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RESEARCH ARTICLE

The East Asiatic region of crop plant diversity

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Abstract Crop plant diversity of E Asiatic region (China, Japan and Korea Peninsula) is extremely interesting because of the region's high level of plant diversity resources and long history of cultivation and domestication, while an inventory of crop plant diversity in this area is still not fully recorded. Crop diversity protects food consumption, especially in poor households within developing nations. This review aims to provide an inventory and a summary of the crop plants in this area, in order to further understand the importance of crop plant diversity and its conservation. In total 175 families, 640 genera and 1484 species were recorded in this paper based on extensive literature reviews and own field work.

Keywords Centers of origin · Crop plant diversity · Literature review · East Asia

Origin of crops and centers of origin of cultivated plant theory

Crops can be defined as plant species which have application value for human beings and are grown and harvested for the purpose of use by man. It is well known that crops are formed by domestication of wild plants or artificial synthesis of new cultivated species.

Bo Liu and Karl Hammer have contributed equally to this work.

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In the late mesolithic age or the neolithic one, humans began to domesticate wild plants, dating back about 10,000 years. In a history of 5000 years to present (Bu 1981; Dong 2006), and in modern times, with the rapid development of human civilization, science and technology, human beings continue to domesticate wild plants and work through hybridization technology to obtain new crops and crop cultivars (Dong 2006).

The crops of the world originated in different regions, which were recognized by scientists. In general, in the origin of the crop, there should be a wild ancestor, and the genetic diversity of the crop may be more abundant. In modern times, there are several famous scholars who have studied the origin of crops, such as the Swiss botanist Alphonse de Candolle's theories on crop origins were groundbreaking research. He published the book "The origin of cultivated plants" (1912).

The Russian scientist N. I. Vavilov published papers on the "Centers of Origin of Cultivated Plants" (1935, 1940). He recognized eight centers; China area was recognized as one by having 138 distinct species of which probably the earlier and most important were cereals, buckwheat and legumes.

His main theory: plant diversity is extremely rich in the tropical and warm temperate regions of the world, but our major food crops mainly come from high mountain valleys. Abundant food in tropical forests was gathered in the form of fruits, nuts and starchy tubers throughout the year, so it seems that there were no processes leading to domestication. So East Asia is a cradle for domestication crops for its mountainous geology platform, such as Mt. Himalayas, Mt. Kunlun, Mt. Tianshan, Mt. Fuji, Mt. Jeju; Tiger leaping valley, Yangtze valley, Three gorges valley, Nu Valley, Yarlung Zangbo valley and etc.

Many archaeological findings in the 1960s and 1970s have confirmed Vavilov's theories concerning the centers and focuses of origin of cultivated plants. Numerous scientists, including the Russian botanists P. M. Zhukovskii, E. N. Sinskaia, and A. I. Kuptsov, have continued Vavilov's work and have modified his theories. In 1971, the American geneticist J. R. Harlan proposed "center of origin and the pan region theory" and "origin and diffusion theory of crop plants".

The British botanist J. G. Hawkes proposed the center of crop origin theory, and considered the origin of agriculture as the core center, from the center of the core crop spreading out and forming multiple types for the diversity of the region, and there will be only a small number of areas of origin of crops which can be called as minor centers (Dong 2006; Vavilov 1940). Vavilov considered that "as a rule the primary foci of crop origins were in mountainous regions, characterized by the presence of dominant alleles." The high mountain areas are seasonal in climate, with a wide range of temperature and rainfall due to differences of altitude and aspect. It seems that the restricted access of the mountain valleys and the wide range of altitudes helped to produce and select the diversity needed for domestication. Evolution of domesticates is very much promoted by the factors of varied microclimate, aspect, altitude, restricted habitats and human selection which are all present in the intertropical mountain zones of the Old and New Worlds (Hawkes 1998).

Introduction to the East Asiatic region of crop

The Chinese-Japanese Region of Zeven and de Wet (1982) has been named by Vavilov the "East Asian Center of Origin". In one of his last papers on gene centers, Vavilov (1935) also included Korea with its very old agri- and horticulture (Hammer 2005).

N. I. Vavilov in his papers put forward the theory of 8 centers of origin for crops in the world. According to his statistics, the East Asian center accounts for 20 percent of cultivated plants, including soybeans and various millets, vegetables, and fruit species.

