Vegetables

9

9.1 Introduction

Most population of the Indian Subcontinent is predominantly vegetarian. The local tribes and communities have domesticated a large amount of plant species as vegetables and/or use them as alternative food, involving several genera, such as *Cucumis*, *Coccinia*, *Luffa*, *Momordica*, *Trichosanthes*, *Solanum*, *Abelmoschus*, *Amorphophallus*, etc. Additionally, wild species diversity of certain exotic crops has either been extended or introduced to the subcontinent, such as *Amaranthus*, *Dioscorea*, etc. Predominant wild species diversity in the Indian Subcontinent occurs for tropical cucurbitaceous, solanaceous, and leguminous vegetable crops and some others, like okra. In addition, wild species diversity is also found in several leafy and rooty, tuberous, and bulbous vegetable crop species, many of whom are directly harvested from the natural habitat by local tribal communities. The complexity of species diversity using different plant parts as vegetables justifies the classification of vegetable crops into three groups, fruity vegetable, leafy vegetable, and root and tuber crops.

Among the cucurbitaceous vegetables, a number of wild taxa occur in genera *Citrullus*, *Cucumis*, *Luffa*, *Momordica* (Fig. 9.1), and *Trichosanthes*. Recently, Renner and Pandey (2013) have listed 94 accepted species, including ten endemics. Important ones are, namely, *Citrullus colocynthis*, *Cucumis hardwickii*, *C. setosus*, *C. hystrix*, *Luffa graveolens, L. acutangula* var. *amara*, *L. cylindrica*, *L. tuberosa*, *L. echinata, Momordica cochinchinensis* (syn. *M. macrophylla*), *M. subangulata*, *M. cymbalaria* (syn. *M. tuberosa)*, *M. dioica*, *M. denticulata*, *M. balsamina*, *Siraitia sikkimensis*, *Trichosanthes anamalaeiensis*, *T. bracteata*, *T. cordata*, *T. cucumerina*, *T. cucumeroides*, *T. dioica*, *T. lobata*, *T. khasiana*, *T. ovata* (syn. *T. truncata*), *T. tricuspidata* (syn. *T. nervifolia*), *T. perottetiana*, and *T. wallichiana*, based on the checklist of Chakravarty (1982). In *Luffa*, most of the species occur in disturbed lands, forest openings, etc. *Luffa acutangula* var. *amara* occurs in Peninsular India and is the wild type related to the cultivated ridge gourd. *Luffa echinata* occurs in the Western Himalayas, the upper Gangetic plains, and Central India, and

A.K. Singh, *Wild Relatives of Cultivated Plants in India*,
DOI 10.1007/978-981-10-5116-6_9

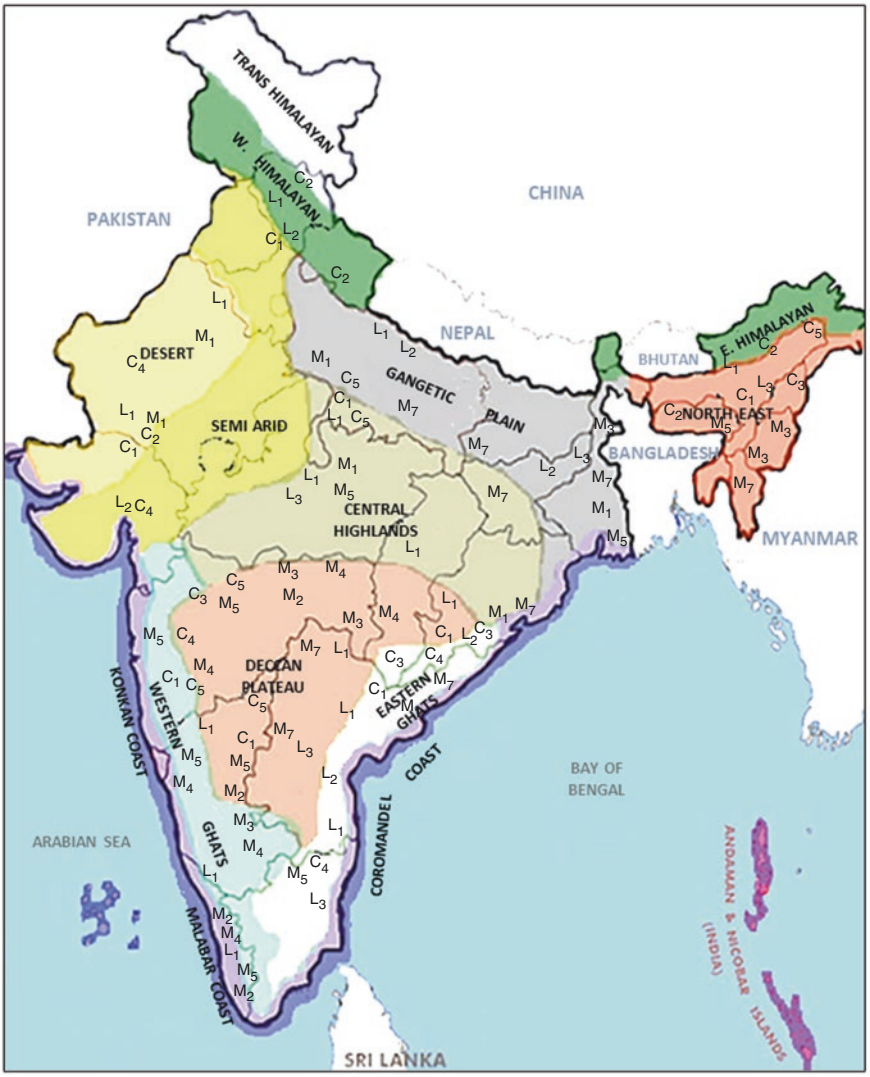

Fig. 9.1 Biogeographical regions associated with distribution of wild species of fruity cucurbitaceous vegetables, *Cucumis*, *Luffa*, *Momordica*
C1 = *Cucumis callosus*; C2 = *C. hardwickii*; C3 = *C. hystrix*; C4 = *C. prophetarum*; C5 = *C. trigonus*; L1 = *Luffa acutangula*; L2 = *L. echinata*; L3 = *L. graveolens*; M1 = *Momordica balsamina*; M2 = *M. charantia muricata*; M3 = *M. cochinchinensis*; M4 = *M. cymbalaria*; M5 = *M. dioica*; M6 = *M. sahyadrica*; M7 = *M. subangulata*

L. graveolens (considered a wild progenitor of *L. hermaphrodita*) in Maharashtra, Bihar, and northward to Sikkim and West Bengal (Fig. 9.1). In *Momordica*, *M. balsamina* occurs in semi-arid northwestern plains and only sporadically elsewhere in upper Gangetic region and in the northern parts of Western and Eastern Ghats.

Momordica dioica and *M. cochinchinensis* occur wild/semi-wild in the Gangetic plains extending eastward. *Momordica cymbalaria* is restricted to the Deccan Plateau, Maharashtra, and southward, with only sporadic occurrence in the eastern peninsular region. *Momordica subangulata* and *M. cochinchinensis* occur largely in the northeastern region (Fig. 9.1). *Trichosanthes* is the most species-rich genera with 22 species occurring in India, and the major zones of species concentration are (a) along the Malabar coast in Western Ghats and (b) low and medium elevation zones (up to 1500 m) in Eastern Ghats and northeastern region. Contiguous regions are major areas of distribution of the wild types of potential importance. *Trichosanthes cucumerina* occurs in the northeastern region, along with semi-wild *T. dioica*. A widely distributed species, *T. bracteata*, occur in eastern India, extending to the south and sporadically in the Himalayas (1500 m). *T. cordata* (related to *T. bracteata*) occurs in the peninsular region, extending to northeastern plains and hills. *Citrullus colocynthis* exhibits much variation in northwestern arid and semi-arid plains, whereas in *Cucumis*, the wild species related to cultivated cucumber (*Cucumis sativus*), *C. hardwickii* occur mostly in the Himalayas or hills. *C. callosus*, distributed in Indo-Malayan region, is found throughout the Peninsular India including the hills. Localized variability of *Cucumis setosus* is restricted to Maharashtra and eastern plains, while *C. hystrix* extends its range from eastern plains to northeastern hills in Assam, Tura Range in Meghalaya, and Mishmi hills, and, in the drier northwestern plains, *C. prophetarum* (Fig. 9.1).

In non-tuberiferous *Solanum* species, the maximum diversity has been observed in South India, foothills of Himalayas, and the northeastern region (Fig. 9.2). *Solanum torvum*, *S. indicum*, *S. insanum*, *S. surattense*, *S. khasianum*, and *S. pubescens* are the widely distributed species in these areas. *Solanum melongena* complex has three species, namely, the *S. melongena, S. incanum* (syn. *S. coagalans*), and *S. melongena* var. *insanum.* Phylogenetically, they are very closely related. More variability in *S. incanum* occurs in northwest plains of India; in *S. insanum* in eastern peninsular tract; and in primitive cultivated form, the potangi type of *S. melongena*.

