam.

26. *Zanthoxylum oxyphyllum* Edgew. Trans. Linn. Soc. London. 20: 42. 1846.
Family: Rutaceae; Local Names: Siltimbur (N); Kundu (L).

Synonyms:

Fagara oxyphylla (Edgeworth) Engler; *Zanthoxylum alpinum* C. C. Huang; *Z. taliense* C. C. Huang; *Z. tibetanum* C. C. Huang.

A small tree is upto 10 m having prickles in the branchlets and leaf rachises. The leaves are used to repel the leech and is also used for the medicinal purposes. The seeds of this plant are used for the preparation of traditional food items.

Fl.: May-June. **Fr.**: September-October.

Distribution: India: Sikkim: 5500-7000 ft.; China, Bhutan, Myanmar, Nepal.

Thus, the study of plant species of wild habitats in the cultivable land is to record the species which still persist the attributes of wild taxa. The domestication of such plant species in the farming area, in due course, may retain some phenotypic characters in the process of natural selection which could possibly manifest diversity in future although these are not prevalent at present.

So, the study caters a support in future for the substantial study of domestication of species of Sikkim and adjoining areas.

Moreover, the domestication activity reduces the exploitation of forest resources. Nonetheless, some of the species are decreasing their population in the forest areas, which require protecting and preserving.

Another point is that most of these species are now available in market in sizable volumes and fetch good markets. Thus, the future possibility of development of new cultivars cannot be ignored. Other beneficial of this domestication is that there will be less exploitation of the forest resources at sources.

But still, the study warrants more researches in the process of species selection, cultivar development, economy, impact on forest population to name a few.

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