China

With over 30,000 species of higher plants—more than 10% of the world's total plant species—China is a key region for crop plant resources holding plant diversity for the well-being of people and the planet. It was recorded in the Flora of China (Wu et al. 2003), that China has 31,362 species of vascular plants in 3328 genera and 312 families, of which 2129 species are ferns and Lycophytes, 237 are gymnosperms, and 28,995 are angiosperms. About 50% of these species are endemic to China.

The agricultural crop genetic resources of China are extremely rich, representing various types of crops and different wild relatives. According to databases, China grows more than 600 main agricultural crops, of which about 290 originated from the country (Scociety of Crop Genetic Resources 1994). After a long period of

natural and artificial selection, a variety of landraces was formed, such as that of rice germplasm resources. This is characterized by two subspecies, 50 botanical varieties and 962 sub-botanical varieties in China.

Li (1970a, b) characterized the agriculture of China in the following ways: (1) N China with a seed and vegetable agriculture, (2) S China with predominantly vegetatively propagated crops, which resembles the Indochinese-Indonesian Region (Region 2). Chang (1970) and Harlan (1971) suggested an independent origin of agriculture in N China, the B1 North Chinese Centre of Origin for Agriculture.

Two independent regions of origin are confirmed in present investigations (Fuller 2007). One of the earliest known sites of agriculture in China is at Yang-Shao from about the 4th millennium BC. There was no foreign influence before 1300 BC. Recently older agricultural sites have been found, as already proposed by Ho (1977). The peculiar diversity of East Asian plants has been characterized by Kubitzki and Krutzsch (1996). It forms the basis for the evolution of the great number of cultivated plants and was the basis for the important process of plant domestication (Allaby 2008).

The great amount of spermatophytic endemic genera with typical centers (Mid-Yangtze center, Dian-Qian-Gui center, South Hengduan Mountain center, Middle Hengduan Mountain center, Qingling center, Huangshan-Tianmushan center, Zhongtiao-South Tianmushan center, Zhongtiao-South Taihangshan center, Inner Mongolia center—see Takhtajan 1986; Li and Li 1997) is the precondition for the selection of many plant species with respect to domestication. The floristic borders are still under discussion (Wu 1993). The Tanaka line (Yunnan Province) of *Citrus* distribution (Tanaka 1954), the Kaiyong line (Sichuan Province, Lang 1994), and the elaborated Tanaka-Kaiyong line (Li and Li 1997) are dividing Sino-Japanese and Sino-Himalayan genera.

The rich ornamental plant species originated from China have been dispersed around the world since thousands of years. Especially in the nineteenth century, many ornamental plants from China were introduced abroad. According to a tentative calculation, exportation of forest plant genetic resources from China included 168 families with 3364 species, and 1101 species have been mass introduced (Xue 2005); such as the Arnold Arboretum introduced woody plants from China as many as 54 families, 142 genera and more than 400 species; the Morton Arboretum imported woody plants from China into US: 59 families and 153 genera and more than 400 species. Many famous ornamental plants such as peony, plum blossom, chrysanthemum, orchids, camellias, rhododendrons, cloves, Chinese rose were originated from E Asia, particularly from China (Long et al. 2015). The Royal Botanic Garden Edinburgh preserved 1700 species of living plants from China. About 50% of German existing plant resources were from China. Up to 40% of the Dutch Garden Plants came from China. Italy has more than 1000 species of ornamental plants that originated in China. More than 70% of California garden plants are adapted from China.

China exports 500 kinds of medicinal materials to Southeast Asia, Japan, the United States and other 80 countries or regions. The export of medicinal plant extracts also accounts for a considerable proportion. At present, China produces and exports plant extracts on a large scale, and produces about 80–100 products (some of these plants come from cultivation).

Many crops such as *Allium tuberosum*, *Amorphophallus konjac*, *Angelica sinensis*, *Brassica rapa* subsp. *pekinensis*, *Camellia sinensis*, *Cinnamomum camphora*, *Diospyros kaki*, *Eleocharis dulcis*, *Hemerocallis citrina*, *Glycine max*, *Morus alba*, *Morella rubra*, *Nelumbo nucifera*, *Panicum miliaceum*, *Prunus mume*, and *Setaria italica*, *Oryza sativa*, *Panax ginseng*, *Vigna angularis* and *Zizyphus jujuba* originate from China. China also contributed some crops not known elsewhere. *Torreya grandis* e.g., is cultivated for nuts. A total of 40,754 *Torreya grandis* trees have been cultivated in Zhuji City, Zhejiang Province in China for more than 100 years. About 30% of the individuals are more than 300 years old (Meng et al. 2003).