In leguminous vegetables, the humid tropical belt of Western Ghats is reported to have wild species of *Canavalia*, particularly in the lowland forests along the coast. Between the two distinct species found, the *C. cathartica* (syn. *C. virosa*) and *C. obtusifolia*, the latter is related to cultivated sword bean, *C. gladiata*. Another climbing large flowering shrubby bean, *C. stocksii* Dalz., a native of Mahabaleshwar (Maharashtra), is possibly a rare variant of cultivated *C. ensiformis*, which has now been treated as part of *C. cathartica*. The northeastern region (Manipur and Mizoram) is another area of diversity for both wild and cultivated forms of sword bean.

Diversity occurs in India for the wild relatives of Okra (*Abelmoschus esculentus*). Nine species and two varieties, namely, *A. angulosus*, *A. tuberculatus*, *A. manihot*, *A. moschatus*, *A. ficulneus*, *A. esculentus*, *A. crinitus*, *A. caillei*, and *A. tetraphyllus* var. *tetraphyllus*, *A. tetraphyllus* var. *pungens*, occur in India. The nearest wild related species to cultivated okra is *A. tuberculatus*, which sporadically occurs in fields/field margins. *Abelmoschus tuberculatus* is confined to north/

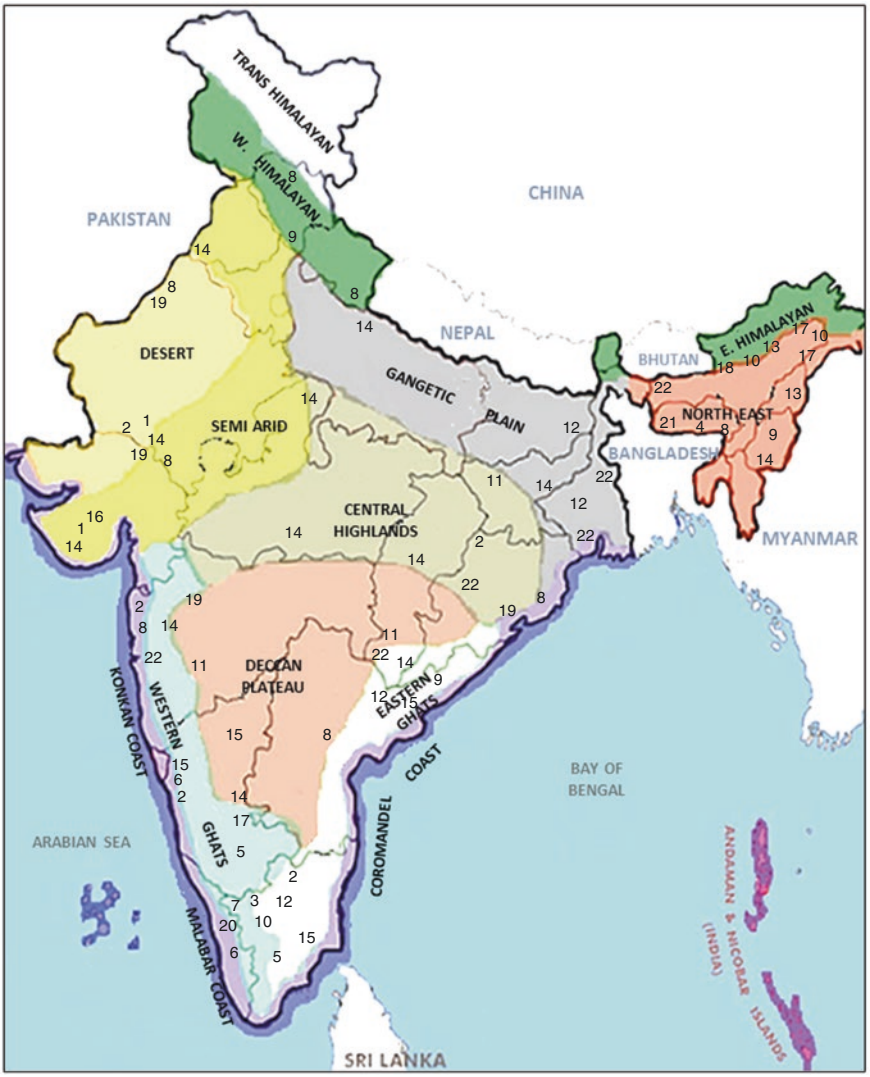

Fig. 9.2 Biogeographical regions associated with distribution of wild *Solanum* species
1 = *Solanum albicaule*; 2 = *S. anguivi*; 3 = *S. barbisetum*; 4 = *S. dubium*; 5 = *S. erianthum*; 6 = *S. giganteum*; 7 = *S. grandiflorum*; 8 = *S. incanum*; 9 = *S. khasianum*; 10 = *S. kurzii*; 11 = *S. mammosum*; 12 = *S. melongena insanum*; 13 = *S. myriacanthum*; 14 = *S. nigrum*; 15 = *S. pubescens*; 16 = *S. purpureilineatum*; 17 = *S. sisymbriifolium*; 18 = *S. spirale*; 19 = *S. torvum*; 20 = *S. vagum*; 21 = *S. viarum*; 22 = *S. surattense*

northwestern plains, often along field borders and except for its tuberculate hard fruits (up to 8 cm long) looks unmistakably like the cultivated okra. Variability in *A. pungens* and *A. tetraphyllus* occurs in the sub-Himalayan range, the former in northeastern belt and the latter in the northwestern *terai* region. Wild *Abelmoschus*

species are also available in the Western Ghats (three of the six spp.): *A. angulosus*, a polymorphic taxon with greater variation in Karnataka and Nilgiri hills, and also *A. manihot* (including *A. pungens*) and *A. ficulneus*.

Among leafy vegetables, northern plains are the major area of variability, where wild types of *Amaranthus*, *Chenopodium*, *Rumex*, and *Malva* are found as common weeds. Predominant ones are *Amaranthus* spp., particularly *A. spinosus*, *Malva rotundifolia*, *M. sylrestris*, and *Chenopodium album.*

In case of tuberous vegetables, which may be the plant roots or non-root tubers of modified plant stem, such as rhizomes, corm, or bulb, the subcontinent is blessed with greater variability in tuberous root type such as *Amorphophallus* and *Dioscorea*, modified stem type such as *Colocasia*, and bulb such as *Allium* spp. About 50 species of *Dioscorea* are found wild, including four cultivated, largely in the west, east, and northeast regions. Other tuberous species are represented by *Amorphophallus paeoniifolius*, *Alocasia macrorrhiza*, *Colocasia esculenta*, *Dioscorea alata*, *D. rotundata*, *D. esculenta*, *D. bulbifera* var. *sativa*, *Ipomoea batatas*, *Manihot esculenta*, and *Xanthosoma sagittifolium*. Besides these crops, there are several minor tuber crops, namely, *Canna edulis*, *Maranta arundinacea*, *Moghania vestita*, *Psophocarpus tetragonolobus*, *Pachyrrhizus erosus*, and *Solenostemon rotundifolius*, found in western peninsular region. In bulbs, around 30 species represent *Allium*, which is naturally distributed in India. The cultivated species are *Allium cepa* var. *cepa*, *A. cepa* var. *aggregatum*, *A. cepa* var. *viviparum*, *A. fistulosum*, *A. tuberosum*, *A. sativum*, *A. ampeloprasum* var. *porrum*, and *A. schoenoprasum*, whereas *A. carolinianum*, *A. chinense*, *A. consanguineum*, *A. humile*, *A. przewalskianum*, *A. stoliczkii*, *A. stracheyi*, *A. victorialis*, and *A. wallichii* occur wild in the Himalayan region. The production of hybrid between leek and garlic demonstrates the scope interspecific hybridization (Yanagino et al. 2003).

9.2 Wild Species Found in India

9.2.1 Fruity Vegetable

1. ***Abelmoschus angulosus* Wall. ex Wight & Arn. (Malvaceae)**. Prickly annual shrub. Native to moist deciduous, semi-evergreen, and shola forests of tropical Asia, including the Western Ghats, up to 1600 m, and forests of Gujarat, Maharashtra, Kerala, and Tamil Nadu. Source of resistance to yellow vein mosaic virus (YVMV) and mites and tolerance to low temperatures and light frost
2. ***Abelmoschus caillei* (A. Chev) Stevels**. Annual, erect hardy plant with large leaves, thick stem, and unique-shaped fruits. Native of Africa and naturalized to the Indian Subcontinent in Western Ghats. It appears close to *A. esculentus* (L.) Moench and *A. manihot* ssp. *tetraphyllus*. Segregating populations involving *A. caillei* and ssp. *tetraphyllus* have been found in Karnataka (Velayudhan et al. 2007). Source of resistance to YVMV and shoot and fruit borer.

3. ***Abelmoschus crinitus* Wall.; syn. *A. cancellatus* (L.f.) J.O. Voigt**. An erect, perennial herb, around 1.5 m tall. Habitat to deciduous forests and wastelands of China, Indo-Malaysia, and India, including Northwest Himalayas, upper Gangetic Plains, and Peninsular India, extending down to the south. Source of resistant *Cercospora* blight.
4. ***Abelmoschus ficulneus* (L.) Wight & Arn**. Stout annual weedy herb, up to 1.5 m tall (Fig. 9.3a). Native to Africa and tropical Asia, including India, extending from Jammu and Kashmir to southern Western Ghats. Yields a white fiber for twine and possesses medicinal properties and a genetic resource.
5. ***Abelmoschus manihot* (L.) Medik**. It is a perennial plant, growing up to 2 m tall. Native of Asia, in India found in tropical and subtropical zones, consisting of middle and lower Gangetic Plains and Southern Deccan Plateau. Grown as ornamental, vegetable, and fiber crop and used for gum/resin. Source of resistant to YVMV. Van Borssum Waalkes, in 1966, classified morphological variation into two subspecies, **ssp. *manihot* (L.) Medik**., mainly consisting of cultivated erect herb types with smooth stems (wild and weedy forms found in coastal plains of Western Ghats and West Bengal), and **ssp. *tetraphyllus* (Hornem.) Borss. Waalk.,** with prickly habit. Within ssp. *tetraphyllus*, Van Borssum Waalkes described two different botanical varieties: variety *pungens* (Roxb.) Hochr., which is distributed in Asia, including tropical Himalayas, middle and lower Gangetic Plains, and northeastern India and a source for resistance to enation leaf curl virus, and variety *tetraphyllus* (Roxb. ex Hornem.) Hochr., which is distributed in sub-Himalayan region, Upper Gangetic, and northwestern plains. Additionally, a large seeded variety *megaspermus* Hemadri is found in Central India (Gujarat, Maharashtra, and Madhya Pradesh) on shady hill slopes and foothills.
6. ***Abelmoschus moschatus* Medik**. Musk okra, an aromatic (essential oils) and medicinal, tropical perennial weedy shrub, valued for its scented seed, is used for flavoring. Native to Asia, including central Himalayas, Eastern Ghats, and Andaman table Islands, the morphological variation has given rise to subspecies *moschatus* and ssp. *tuberosus* (Span.) Borss. Waalk (ornamental), found in Karnataka, Kerala, and Tamil Nadu. Cultivated.
7. ***Abelmoschus tuberculatus* Pal & Singh**. Herb or undershrub, found in semi-arid regions of North and Northwestern India. A close relative of *A. esculentus* but differs by its strigose hairs on the stem and shorter capsules. A spontaneous hybrid between *Abelmoschus tuberculatus* and *A. esculentus* has been reported (Nair and Kuriachan 1976). Tolerant to YVMV and fruit borer.
8. ***Canavalia cathartica* Thours; syn. *C. virosa* (Roxb.) Wight & Arn. (Fabaceae/Leguminoseae)**. Perennial climber or trailer (Fig. 9.3b), native to Africa and Asia, including northeastern region, Eastern Ghats of Peninsular India, and Australia. Grows even in mangroves. A neglected wild bean, consumed by Malayali tribes in Tamil Nadu as staple food after soaking seeds in water. Anti-poisonous. Occasionally cultivated. Source of nutritional traits for jack bean *C. ensiformis*.

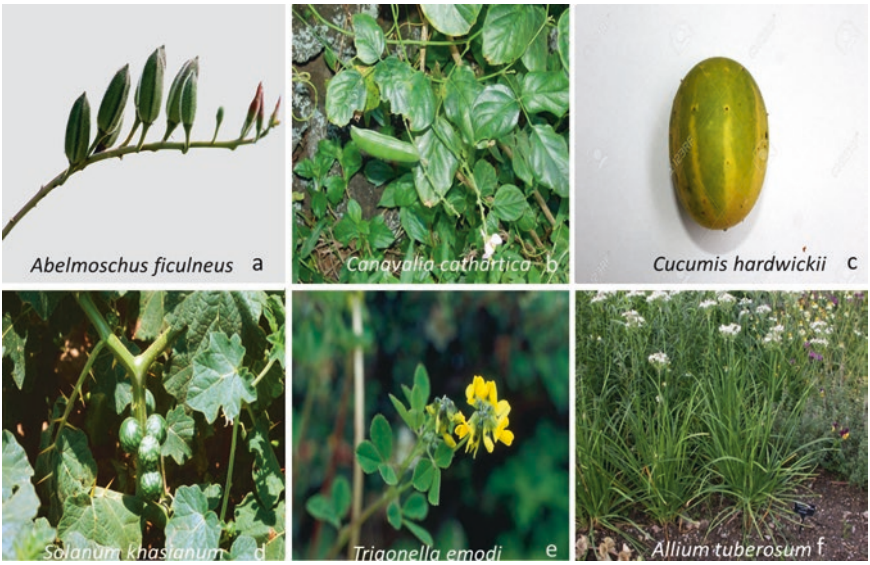

Fig. 9.3 Representative wild relatives of economically important vegetable crops: (**a**) *Abelmoschus ficulneus*, (**b**) *Canavalia cathartica*, (**c**) *Cucumis hardwickii*, (**d**) *Solanum khasianum*, (**e**) *Trigonella emodi*, and (**f**) *Allium tuberosum*

9. ***Canavalia rosea* (Sw.) DC.; syn. *C. obtusifolia* DC., *C. maritima* (Aubl.) Thouars**. Coastal jack bean, a trailing herbaceous vine. Pantropical distribution including the coastal habitats of western Peninsular India and Andaman Islands. A rare variant of cultivated *C. ensiformis* gene pool. Based on probable affinities with *C. gladiata*, it belong to secondary gene pool of sword bean. Highly salt tolerant.
10. ***Citrullus colocynthis* Schrad. (Cucurbitaceae)**. A drought hardy desert vine. Native to northern Africa to Mediterranean Basin, extending and naturalizing in fallow land of arid and semi-arid zone of northwestern plains of India. Seeds are rich in oil and can be source of biofuel and also used medicinally. It is a member of secondary gene pool of watermelon. Natural hybrid between *C. lanatus* and *C. colocynthis* has been reported (Singh 1978). Potential source for drought tolerance and pest resistance.
11. ***Cucumis callosus* (Rottl.) Cogn.; syn. *C. trigonus* Roxb.; *C. melo* L. subsp. *agrestis* (Naudin) Pangalo**. A feral vine found in semi-arid regions of most of the Indian Subcontinent, particularly in northwest and central plains, and Eastern Ghats. Progenitor and member of primary gene pool of *C. melo* (John et al. 2013). Reported to possess genes for resistance to fruit fly and leaf-eating caterpillars. *Turbinatus* types possess edible fruits.
12. ***Cucumis hardwickii* Royle; syn. *C. sativus* L. var. *hardwickii* (Royle) Alef**. An annual monoecious climber (Fig. 9.3c) found in the foot hills of Himalayas and those of Gangetic Plains and other hills. Member of primary gene pool of *C. sativus*, being a wild sympatric taxa having 2n = 14, with which it hybridizes readily and considered its progenitor. It is cold tolerant and resistant to powdery mildew.