Japan

In comparison with China, Japan and Korea are secondary regions of diversity with many locally selected crops. The E Asiatic Region is the primary region of diversity for several crops from the Amur-Ussuri Region.

There are about 7000 species of "vascular plants" (angiospermae, ferns, and others) in Japan, and about 40% of these (approximately 2900 species) are recognized as being endemic to Japan. Japan's diverse

and unique flora was created through a combination of human efforts and natural conditions.

Japan is located on a long, narrow island archipelago with a wide range of climates, from the subarctic region of Hokkaido in the north to the subtropical region of Okinawa in the south, and is characterized by clearly defined seasons and plentiful rainfall. The country is surrounded on all sides by the ocean, and its inland geography is varied and complex, and with many rugged mountainous areas.

This great diversity in climate and geography has given rise to many species of plants. The Japan archipelago was spared from the ravages of the glaciers and the resulting massive extinction of plant life that has taken place on many continents. At the same time, the process of repeated invasion by and isolation from other plant species that resulted from recurring connection to and separation from the Asian continent over millions of years has contributed to the richness of Japan's natural flora.

Korean Peninsula

There are 3381 species in Korean Peninsula, which belong to 203 families and 1179 genera according to the Provisional Checklist of Vascular Plants for the Korea Peninsula Flora (KPF) (Chang et al. 2014).

The floristic similarity of China, Japan and Korea

1. Many plants in eastern China are conspecific with those in Japan. For example, *Cercidiphyllum japonicum*, *Magnolia sieboldii*, *Lindera praecox*, *Kirengeshoma palmata*, *Platycrater arguta*, *Oxalis obtriangulata*, *Orixa japonica*, *Ilex purpurea*, *Acer nikoense*, *Meliosma myriantha*, *Eurya japonica*, *Styrax obassia*, *Comanthosphace japonica*, *Rabdosia longituba*, *Mitchella undulata*, *Croomia japonica*, *Cypripedium japonicum*, *Galeola septen-trionalis* and others. Especially, *Peltoboykinia tellimoides* and *Petrosavia sakuraii* were formerly considered as being confined to Japan. *Yoania japonica* as distributed only in N India and Japan, but the specimens of these species have recently been collected from Mt.Jiulong in Zhejiang Province.
2. Though the genera *Cunninghamia*, *Glyptostrobus*, *Metasequoia*, *Liriodendron*, *Sassafras*, and *Liquidambar* existing now in eastern or central parts of China are extinct from Japan, the fossils of leaves, fruits or seeds of these taxa have been discovered from Japanese Tertiary Strata, which seems to indicate closer floristic relationship between Japan and eastern China.
3. The fact that some species in Japan have close relatives in Nepal, India (Sikkim) or Bhutan may suggest that the western edge of the Sino-Japanese Floristic Region probably extends to the Himalayan corridor (Mien 1984).

Collecting method

Literature review

Based on the features and application of crops, they can be divided into several categories: food crops, economic crops, vegetables, fruit crops, forage and green manure crops, flowers and garden plants, medicinal plants and forest crops. The scientific studies published in journals, books, thesis and reports mainly from 1979 to 2014 mainly were reviewed. Pertinent literature was searched in different electronic databases (ISI Web of Science, Wanfang Data, VIP Information, Science Direct, and Google Scholar). We considered a publication to be useful when it dealt with plant cultivation.

Inclusion criteria

This paper focuses on crop plants, where a broad definition of a crop plant is applied. That is, we included plants grown under human cultivation and some cases of human management (semi-cultivation). In the selection of material we followed Hanelt and IPK (2001). This six-volume encyclopedia was based on Mansfeld (1959) and Schultze-Motel (1986). In all of these cited volumes the following plant groups have not been included: plants which are exclusively cultivated as ornamentals and those which are grown as forest crops for the production of timber.

Only few of the secondary crops have been included, i.e. crops with a rich diversity. We would like to provide an inventory of the species list of cultivated species in E Asiatic area, while, for some single species harbor hundreds of cultivars, like rice,

sorghum, Chrysanthemum, we did not include their cultivars.

The inventory of crop genetic resources in China, mostly available in Chinese Crop Germplasm Resources Information System (CGRIS), has reached 340 species and 470,000 accessions (http://www.cgris.net/).