13. ***Cucumis hystrix* Chak**. A rare scandent herb with white hirsute stem, climbing by tendrils. Native to Asia including northeastern hills of India, with 2n = 24. Genetic resource, as member of tertiary gene pool of *C. sativus*, based on successful interspecific hybrid obtained between *C. sativus* and *C. hystrix* (Chen et al. 1997) and of *C. melo* based on distant affinities (Sebastian et al. 2010). An amphidiploid species (*Cucumis* x *hytivus* Chen and Kirkbride, 2n = 38) was produced by chromosome doubling of hybrid (Chen and Kirkbride 2000). These facts indicate the possibility of gene introgression from *C. hystrix* to both cultivated species of *Cucumis* with 2n = 24 and 2n = 14.
14. ***Cucumis prophetarum* L**. A monoecious gray-green perennial trailer, habitat to dry areas of semi-evergreen forests of arid and semi-arid Indus and northwestern plains and parts of Peninsular India. Genetic resource, as member of secondary gene pool of West Indian gherkin *C. anguria* and tertiary of *C. melo* and *C sativus* (Sebastian et al. 2010). Used in treatment of inflammation in Indian medicine system.
15. ***Cucumis ritchiei* (Clarke) H Schaef**. Prostrate or climbing hirsute herbs. Habitat to hedges and bushes in Peninsular India. Genetic resource, member of tertiary gene pool of *C. anguria* and *C. melo* (Sebastian et al. 2010).
16. ***Cucumis setosus* Cogn**. A rare, endemic, wild, or semidomesticated vegetable restricted to Maharashtra and adjoining states of India (Gangetic plains, Bundelkhand). Member of primary gene pool of *C. sativus*, distinct, without bitter principle (John et al. 2014).
17. ***Dolichos uniflorus* Lam.; syn**. ***Macrotyloma uniflorum* var. *uniflorum* (Fabaceae/Leguminosae)**. Horse gram or *kulthi*, growing wild as annual herb in Western Ghats, Khandala, southward. The variability in these wild types is part of primary gene pool of horse gram, used for food and fodder.
18. ***Lablab purpureus* (L.) Sweet.; syn. *L. niger* Medik (Fabaceae/Leguminosae)**. An herbaceous, twining plant. Native of Africa, escaped to the wild in India. Available variants have been classified into long-podded var. *lignosus* (Linn.) Prain, synonym of cultivated *Lablab purpureus*, hyacinth bean or *seim*, found in eastern coast of Andhra Pradesh. Small-podded, drought hardy types, var. *typicus* Prain is restricted to scrub jungles. Besides being a vegetable, it is used as pulse, fodder, soil improver, etc.
19. ***Luffa acutangula* var. *amara* (Roxb.) Clarke. (Cucurbitaceae)**. Monoecious, climbing annual with prominently ribbed ovary. Native to moist deciduous forests all over India. Medicinal, fruits used in vata, kapha anemia, asthma, leukoderma, tumors, etc. Member of primary gene pool of cultivated ridge gourd, *L. acutangula*.
20. ***Luffa echinata* Roxb**. It is a spreading climbing herb of tremendous medicinal value (antiulcer). Native to Africa and Indian Subcontinent, distributed all over, particularly northwestern Himalayas and upper Gangetic plains. Genetic resource, member of secondary gene pool of ridge gourd, *L. acutangula*, and sponge gourd (*L. cylindrica*), with whom it is crossable, but hybrid is complete sterile (Singh 1990).

21. ***Luffa graveolens* Roxb**. Native to India, widely distributed in north-central and eastern plains and Eastern Ghats, extending up to Tamil Nadu; sporadically occur elsewhere in Eastern Himalayas. Genetic resource, as member of secondary gene pool of ridge gourd and sponge gourd, with whom it is crossable, but produces hybrid with complete pollen sterility (Dutt and Roy 1990).
22. ***Momordica balsamina* L. (Cucurbitaceae)**. Balsam apple, a tendril-bearing monoecious annual vine with red spindle-shaped ripe fruit. Native to Africa and Asia. In India adapted to dry sandy soil as an invasive species in northwestern Indo-Gangetic Plains. A medicinal and nutraceutical plant. Cultivated as an underutilized vegetable.
23. ***Momordica charantia var. muricata* (Willd.) Chakrav**. Wild free-living monoecious annual climber with small round fruit than cultivated *M. charantia*. Native to Africa, tropical Asia, and Australia. In India, it is found in many parts of the subcontinent, including Malabar region. Possesses many medicinal benefits. Part of primary gene pool of *M. charantia* with high crossability and pollen fertility (Bharathi et al. 2012).
24. ***Momordica cochinchinensis* Spreng; syn. *M. macrophylla* Gage**. A tropical dioecious species of South and Southeast Asian origin. In India, distributed in peninsular and northeastern region in humid tropical forests and openings. Fruit traditionally used as vegetable and in medicine. Rich in nutrients including carotenoids, fatty acids, vitamin E, polyphenol compounds, and flavonoids. All dioecious species are closely related (Bharathi et al. 2012) and appear to be a member of secondary gene pool of *M. dioica*.
25. ***Momordica cymbalaria* Fenzl. Ex Hook.f.; syn. *M. tuberosa* (Roxb.) Cogn**. It is a monoecious perennial vine with tuberous roots. Native to Africa and Indian Subcontinent in eastern peninsular tract of Madhya Pradesh, Andhra Pradesh, Karnataka, and Tamil Nadu. Charantin in its leaves and fruits is responsible for medicinal properties. Traditionally used for the treatment of diabetes mellitus and as an antiovulatory agent. Member of secondary gene pool for *M. charantia* and tertiary for *M. dioica* (Bharathi et al. 2012).
26. ***Momordica dioica* Roxb. Ex Willd**. Climbing dioecious herbs with tuberous roots, native to Indo-Malayan region and deciduous and semi-evergreen forests and plains of Western Ghats of India. Cultivated for fruit.
27. ***Momordica subangulata* Blume subsp. *renigera* (Wall. ex G. Don) W.J.de Wilde**. A perennial dioecious species with ovoid fruit having flattened spines. Found in Northeast India. It is a tetraploid and has been successfully crossed with *M. dioica* (Bharathi et al. 2011) producing sterile triploid. Therefore, it is a tetraploid species close to cultivated dioecious species as part of the secondary gene pool (Bharathi et al. 2012).

Another dioecious perennial species *Momordica sahyadrica* earlier considered *M. dioica* is described from a very narrow habitat of Western Ghats (Kattukunnel and Antony 2008).

28. ***Nesphostylis bracteata* (Baker) D. Potter & J.J. Doyle; syn. *Dolichos bracteatus* Baker (Fabaceae/Leguminoseae)**. A perennial climber with purple flowers. Endemic to Indian Peninsula and Western Ghats (largely Konkan Hills). The young pods are eaten; rare and allied to hyacinth bean and *Lablab purpureus*.
29. ***Solanum anguivi* Lam.; syn. *S. indicum* L**. An annual, diffusely branched 1.5 m tall undershrub, prickly with sharp, yellowish spiny berries. Native of Africa, naturalized in tropical and South India (Tamil Nadu). Traditional ethnomedicine; roots are anti-inflammatory, and fruits are used in treatment of diabetes/respiratory disorders. Progenitor of scarlet eggplant (Sakata and Lester 1997) and member of tertiary gene pool of eggplant. Source of resistance to eggplant diseases (*Fusarium* wilt).
30. ***Solanum erianthum* D. Don**. Potato/tobacco tree or *Ban Tamakhu*, a fast-growing evergreen shrub/small tree. Native of Americas and naturalized to tropical Australia and Asia, including the tropical and subtropical India, Andaman's forests, and wastelands. Grown as ornamental and listed as cultivation escape. Eaten in the south, a potential medicinal plant.
31. ***Solanum khasianum* C.B. Clarke**. A bushy annual or short-lived perennial plant (Fig. 9.3d). Found in Western Himalayas, northeastern region, and Eastern Ghats, but common to Meghalaya. A close relative of *S. melongena* (Brinjal) and member of its secondary gene pool with resistance to shoot and fruit borer. Berries are important source of the glycoalkaloid solasodine, a raw material to produce steroidal drugs.
32. ***Solanum kurzii* Brace ex Prain**. A rare perennial shrub species with white-blue flowers and egg-shaped fruits. Native to Himalayas and northeastern region. Used in folk medicine.
33. ***Solanum melongena* Linn var. *incanum* L. and var. *insanum***. Variety *insanum* is an armed subshrub 75 cm tall. Distributed over tropical Asia, including India on roadsides, wastelands, homesteads, in the eastern and southern parts. It is the wild progenitor of the cultivated eggplant, *S. melongena,* and produces fully fertile hybrid. Member of primary gene pool and source of resistance to shoot and fruit borer. Used in Ayurvedic formulations. The distribution range of the other variant *incanum* L. is from Africa to India. It is a member of secondary gene pool and being used as a source of variation for phenolic content and drought resistance as well as to develop ILs (introgression lines).
34. ***Solanum nigrum* L**. Black nightshades or *Mokoi*, an annual weed, erect, much branched, tall up to 0.5 m, with white flowers and fruits, berry, edible. Native to Africa, Europe, and Asia, including India, as weed. Genetic resource with disease resistance (bacterial wilt) for potato (Jansky 2000). Used in folklore medicine.
35. ***Solanum pubescens* Willd**. An unarmed pubescent shrub, habitat to dry deciduous forests, wayside, and shola border of Peninsular India, Karnataka, Kerala, and Tamil Nadu. Needs further investigations.