Results: checklist

The East Asiatic region's crop plants represent a vast genetic resource. In total 175 families, 640 genera and 1484 species were recorded in this paper based on extensive literature reviews and own field works. They were presented in the supplement-Dictionary of cultivated plants, attached to this paper (see Electronic supplementary material, Index of families and genera in Table 1).

Compared with "A checklist of the cultivated plants of Yunnan (PR China)", Yunnan cultivated 1701 taxa, 1562 species, 837 genera, 190 families, Yunnan checklist includes plenty of cultivated varieties, and also some ornamental plants, and some plants with limited cultivation. While, this checklist try to include more commonly cultivated species, our guideline try to avoid some species with very limited cultivation, or some species only cultivated for flower export, such as *Echeveria* (Crassulaceae) only for pot succulent flower, *Ageratum* (Compositae) only few reported cultivation area, *Bellis* (Compositae) cultivated as cut flower. We added some commonly cultivated species, such as we added one new genus *Actinidia* (Actinidiaceae) with 7 species, we excluded *Bixa* (Bixaceae) because this plant only cultivated in Hainan, Yunnan, Guangdong and Taiwan, only few individuals have been cultivated, and not many people know or even use this species.

Use of checklists

The usefulness of checklists for cultivated plants has been elaborated by Hammer (1990, 1991). A summary about the checklist activities has been provided, when the checklist about the cultivated plants of Yunnan (China) was presented (Li et al. 2011). Some more recent examples for relevant checklists are: Oman (Hammer et al. 2009), Sudan Khartoum (Thompson et al. 2010, Albania (Hammer-Spahillari et al. 2011; Hammer et al. 2011).

Crop genetic pools for future crop development

East Asiatic crop genetic resources are extremely rich. The diversity of E Asiatic crop genetic resources has been highly valued by the international community traditionally, and occupies an important position.

Many other countries obtained plenty of valuable genetic resources from East Asia, and made use of them. For instance, kiwi fruit (*Actinidia chinensis* var. *deliciosa*) is native to China. It is traditionally eaten as a wild fruit, especially common along the Yangtze River (well known as yang-tao). Now it has been widely cultivated all over the world and with a large number of cultivars.

While, the great potential biogenetic resources are still under exploited. It will be helpful to explore more available crops and their relatives, to expand the scope of cultivation, to provide a wide range of use to other countries. Such as kiwi fruit, only few species such as *Actinidia chinensis* var. *deliciosa* have been cultivated and spread, now there are still 44 species in the genus of *Actinidia* endemic to China. The majority of them was only known by local communities as wild fruit, while few of them have been exploded and developed as genetic resources for improvement the quality of kiwi fruit. As a result, it also has significance for the identification and evaluation of excellent genes of plant resources.

In conclusion, protection and utilization of the genetic resources of crops have become a common aspiration and urgent task. Our paper is of significance to provide an inventory for the collection, preservation, identification and selection of wild plants as genetic resources for cultivated ones.

The area has a complex and diverse topography, various climates and geomorphic types, which partly provide an explanation for the high biodiversity. The climates in E Asia are diverse, with horizontal and vertical zonality. The elevation rises from sea level to Tibetan Plateau with an average elevation of above 4000 m is characterized by an alpine cold climate and vertical climate distribution. Because of this diversity the area harbors enormous biological resources for human survival. Local people cultivated crops to cover the basic human needs for grain, cotton, oil, livestock fodder. Thousands of species are used.

Table 1 Comparisons of genera of the electronic appendix (number of species in brackets) with genera (number of species in brackets) reported in Zeven and de Wet (1982)

Genera reported (number of species in brackets)	Genera reported by Zeven and de Wet (1982)
Oscillatoriales (Cyanobacteria)	
Spirulina (2)	–
Bangiophyceae (Rhodophyta)	
Porphyra (7)	–
Bryopsidophyceae (Chorophyta)	
Caulorapa (1)	–
Chordariales (Heterocontophyta)	
Cladosiphon (1)	–
Florideophyceae (Rhodophyta)	
Exarteria (1), *Gelidium* (1), *Gracilaria* (3)	–
Phaenophyceae (Heterocontophyta)	
Cladosiphon (1), *Ecklonia* (1), *Laminaria* (1), *Undularia* (3)	Laminaria (1)
Ulvophyceae (Chlorophyta)	
Enteromorpha (4), *Monostroma* (1)	–
Agaricaceae (Basidiomycetes)	
Agaricus (5), *Macrolepiota* (1)	–
Auriculariaceae (Basidiomycetes)	
Auricularia (4)	–
Bolbitiaceae (Basidiomycetes)	
Agrocybe (3)	–
Cantharellaceae (Basidiomycetes)	
Cantharellus (1)	–
Climacodontaceae (Basidiomycetes)	
Mycoleptodonoides (1)	–
Clavicipitaceae (Ascomycetes)	
Cordiceps (2)	–
Coriolaceae (Basidiomycetes)	
Grifola (1), *Trametes* (1)	–
Fistulinaceae (Basidiomycetes)	
Fistulina (1)	–
Ganodermaceae (Basidiomycetes)	
Ganoderma (3)	–
Hericiaceae (Basidiomycetes)	
Hericium (2)	–
Phallaceae (Basidiomycetes)	
Dictyophora (3)	–
Lentinaceae (Basidiomycetes)	
Hoebuehlia (1), *Pleurotus* (8)	–
Polyporaceae s.str. (Basidiomycetes)	
Laetiporus (1), *Neolentinus* (1), *Polyporus* (1), *Wolfiporia* (1)	–
Pluteaceae (Basidiomycetes)	
Volvariella (2)	–
Schizophyllaceae (Basidiomycetes)	
Schizophyllum (1)	–

Table 1 continued

Genera reported (number of species in brackets)	Genera reported by Zeven and de Wet (1982)
Strophariaceae (Basidiomycetes)	
Pholiota (2), *Stropharia* (1)	–
Tremellaceae (Basidiomycetes)	
Tremella (4)	–
Tricholomataceae (Basidiomycetes)	
Flammulina (1), *Hypsizygus* (2), *Lentinula* (1), *Oudemansiella* (1), *Sarcomyxa* (1), *Tricholoma* (2)	–
Ustilaginaceae (Basidiomycetes)	
Yenia (1)	–
Adianthaceae (Pteridophyta)	
Ceratopteris (1)	–
Azollaceae (Pteridophyta)	
Azolla (2)	*Azolla* (1)
Equisetaceae (Peridophyta)	
Equisetum (1)	–
Osmundaceae (Pteridophyta)	
Osmunda (1), *Osmundastrum* (1)	–
Polypodiaceae (Pteridophyta)	
Pteridium (1)	–
Acanthaceae	
Andrographis (1), *Justicia* (2), *Peristrophe* (2), *Strobilanthes* (1), *Thunbergia* (1)	–
Acoraceae	
Acorus (3)	–
Actinidiaceae	
Actinidia (7)	*Actinidia* (4)
Adoxaceae	
Viburnum (3)	–
Aizoaceae	
Tetragonia (1)	*Tetragonia* (1)
Alismataceae	
Sagittaria (1)	*Sagittaria* (1)
Alliaceae	
Allium (11)	*Allium* (9)
Amaranthaceae	
Achyranthes (2), *Amaranthus* (2), *Bassia* (1), *Beta* (1), *Celosia* (2), *Cyathula* (2), *Haloxylon* (1), *Salsola* (1), *Spinacia* (1), *Suaeda* (1)	*Amaranthus* (1), *Bassia* (1), *Corchorus* (1), *Salsola* (2), *Suaeda* (1)
Amaryllidaceae	
Crinum (2), *Lycoris* (3), *Narcissus* (1)	–
Anacardiaceae	
Cotinus (1), *Dracontomelon* (1), *Mangifera* (2), *Pistacia* (3), *Rhus* (2), *Toxicodendron* (2)	*Rhus* (2)