36. ***Solanum purpureilineatum*** **Sabnis & Bhatt**. A new species reported from Kathiawar, Gujarat, India (Sabnis and Bhatt 1970). Needs to be bio-prospected.
37. ***Solanum sisymbriifolium*** **Lam**. Sticky nightshade, a 1 m-tall densely prickly perennial plant with small edible fruits. Native to South America, naturalized in Eastern Himalayas, India. Member of tertiary gene pool of eggplant. Source of resistance to pest and diseases of eggplant, such as shoot and fruit borer (Collonnier et al. 2001, 2003). Also cultivated as ornamental.
38. ***Solanum spirale*** **Roxb**. A small fruiting shrub found in mid-elevation of 500 to 1900 m in Paleotropical areas of Asia, extending from China to India, Southeast Asia, and Australia. Cultivated in backyard gardens as vegetable and used in local medicine. In addition to Etioline, solaspiralidine, a glycoside, was isolated from its roots (Ripperger 1996).
39. ***Solanum torvum*** **Sw.; syn.** ***S. rudepannum*** **Dunal**. Turky berry, a bushy, erect, and spiny perennial plant 2–3 m tall. Native to Americas and widely naturalized, including in the Indian tropics and the eastern plains. Source of resistance to *Verticillum* wilt, bacterial wilt, and pest. Member of tertiary gene pool of eggplant (Bletsos et al. 1998). Used as root stock for eggplant (Gisbert et al. 2011). Used as vegetable and folklore medicine.
40. ***Solanum vagum*** **Heyne** ***ex*** **Nees**. An unarmed spreading shrub with globose berries, red when ripe, endemic to grasslands of southern Western Ghats.
41. ***Solanum viarum*** **Dunal.; syn. S.** ***khasianum*** **var.** ***chatterjeeanum***. The tropical soda apple or *Khasi kateri* is a perennial shrub with golf ball-sized fruit. Native to South America, invasive and naturalized all over India as an exotic noxious weed. Genetic resource, as a part of the secondary gene pool of tomato and tertiary gene pool of eggplant (Collonnier et al. 2001). Medicinal source of solasodine.
42. ***Solanum virginianum*** **L.; syn.** ***S. surattense*** **Burm. f.,** ***S. xanthocarpum*** **Schard. & H. Wendl**. Yellow-fruit nightshade or *Kateli*, a wild prostrate prickly undershrub. Distributed from India to Polynesia, common up to 2000 m in the warmer parts, particularly of South India. Member of tertiary gene pool of eggplant with disease resistance (Collonnier et al. 2001). Potential source of solasodine and used to treat cough, asthma, and chest pain, considered one of the *Dasamula* of Ayurveda.

Several exotic wild species of African and American origin are cultivated (*Solanum giganteum* Jacq., *S. mammosum* L.) in India, whereas some have naturalized either in specific or many regions, depending on adaptation. For example, *Solanum albicaule* Kotschy ex Dunal and *S. dubium* (Kantakaari) native of Africa are recorded from Saurashtra and Rajasthan and Maharashtra, respectively, whereas *Solanum barbisetum* Nees. and *S. grandiflorum* Ruiz & Pav., native of South America, are naturalized in evergreen forests of Nilgiri Hills and Coimbatore in Tamil Nadu, while *S. myriacanthum* Dunal., native of Mexico and South America, is in Nagaland and Arunachal Pradesh. Some are being used in traditional medicine system and need further investigation for assessing their potential as genetic resource.

43. ***Trichosanthes bracteata*** **Lam.; syn.** ***T. tricuspidata*** **Lour. (Cucurbitaceae)**. A large woody climber, fruits with hard rind, red when ripe. Common on trees and hedges, throughout India, particularly in peninsular region and northeast; var. *bracteata* occurs largely in eastern India, in the Himalayas up to 1500 m, near cultivation lands. Distribution extends southward up to Andaman Islands. Medicinally, one teaspoon of mature seed powder, once a day, is taken by tribes to develop sterility. *Trichosanthes anamalaiensis* Bedd. is now considered its variant.
44. ***Trichosanthes cordata*** **Roxb**. Robust climber, habitat to foot hills of Himalayas from Garhwal to Sikkim and Northeast Hill region, up to 500 m. Doubtful entity, needs further investigations.
45. ***Trichosanthes cucumeriana*** **L**. Monoecious climbing herb with fruits 3–7 x 2.5–5.5 cm. Native to Asia and Australia, including India, particularly Gangetic Plains and Eastern Himalayas. Ancestor of cultivated snake gourd *T. anguina* L., with which it is conspecific and freely cross-compatible (Singh and Roy 1979), with smaller fruit size. Part of primary gene pool of cultivated snake gourd.
46. ***Trichosanthes dioica*** **Roxb**. Pointed gourd/*parwal*. Native to tropical Asia, wild or semi-wild populations occur in Brahmaputra Valley, plains of Assam, and North India, with greater resilience to stresses. Wild forms are part of primary gene pool of cultigens.
47. ***Trichosanthes majuscula*** **(C.B. Clarke) Kundu**.; **syn.** ***T. dunniana***. Robust climber, confined to Meghalaya, Khasi-Jaintia-Garo hills. Requires further study. Appears close to *T. wallichiana* except for larger leaves.
48. ***Trichosanthes himalensis*** **Clarke.; syn.** ***T. pilosa*** **Lour.;** ***T. ovigera*** **Blume**. Japanese snake gourd, a perennial climbing plant with stem that can sprawl or climb by tendrils. Reported in India from Meghalaya and Eastern Himalayas between 600 and 1500 m. It is cultivated in China for its edible fruit and medicinal roots.
49. ***Trichosanthes kerrii*** **Craib; syn.** ***T. tomentosa*** **Chakr**. Robust climber. Reported from Northeastern Hill region. Needs further study.
50. ***Trichosanthes lepiniana*** **(Naud.) Cogn**. Tendril climber with robust stem. Habitat to roadsides, evergreen broad-leaved forests, and groves in Deccan Peninsula and Kerala.
51. ***Trichosanthes nervifolia*** **L.** Scandent climbing herb with white flowers, habitat to semi-evergreen forests and plains in Southwest India, Malabar, and Sri Lanka.
52. ***Trichosanthes truncata*** **Clarke.; syn.** ***T. ovata*** **Cogn**. A perennial climbing vine with egg leaves and dioecious flower. Reported from Northeast Hill region. Needs further study.
53. ***Trichosanthes wallichiana*** **(Ser.) Wight**. A climber, reported from moist deciduous forests of Northeast India. Close ally of *T. bracteata* from which membranous leaves with basal black-dotted glands separated it.

9.2.2 Leafy Vegetables

54. ***Chenopodium album* L. (Amaranthaceae)**. A fast-growing weedy annual herb, distributed from Europe to Eastern Asia as weed. Found in North India abundantly during winters, harvested from nature, and consumed as leafy vegetable/food crop. It has a very complex taxonomy and is divided in numerous micro-species, subspecies, and varieties. It hybridizes with several *Chenopodium* species, such as *C. foliosum* (Moench) Asch., and many others found in Himalayan region (Singh 2015). Cultivated on a very small scale as leafy vegetable or grain.
55. ***Ipomoea aquatica* Forssk. (Convolvulaceae)**. A semiaquatic, tropical herb that grows wild in water or on moist soil. Native to Africa, Asia, and Australia, including India. Invasive. Leaves vary from sagittate to lanceolate. Cultivated in tropics for vegetable and fodder.
56. ***Lactuca cooperi* Anthony (Compositae/Asteraceae)**. A perennial herb, endemic to Eastern Himalayas (Sikkim) in alpine and sub-alpine meadows and on exposed hill slopes. Genetic resource for *L. sativa* L., the lettuce. Under threat, endangered.
57. ***Lactuca remotiflora* DC.; syn. *L. intybacea***. An annual or biennial erect herb, up 25–60 cm tall. Leaves mostly radical, obovate, orbicular, or oblong. Distributed on dry sandy locations of Indus and Gangetic plains and Indian peninsula. A rare medicinal plant.
58. ***Lactuca runcinata* DC.; syn. *L. heyneana* DC**. An erect herb, with leaves radical and cauline. Common weed in many parts of India, Jammu and Kashmir, Rajasthan, Maharashtra, and Tamil Nadu. Antibacterial.
59. ***Lactuca serriola* L.; syn. *L. scariola* L**. An annual erect, prickly herb up to 1.5 m tall. Leaves sessile pinnatifid. Native to Africa, Europe, and Asia, including Indian Himalayan region. Referred as prickly lettuce or compass plant, because under the Sun, the upper leaves twist around to hold their margins upright. Ornamental, culinary, and folklore medicine. Closest wild relative and member of primary gene pool of *L. sativa*, the lettuce (Koopman et al. 2001).
60. ***Malva pusilla* Sm.; syn. *M. rotundifolia* L. (Malvaceae)**. Dwarf Mallow, an annual/biennial herb. Native to Europe and Asia. An invasive species, naturalized in Western Himalayas, northern plains, and the Deccan Peninsula. Blessed with medicinal properties. Vegetable is extracted from the wild. Successful interspecific hybridization within genus *Malva* suggests possibility of genetic introgression.
61. ***Malva sylvestris* L.** Blue mallow, an annual, biennial, or perennial plant, standing 1 m tall with showy bright mauve-purple flowers, with dark veins. Native of Africa, Europe, and Asia, including Western Himalayas up to 2400 m, Bihar, and Deccan Peninsula, in fields, hedgerow and fallow lands. Ornamental, young leaves used as vegetable and medicine. Extracted from the wild as well as cultivated.
62. ***Malva verticillata* L.** Whorled mallow, an annual/biennial plant growing to 1.7 m. Leaves cordate, downy pubescent, with pink flowers, crowded in clusters.