Table 1 continued

Genera reported (number of species in brackets)	Genera reported by Zeven and de Wet (1982)
Apocynaceae	
Alstonia (1), *Apocynum* (1), *Cerbera* (1), *Cynanchum* (3), *Dischidia* (1), *Dregea* (1), *Holarrhena* (1), *Hoya* (1), *Metaplexis* (1), *Nerium* (1), *Rauvolfia* (2), *Tabernaemontana* (1), *Telosma* (1)	–
Aquifoliaceae	
Ilex (3)	*Ilex* (1)
Araceae	
Alocasia (1), *Amorphophallus* (4), *Colocasia* (2), *Epipremnum* (1), *Lasia* (1), *Philodendron* (1), *Pinellia* (1) *Sauromatum* (1), *Steudnera* (2), *Typhonium* (3)	*Colocasia* (1)
Araliaceae	
Aralia (3), *Eleutherococcus* (2), *Fatsia* (1), *Hedera* (1), *Heteropanax* (1), *Panax* (2), *Tetrapanax* (1)	*Aralia* (1), *Panax* (2), *Tetrapanx* (1)
Aristolochiaceae	
Aristolochia (5), *Asarum* (3)	–
Asparagaceae	
Asparagus (5), *Convallaria* (1), *Hosta* (3), *Liriope* (2), *Ophiopogon* (1), *Polygonatum* (3), *Reineckea* (1), *Rohdea* (1)	*Liriope* (1), *Ophiopogon* (1)
Asphodelaceae	
Anemarrhena (1)	*Anemarrhena* (1)
Asteliaceae	
Cordyline (1)	–
Balsaminaceae	
Impatiens (3)	*Impatiens* (1)
Begoniaceae	
Begonia (2)	–
Berberidaceae	
Berberis (2), *Dysosma* (1), *Epimedium* (2), *Mahonia* (4), *Nandina* (1)	–
Bignoniaceae	
Camptis (1), *Catalpa* (3), *Mayodendron*(1), *Oroxylum* (1), *Pauldolphia* (1)	–
Boraginaceae	
Lithospermum (2)	*Lithospermum* (1)
Burseraceae	
Canarium (2)	*Canarium* (1)
Buxaceae	
Buxus (4), *Simmondsia* (1)	–
Cabombaceae	
Brasenia (1)	*Brasenia* (1)
Calycanthaceae	
Chimonanthes (2)	–
Campanulaceae	
Adenophora (3), *Codonopsis* (2), *Platycodon* (2)	*Codonopsis* (1), *Platycodon* (1)
Cannabaceae	
Cannabis (1), *Humulus* (2)	*Cannabis* (1), *Humulus* (3)

Table 1 continued

Genera reported (number of species in brackets)	Genera reported by Zeven and de Wet (1982)
Caprifoliaceae	
Lonicera (3), *Sambucus* (1)	–
Caryophyllaceae	
Gypsophila (1), *Dianthus* (1), *Psammosilene* (1)	–
Celastraceae	
Euonymus (2), *Tripterygium* (1)	*Euonymus* (1), *Tripterygium* (1)
Chloranthaceae	
Chloranthus (2)	*Chloranthus* (1)
Combretaceae	
Anogeissus (1), *Combretum* (2)	–
Commelinaceae	
Commelina (1), *Tradescantia* (4)	–
Compositae (Asteraceae)	
Achillea (1), *Acmella* (1), *Arctium* (1), *Artemisia* (11), *Aster* (2), *Atractylodes* (5), *Carthamus* (1), *Chrysanthemum* (3), *Cirsium* (1), *Crepidiastrum* (2), *Crossostephium* (1), *Dahlia* (1), *Dendranthema* (1), *Doellingeria* (1), *Erigeron* (1), *Eupatorium* (1), *Farfugium* (1), *Glebionis* (2), *Gynura* (2), *Helianthus* (1), *Hololeion* (1), *Ixeridium* (1), *Kalimeris* (1), *Lactuca* (1), *Laggera* (1), *Ligularia* (1), *Petasites* (1), *Solidago* (1), *Tanacetum* (1), *Xanthium* (1)	*Arctium* (1), *Artemisia* (1), *Chrysanthemum* (3), *Gynura* (1), *Lactuca*(2), *Petasites* (1), *Xanthium* (1)
Convolvulaceae	
Calystegia (1), *Ipomoea* (2)	–
Cornaceae	
Aucuba (1), *Cornus* (2), *Helwingia* (1), *Torricellia* (1)	–
Corylaceae	
Corylus (3)	*Corylus* (3)
Crassulaceae	
Bryophyllum (1), *Hylotelephium* (2), *Kalanchoe* (1), *Penthorum* (1), *Sedum* (3), *Sinocrassula* (1),	–
Cruciferae	
Brassica (3), *Capsella* (1), *Eutrema* (2), *Isatis*(1), *Lepidium* (1), *Orychophragmus* (1), *Raphanus* (1), *Rorippa* (1)	*Brassica* (3), *Eutrema* (1), *Raphanus* (1), *Rorippa* (1)
Cucurbitaceae	
Benincasa (1), *Bolbostemma* (1), *Citrullus* (1), *Cucumis* (3), *Cucurbita* (2), *Gynostemma* (1), *Hemsleya* (2), *Hodgsonia* (1), *Lagenaria* (1), *Luffa* (1), *Siraitia* (1), *Thladiantha* (1), *Trichosanthes* (4)	*Cucumis* (2), *Hodgsonia* (1), *Trichosanthes* (2)
Cupressaceae	
Cupressus (2), *Juniperus* (5), *Platycladus* (1), *Cryptomeria* (1), *Cunninghamia* (1), *Glyptostrobus* (1)	–
Cyatheaceae (Cyatheales)	
Cyathea (1)	–
Cycadaceae	
Cycas (4)	–
Cyperaceae	
Carex (3), *Cyperus* (6), *Eleocharis* (1), *Lepironia* (1)	*Carex* (1), *Cyperus* (3), *Eleocharis* (1)
Dioscoreaceae	