Native to China and naturalized in Himalayas up to 3600 m and in Nilgiri Hills. Stem and leaves are eaten as vegetable, and roots are used for whooping cough and the ash of leaves in scabies.

63. ***Nasturtium officinale*** **R. Br. (Brassicaceae)**. Watercress is aquatic or terrestrial noxious perennial weed with significant genetic diversity that can be used in improvement. Native to Europe and Asia including Indian Subcontinent. One of the oldest leafy vegetable and folklore medicine with diverse chemical activities. Cultivated as leafy vegetable, rich in vitamins and minerals.
64. ***Rumex acetosella*** **L. (Polygonaceae).** The red sorrel is a perennial weedy herb that can reach 0.5 m in height. A garnish for green salad, tart-flavoring agent, and a curdling agent for cheese. Native to Africa, Europe, and Asia, including India. Found as weed in Eastern Himalayas (Sikkim), Nilgiris, and Palani hills.
65. ***Rumex dentatus*** **Linn.** Indian dock, an annual herb 20–60 cm tall. Native in Europe and Asia, including Indian Subcontinent, common as roadside weed in Northwestern Himalayas and northern and central plains. More variability in hills, extending to eastern region; forms from plains are akin to *R. nigricans*. Plant infusion rich in flavonoids, phenolic, reducing sugars, total sugars, and antioxidant activity.
66. ***Rumex patientia*** **L.** An herbaceous perennial, native to Europe and Asia, including India. Widely distributed in Western Himalayas, from Kashmir to Kumaun, and Northeast with lot of genetic variation. Consumed as spinach in high-altitude cold desert of Ladakh. Several health-promoting compounds, including phenols, are found, besides antioxidant activity.
67. ***Rumex vesicarius*** **L**. An annual, native of Africa and Asia, including many parts (Punjab) of Indian Subcontinent. Most popular *Rumex* reported from Chhattisgarh. Cultivated. Used as vegetable and in folklore medicines as source of vitamins, minerals, proteins, fiber, carotenes, and flavonoids with health benefits. Vital source of phytochemical antioxidants to prevent damage associated with free radicals.
68. ***Trigonella cachemiriana*** **Cambess. (Fabaceae/Leguminosae).** Prostrate or spreading much branched herb. Native of Asia, including Himachal Pradesh, Kashmir, and Punjab in India. Needs bioprospecting from genetic resource point of view of fenugreek.
69. ***Trigonella emodi*** **Benth**. Himalayan fenugreek, a perennial glabrous erect herb 20–60 cm tall (Fig. 9.3e). Native to Western Asia and Himalayas, up to 3000 m, and plains of Punjab and Uttar Pradesh. *T. emodi* var. *podperae* Sirj., syn. *T. podperae* (Širj.) Vass., is endemic to Ladakh. It is an erect herb with many branches from the base. Not much work done, needs bioprospecting.
70. ***Trigonella fimbriata*** **Benth**. Perennial erect herb. Native to Northwestern Himalayas, including Kashmir, Himachal Pradesh, northern Punjab, and Uttarakhand.
71. ***Trigonella uncata*** **Boiss. & Noë; syn.** ***T. glabra*** **Thunb. subsp.** ***uncata*** **(Boiss. & Noë) Lassen**. Not a climbing annual herb. Native to Asia, including West Asia and Indian Subcontinent. Common in Gujarat, Rajasthan. Needs collection, characterization, and evaluation of genetic potential.

72. ***Trigonella gracilis* Benth**. *Tinpaate Jhaar*, perennial trailing glabrous 15–45 cm-long herb. Native to Indian Subcontinent: Kashmir, Himachal Pradesh, Punjab, and Uttarakhand. It is used as a green fodder and a genetic resource for fenugreek.
73. ***Trigonella occulta* Delile**. Densely branched annual herb with glabrous stem, pinnately trifoliate leaf. Found in moist places of Indus plains, Gangetic Plains, and in Koraput region. Leaves used as vegetable and green fodder and seeds in diarrhea.
74. ***Trigonella polycerata* L.; syn. *Medicago polycerata* (L.) Trautv**. It is glabrous or slightly hairy herb. Native to Indian Subcontinent, found in Western Himalayas, Indus, and Gangetic Plains. It has medicinal potential.

9.2.3 Root, Tuber, and Bulb Vegetables

75. ***Allium carolinianum* DC. (Amaryllidaceae/Liliaceae)**. A 60 cm-tall herb, with narrow, flat leaves, shorter than the scape, which produces egg-shaped bulbs up to 25 mm across. Native to Asia, including Indian Subcontinent in upper reaches of Western Himalayas, Ladakh. Used for flavoring and as vegetable.
76. ***Allium cepa* var. *aggregatum*; syn. *A. ascalonicum* L**. Shallot or *Ek-dana-lasun* is a small, clustered onion with intense flavor. Native to Central or Southwest Asia, from where it spreads to the Mediterranean and Indian hills. Expressing great variability for bulb. Mostly cultivated and used as condiment in Indian cuisine and known as an Ayurveda herb. Variety *viviparum* (Metzg) Alef., member of the primary gene pool of *Allium cepa*, is also cultivated; wild form does not occur.
77. ***Allium chitralicum* Wang & Tang**. An herb with narrow leaves, rose-colored flowers, and egg-shaped bulbs. Native to upper reaches of Afghanistan, Pakistan, Northwestern Himalayas, and Ladakh. Needs collection, characterization, and evaluation of genetic potential.
78. ***Allium griffithianum* Boiss**. Up to 40 cm-tall herb with ovoid bulb, coriaceous outer coats, fibrous grayish black; membranous inner coats. Native to high mountains of Asia, including Indian Subcontinent (Himalayas and Khasi hills).
79. ***Allium humile* Kunth**. An 8–30 cm-tall plant with flat, fleshy, linear leaves, about 5 mm wide, scape is up to 15 cm, with slightly compressed narrow, cylindrical bulbs. Grows naturally on slopes at high elevations in the Western Himalayas.
80. ***Allium hypsistum* Stearn**. A bulbous herb 20 cm tall, bulbs densely clustered, tufted, cylindrical, and elongated, 1 cm in diameter, and situated on short rhizome. Native to Nepal, extending to Eastern Himalayas. Used as food and folk medicine.
81. ***Allium macleanii* Baker**. It is a perennial herb 1 m tall, with a spherical umbel crowded with many purple flowers. It has tuberous bulbs. Native to mid- and

West Asia and Indian Subcontinent (Himalayas). Cultivated in Afghanistan and used in Unani and Ayurveda medicine.

82. ***Allium prattii* Wright**. A 60 cm-tall herb with solitary or clustered subcylindrical bulbs. An Asian species of wild onion, native to Central Himalayas (Assam, Nepal, Sikkim, Bhutan) and China. Important genetic resource, needing collection and characterization.
83. ***Allium rhabdotum* Stearn**. Native to Indian Subcontinent (Bhutan and Sikkim). Member of tertiary gene pool of onion (Fritsch and Friesen 2002).
84. ***Allium roylei* Stearn**. A plant with ca. 40 cm tall scape. It has an egg-shaped bulb ca. 30 mm across. Endemic to high altitudes of Afghanistan and Himalayas in India. Source of resistance to powdery mildew, leaf blight, etc., as member of secondary gene pool of onion and Welsh onion (Chuda and Abrams 2009). Leaf blight introgressed into *A. cepa* (de Vries et al. 1992). Used as flavoring agent. Endangered.
85. ***Allium rubellum* M. Bieb**. A lovely, bright rare species, diploid (2n = 16). Native to Asia, including Western Himalayas on exposed hillocks in the Indian Subcontinent with much variation. A triploid form was collected from Pathankot. Used locally as flavoring agent in curries and as vegetable. Semidomesticate, grown in kitchen gardens. Overexploitation is shrinking its populations.
86. ***Allium schoenoprasum* L**. *Chives*, a cultivated pot herb, allied to garlic, with purple flowers and narrowly ovoid, 2 cm long, 0.5 cm broad, scaly bulb. Native to Asia, Europe, and North America, including Western Himalayas from Kashmir to Kumaon up to 3300 m, in alpine meadows. Member of tertiary gene pool of leek and Welsh onion (Kik 2002; Umehara et al. 2007)
87. ***Allium sikkimense* Baker**. Bulbs are clustered, cylindrical, 0.3–0.5 cm in diameter. Native to Sikkim, Tibet, Bhutan, Nepal, India, and parts of China in forest margins, scrub, slopes, and meadows; 2400–5000 m. An ornamental onion with large true light-blue flowers. Possesses ethnobotanical use and a genetic resource.
88. ***Allium stracheyi* Baker**. *Jambu* is a perennial herb about 35 cm tall with rosy flowers. Native to Tibet to Western Himalayas and upper Gangetic Plains. Used as vegetable, spice, condiment and seasoning, and occasionally as medicine (Pandey et al. 2008). Vulnerable.
89. ***Allium tuberosum* Roxb**. Perennial herb with tender leaves having light taste of garlic (Fig. 9.3f), used to flavor vegetables, salads, omelets, etc. Bulbs cylindrical, 4–6 cm long, light brown on drying. Distributed in Himalayas, northeastern hills, and Shanxi, China. Sporadic, up to 1800 m, wild on exposed hills, etc. Cultivated as ornamental and vegetable. Member of primary gene pool of Chinese chives (Blattner and Friesen 2006).
90. ***Allium victorialis* L**. Alpine leek, a perennial, broad-leaved species of wild onion with cylindrical bulb 4–6 cm long, coat net-veined, fibrous. Native to Asia, Europe, and North America, including Northwestern Himalayan region of India. Cultivated.