Table 1 continued

Genera reported (number of species in brackets)	Genera reported by Zeven and de Wet (1982)
Dioscorea (4), *Tacca* (1)	*Dioscorea* (2)
Dipterocarpaceae	
Dipterocarpus (1)	–
Ebenaceae	
Diospyros (2)	*Diospyros* (2)
Elaeagnaceae	
Elaeagnus (3)	*Elaeagnus* (3)
Ephedraceae	
Ephedra (3)	–
Ericaceae	
Rhododendron (4)	–
Eucommiaceae	
Eucommia (1)	*Eucommia* (1)
Euphorbiaceae	
Alchornea (1), *Aleurites* (1), *Antidesma* (2), *Baccaurea* (1), *Euphorbia* (2), *Hevea* (1), *Jatropha* (1), *Macaranga* (1), *Manihot* (1), *Neoshirakia* (1), *Triadica* (1) *Vernicia* (3)	*Triadica* (1), *Vernicia* (3),
Fagaceae	
Castanea (4), *Quercus* (6)	*Castanea* (2), *Quercus* (4)
Flacourtiaceae	
Hydnocarpus (3), *Idesia* (1), *Itoa* (1)	–
Gentianaceae	
Gentiana (2), *Swertia* (1)	–
Geraniaceae	
Geranium (1), *Pelargonium* (2)	–
Ginkgoaceae	
Ginkgo (1)	*Ginkgo* (1)
Gramineae	
Arundinaria (1), *Arundinella* (1), *Avena* (1), *Bambusa* (36), *Cephalostachyum* (1), *Chimonobambusa* (10), *Coix* (2), *Cympopogon* (1), *Dendrocalamus* (5), *Echinochloa* (2), *Eleusine* (1), *Elymus* (3), *Eriochloa* (1), *Fargesia* (7), *Hordeum* (1), *Ischaemum* (1), *Leymus* (1), *Miscanthus* (4), *Oryza* (1), *Paspalum* (1), *Panicum* (1), *Pennisetum* (1), *Phragmites* (1), *Phyllostachys* (34), *Pleioblastus* (1), *Pseudosasa* (3), *Saccharum* (3), *Sasa* (1), *Secale* (1), *Semiarundinaria* (1), *Setaria* (1), *Sinobambusa* (2), *Sorghum* (1), *Spodiopogon* (1), *Themeda* (1), *Thyrsostachys* (1), *Triticum* (4), *Yushania* (1), *Zea* (1), *Zizania* (1), *Zoysia* (5)	*Avena* (1), *Bambusa* (12), *Chimonobambusa* (1), *Echinochloa* (2), *Hordeum* (1), *Leymus* (1), *Miscanthus* (1), *Oryza* (1), *Paspalum* (1), *Phyllostachys* (7), *Pseudosasa* (1), *Saccharum* (1), *Setaria* (1), *Sinobambusa* (1), *Sinocalamus* (1), *Sorghum* (1), *Triticum* (1), *Zea* (1), *Zizania* (1)
Grossulariaceae	
Ribes (5)	*Ribes* (3)
Guttiferae	
Garcinia (3)	–
Haloragaceae	
Myriophyllum (1)	–
Hamamelidaceae	
Distylium (1), *Liquidambar* (1), *Loropetalum* (2)	–