91. ***Allium wallichii* Kunth**. Himalayan onion herb 0.6 m tall with linear-to-oblong lanceolate leaves. Distributed over Kumaon Himalaya to Northeast Himalayas (Sikkim, Darjiling) to Tibet and parts of China. Used for medicinal purposes and as a spice, threatened due to overharvesting.

In addition, *Allium gilgiticum* Wang & Tang., an herb with cylindrical bulbs, endemic to upper reaches of Western Himalayas in Gilgit and Ladakh, known from type collections gathered in 1930 (Karthikeyan et al. 1989). Rare and quite possibly extinct and needs recollection and further investigation.

92. ***Alocasia acuminata* Schott**. A terrestrial herb, small to medium sized, slightly robust, up to 75 cm tall, evergreen. Distributed in forests of Assam, Northeast India, and Indochina region. Used as food and extracted from the wild.
93. ***Alocasia cucullata* (Lour.) G. Don**. Chinese taro, perennial herb producing thick, erect stems and heart-shaped leaf. Native to Asia, including Northeast India and Western Ghats. Used as food, source of starch and vegetable and also folk medicine and ornamental. Extracted from the wild and cultivated.
94. ***Alocasia macrorrhizos* (L.) G. Don; syn. *A. indica* Schott**. Elephant ear taro, a massive aroid, stout perennial; stem 4–5 cm thick, arrow-shaped leaves. Native of rainforests of Malaysia. Naturalized to tropical Asia, including sub-Himalayan tract of East Himalayas, northeastern region, Bengal plains, and peninsular humid tract. Member of primary gene pool of giant taro (Nauheimer et al. 2012). Cultivated as ornamental/vegetable. The stem tuber is peeled, cut into pieces, and eaten. An Ayurveda plant.
95. ***Amorphophallus bulbifer* (Roxb.) Blume (Araceae)**. Prettiest of the voodoo lilies with striking flower, corm globose, up to 15 cm across, and tubercle. Petiole 1 m long, produces bulbils on the top of the petioles, wherefrom the leaflets depart. Native to Asia, including Eastern Himalayas (Sikkim), north-eastern hills (Khasi Hills), Eastern peninsular tract, West Bengal, and Kerala, Western Ghats in India.
96. ***Amorphophallus commutatus* (Schott) Engl**. Herbs with corms. Leaves tripartite compound, up to 50 m-long, elliptic leaflets, caudate acuminate; petiole to 50 cm long. Endemic to evergreen forests of Western Ghats, with significant variability of varietal complex. With antioxidant properties and genetic resource.
97. ***Amorphophallus hohenakeri* (Schott.) Engl. & Gehrm**. An herb with corm of 3 cm across, smooth, depressed globose, and dull white inside. Endemic to evergreen forests of Western Ghats (Jaleel et al. 2011). Needs collection and characterization.
98. ***Amorphophallus konkanensis* Hett., S.R. Yadav & K.S. Patil**. An herb with globose or depressed globose, 3–4 cm in diameter tubers. Found on forest clearing, road sides, and hedges of cultivated field in North Western Ghats (Goa, Maharashtra, and Karnataka). Recently reported from Madhya Pradesh.

99. ***Amorphophallus longistylus* Kurz ex Hook. f**. A little known rare species, endemic to India in Andaman and Nicobar Islands. Needs collection and characterization.
100. ***Amorphophallus muelleri* Blume**. A perennial herb producing a single leaf each year from a tuberous rootstock. Triploid, native in Tropical Asia (Myanmar, Thailand, Malaysia, Indonesia, and Andaman Islands). Corm eaten raw or boiled or baked. Valued for glucomannan content and used in the food industry, paper industry, pharmacy, and cosmetics.
101. ***Amorphophallus mysorensis* E. Barnes & C.E.C. Fisch**. An herb, endemic to South Karnataka—Billigirirangan Hills. Needs collection and characterization.
102. ***Amorphophallus paeoniifolius* (Denst.) Nicolson A. *campanulatus* (Roxb.) Bl. ex Decne**. Elephant yam or *Jimikand*, annual herb with large, depressed globose, much-warted tubers, 20–25 cm in diameter. Native of Africa and Asia, including Indian Deccan Plateau. Cultivated as a tropical tuber crop for starch and as vegetable. Corm is considered stomachic and tonic; used in piles and as restorative in dyspepsia and debility.
103. ***Amorphophallus smithsonianus* Sivadasan**. A new species with smooth, glossy, compressed globose or sub-globose, 3.0–4.5 x 3.5–4.0 cm corms. Native to South Western Ghats. Fruits and seeds have medicinal properties. Needs further studies.
104. ***Amorphophallus sylvaticus* (Roxb.) Kunth**. An herb with 5 cm-thick corms. Distributed in semi-evergreen forests of India [Eastern (Bastar) and Western Ghats] and Sri Lanka. Fruits and seeds have medicinal properties.
105. ***Colocasia affinis* Schott (Araceae)**. Dwarf elephant ear, a perennial terrestrial herb with stolon's trailing horizontally, thin, 3.7–40 cm × ca. 4 mm, pale green, branched, and triangular or ovate tubercles, ca. 2 cm in diameter. Extended from China to East Himalayas, Assam, and Indochina. Ornamental. Related to taro.
106. ***Colocasia antiquorum* Schott.; syn. *C. esculenta* (L.) Schott var. *antiquorum*.** An erect herb up to 2 m tall with small main corm and many cormels. Native to Southeast Asia including India, in sub-Himalayan tract, peninsular region, and northeastern region, in water-logged humid tropical belt with greater variability in eastern region. Member of primary gene pool of taro, *C. esculenta* (Ivancic and Lebot 1999).
107. ***Colocasia fallax* Schott**. Silver leaf dwarf elephant ear, a small herb, growing to 0.6 m tall with inconspicuous fragrant white flowers. Extending from China to Eastern Himalayas (Sikkim, Assam, and Khasi Hills) with three forms different in petiole color.
108. ***Dioscorea alata* L. (Dioscoreaceae)**. Known as Greater, water or winged yam is a creep and shrub. Native of Asia, cultivated for desserts and starch, escaped into the wild in Western Himalayas and northeastern region generating variability. Part of primary gene pool of greater yam (Egesi et al. 2002). Medicinal and ornamental.

109. ***Dioscorea bulbifera*** **Linn.** Air potato, a perennial vine with broad leaves forming bulbils in leaf axil and tubers beneath ground. Native of Africa and Asia, cultivated as food crop, escaped, and naturalized in Western and Eastern Himalayas and most of India. Part of primary gene pool of air potato (Terauchi et al. 1991). Used as folk medicine.
110. ***Dioscorea decipiens*** **Hook.f**. Climber of up to 12 m, tubers are vertical and cylindrical, one per growing season, with withering tuber from previous season. Tubers are edible. Habitat to mixed deciduous and hilly evergreen forest of Northeast India.
111. ***Dioscorea deltoidea*** **Wall. ex Griseb.** Perennial, dioecious, glabrous twining climber. Roots are tuberous, and rhizome is horizontal, irregular, and ginger shaped. Native of Asia in forest and open fields of Himalayas and Punjab. Possesses high medicinal value (roundworm, constipation, antimicrobial). Cultivated, but still harvested from the wild, endangered.
112. ***Dioscorea glabra*** **Roxb.** Glabrous herb with cylindrical tubers. Habitat to evergreen broad-leaved and scrub forests, mountain slopes, valley sides in Southeast Asia, including Northeast Himalayas/India, Bengal, Chota Nagpur, and Andaman. Ayurveda medicinal plant for general tonic. Extracted from the wild.
113. ***Dioscorea hamiltonii*** **Hook.f.** Plant with angled stem, glabrous. Habitat to Asia, including Eastern Himalayas, Bihar, Chota Nagpur Plateau, and the Western Ghats. Ayurveda plant, *Varahi*, leaves used to treat jaundice and mumps. Part of secondary gene pool of greater yam (Hsu et al. 2013).
114. ***Dioscorea hispida*** **Dennst; syn.** ***D. daemona*** **Roxb.** Twiner with glabrous stems twining to left; leaflets are subequal, 17x12 cm, and obovate, with large tubers. Distributed from India and southern China, through Southeast Asia to New Guinea. Produces intoxicating tubers of medicinal value. Famine food.
115. ***Dioscorea intermedia*** **Thw.** *Shoddi kalasu*, a climbing herb; stems neither winged nor conspicuously angled. Leaves alternate. Tuber >1, grows horizontally. Distributed in evergreen forests of South India (Kerala) and Sri Lanka. Medicinal.
116. ***Dioscorea kalkapershadii*** **Prain & Burkill.** Climber with slender stem, sparsely prickly, hirsute, at length glabrescent; leaves alternate, compound, single tuber. Found in Gangetic Plains, Chota Nagpur Plateau, and Southern Western Ghats.
117. ***Dioscorea kumaonensis*** **Kunth.** Stem somewhat smooth. Tubers elongate to globose, seldom eaten. Distributed in Temperate Himalayas and Northeast India with var. *straminea* and var. *vera*. A new source of antirheumatic drug.
118. ***Dioscorea lepcharum*** **Prain & Burkill.** It is an edible yam with several tubers produced upon at the end of a long stalk, spreads laterally, descends in soil, recently rediscovered (Saikia, et al. 2014) in the Eastern Himalayas (Sikkim) and northeastern region.
119. ***Dioscorea oppositifolia*** **L.** *Amilkaakanda*, a climber, terete stem, twining right. Native to moist deciduous, semi-evergreen, and evergreen forests of Myanmar and to the Indian Subcontinent. Ayurveda medicine to reduce swelling.

120. ***Dioscorea pentaphylla* L.; syn *D. jacquemontii* Hook.f.; *D. tripylla* L.** *Vaaraahikanda*, a tuberous climber, native to Asia and Australia including India, from 1800 m in the Himalayas to Andaman Islands. Famine food, Ayurveda medicine. Dry tubers sold.
121. ***Dioscorea prazeri* Prain & Burkill; syn. *D. clarkei* Prain & Burkill.** Climber up to 5 m. Habitat to evergreen forests of Indo-Malayan region, including Central to Eastern Himalayas, northeast region. Ayurveda medicine, tuber antiphthiriac and fish poison. Endangered medicinal plant.
122. ***Dioscorea pubera* Blume; syn. *D. anguina* Roxb.** Plant pubescent, with stem twining to the right having 1–2 tubers narrowly cylindrical, rootless, flesh lemon yellow. Habitat to India, Nepal, and Bhutan in Eastern Himalayas, Northeast and Bastar. Exploited from nature.
123. ***Dioscorea scortechinii* Prain & Burkill.** Large forest climber with compound leaf, tuber one like *D. pentaphylla*. Distributed from Eastern Himalayas, Assam, Bangladesh, and Northeast India to Sumatra.
124. ***Dioscorea spicata* Roth.** A perennial twiner, leaves opposite or subopposite. Found in Indian Subcontinent, including Bangladesh and Sri Lanka. Ayurveda plant with antioxidant with free radical scavenging capacity. Marginally cultivated.
125. ***Dioscorea tomentosa* Koenig ex Spreng.** Climber with stem twining to the left, terete, with flattened and matted hairs. Leaves trifoliate. Habitat to semi-evergreen, moist, and dry deciduous forests of Indian Subcontinent.
126. ***Dioscorea trinervia* Roxb. ex Prain & Burkill.** Distributed in Northeast India, Assam, Bangladesh, Indochina, and Myanmar. Medicinal.
127. ***Dioscorea vexans* Prain & Burkill.** Tuberous climbers with opposite leaves. Endemic and rare species from Andaman and Nicobar Islands. Medicinal, having antifertility properties.
128. ***Dioscorea wallichii* Hook. f.** A yam with stem twining to the right, smooth or scarcely prickly toward the base. Leaves up to 12 × 12 cm, orbicular. Tubers can grow over 1 m. Found in evergreen and moist deciduous forests of Eastern Himalayas and Western Ghats. Tubers are edible and possess medicinal properties along with roots.
129. ***Dioscorea wattii* Prain & Burkill.** Tubers unknown, woody crown is present with numerous rhizome, large capsule, seeds surrounded by wings. Found in Eastern Himalayas, Northeast India, and Naga Hills, rare.
130. ***Dioscorea wightii* Hook.f.** Glabrous climbing shrub, stem slender, terete, twining to the right. Leaves simple, 3–6 × 2–4.5 cm, ovate, acuminate. Endemic to Indian Peninsula and Chota Nagpur Plateau. Listed in the Red List of Threatened Species (Chadburn and Contu 2014). Medicinal.
131. ***Flemingia procumbens* Roxb.; syn. *F. vestita* Benth. ex Baker (Fabaceae/Leguminosae).** Perennial non-climbing shrub with tuberous roots, used as food and drink. Cultivated for juicy tuber, a highly priced vegetable in Meghalaya. Naturally distributed in Himalayas and Northeast Hills with significant genetic variability as source for improvement. Also found in Uttar Pradesh and Tamil Nadu. Used in mixed cropping because of its nitrogen fixation property. Medicinal.

9.3 Perspective

The utilization of wild relatives in crop improvement has been most successful and popular in solanaceous vegetables, particularly *Lycopersicon* and *Solanum*. In these taxa, many wild relatives have been identified with gene conferring resistance to biotic and abiotic stresses. The experience in utilization of these taxa in introgression of desired genes into cultivated species from their wild relatives has been possible because of the positive response of solanaceous species to both conventional and biotechnological manipulations thereby developing genetically engineered interspecific hybrids/cultivars. Therefore, successful utilization of wild species in crop improvement requires amenability to these resources with expertise in biotechnological techniques to overcome hybridization barriers, establishing successful hybrids, besides conventional cytogenetic manipulations to improve genetic recombination. In the Indian context, conventional approaches would be sufficient in the case of eggplant for transfer of resistances from species, such as *S. insanum* and *S. incanum* into *S. melongena*, since there are no crossability barriers. Transfer of desired characters from species, such as those resistant to shoot and fruit borer from *S. khasianum* and root knot nematode from *S. sisymbrifolium* and those resistant to several root diseases from *S. torum*, may require biotechnological approaches because of the cross-ability barriers between these species and the cultivated *S. melongena*.

A large number of wild species related to important vegetable crops have been described based on morphological distinctiveness; however, experimental taxonomic studies are required in certain cases, such as *Trichosanthes* in fruity vegetables, *Lactuca* and *Trigonella* in leafy vegetables, and *Allium* and *Dioscorea* in bulbous and tuberous vegetables, to produce an inventory of species that are genetically distinct in terms of their distinctive features, genetic distance, and phylogenetic relationships, particularly with cultivated species to assess their value as a genetic resource and facilitate conservation, avoiding redundancy and feasibility for introgression of genes with application of appropriate breeding strategies. Such studies shall throw new light on genetic relationship of *Lactuca* and *Trigonella* wild species found in India with their cultivated counterpart and as potential genetic resource.

In other cases, such as *Abelmoschus*, narrow genetic base has been the major concern. Concerted efforts are required for exploitation of available wild genetic resources and to augment genetic diversity from unexplored pockets of the subcontinent as well as from Africa for broadening the genetic base on priority. Useful information has been generated on the economic potential of wild species, particularly on their inherent resistance potential against one or more biotic and abiotic stresses. However, in these cases, greater emphasis is required on their collection for capturing existing variability before they are being lost under the pressure of infrastructure development and climate change, particularly from the eastern and northeastern regions of the Indian Subcontinents. Further, in several cross-combinations, variability has been created through interspecific hybridization, while in others, intermediate forms resulting from natural hybridization do occur. Both types are

easy to be exploited for genetic introgression. Therefore, they require immediate collection attention. For example, the variability created by natural hybridization between *A. manihot*, *A. tetraphyllus*, and *A. caillei* (African) needs to be fully understood, collected, and exploited.

In cases like cucurbitaceous vegetables, efforts are needed to collect diverse germplasm in case of the species reported with resistance to various biotic and abiotic stresses, such as *Cucumis*, while in other genera, *Luffa*, *Momordica*, etc., the wild relatives need to be characterized and evaluated, possibly under different agroclimatic conditions, because of their wider distribution throughout the subcontinent.

Also for making full use of genetic diversity available in the wild relatives of vegetable crop species, the application of molecular techniques needs to be encouraged for identification and differentiation of germplasm and study of interspecific differentiation between cultivated species and the wild relatives. These tools should also be encouragingly utilized to overcome crossability barriers and promote utilization of wild species.

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