Table 1 continued

Genera reported (number of species in brackets)	Genera reported by Zeven and de Wet (1982)
Hydrangeaceae	
Dichroa (1), *Hydrangea* (1)	–
Hydrocharitaceae	
Ottelia (2), Valisneria (1)	–
Iridaceae	
Gladiolus (1), *Iris* (7)	*Iris* (2)
Juglandaceae	
Carya (4), *Juglans* (8), *Pterocarya* (1)	*Juglans* (4)
Juncaceae	
Juncus (1)	–
Labiatae	
Agastache (1), *Anisochilus* (1), *Elsholtzia* (5), *Leonurus* (2), *Lycopus* (1), *Mentha* (1), *Mosla* (2), *Nepeta* (4), *Orthosiphon* (1), *Perilla* (1), *Pogostemon* (1), *Prunella* (1), *Salvia* (1), *Scutellaria* (1), *Stachys* (1), *Teucrium* (2)	*Elsholtzia* (1), *Mentha* (1), *Perilla* (1), *Stachys* (1)
Laminariales (Phaeophyceae)	
Ecklonia (1), *Laminaria* (1), *Undaria* (3)	*Laminaria* (1)
Lardizabalaceae	
Akebia (1), *Holboellia* (2), *Stauntonia* (1)	–
Lauraceae	
Cinnamomum (9), *Laurus* (1), *Lindera* (2), *Litsea* (2), *Persea* (1)	*Cinnamomum* (2)
Leguminosae	
Acacia (3), *Aeschynomene* (1), *Afzelia* (1), *Albizia* (2), *Amphicarpea* (1), *Arachis* (1), *Astragalus* (3), *Bauhinia* (1), *Bowringia* (1), *Caesalpinia* (3), *Canvalia* (2), *Caragana* (2), *Cassia* (2), *Cercis* (1), *Chamaecrista* (2), *Christia* (1), *Codariocalyx* (1), *Crotalaria* (1), *Cullen* (1), *Dalbergia* (1), *Dialium* (1), *Desmodium* (1), *Entada* (1), *Erythrina* (1), *Erythrophleum* (1), *Gleditsia* (3), *Glycine* (2), *Glycirrhiza* (2), *Indigofera* (2), *Kummerovia* (2), *Lathyrus* (1), *Lens* (1), *Lespedeza* (5), *Lotononis* (1), *Medicago* (3), *Melilotus* (1), *Mucuna* (3), *Phaseolus* (3), *Pisum* (1), *Pueraria* (2), *Robinia* (1), *Saraca* (1), *Senna* (5), *Sophora* (4), *Stylosanthes* (1), *Tamarindus* (1), *Thermopsis* (1), *Vicia* (5), *Vigna* (4), *Wisteria* (3)	*Astragalus* (1), *Canavalia* (1), *Gleditsia* (1), *Glycine* (2), *Lespedeza* (3), *Mucuna* (1), *Phaseolus* (1), *Pueraria* (1), *Vicia* (1), *Vigna* (1), *Wisteria* (1)
Lemnaceae	
Spirodela (1)	
Liliaceae	
Aspidistra (1), *Cardiocrinum* (2), *Erythronium* (1), *Fritillaria* (6), *Lilium* (9)	*Fritillaria* (1), *Lilium* (4) –
Magnoliaceae	
Magnolia (16), *Liriodendron* (1), *Michelia* (1), *Tsongiodendron* (1)	*Magnolia* (1)
Malvaceae	
Abelmoschus (1), *Abutilon* (1), *Corchorus* (2), *Firmiana* (1), *Gossypium* (3), *Hibiscus* (5), *Malva* (2), *Microcos* (1), *Sterculia* (6)	*Abutilon* (1), *Corchorus* (1), *Gossypium* (1), *Hibiscus* (1), *Malva* (2)
Meliaceae	

Table 1 continued

Genera reported (number of species in brackets)	Genera reported by Zeven and de Wet (1982)
Aglaia (1), *Aphanamixis* (1), *Melia* (1)	–
Menispermaceae	
Cocculus (1), *Stephania* (2)	*Cocculus* (1)
Menyanthaceae	
Nymphoides (1)	–
Moraceae	
Artocarpus (3), *Broussonetia* (2), *Cudrania* (1), *Ficus* (4), *Morus* (7)	*Broussonetia* (2), *Morus* (1)
Moringaceae	
Moringa (1)	–
Musaceae	
Musa (3), *Musella* (1)	*Musa* (1)
Myricaceae	
Morella (2)	*Morella* (1)
Myrsinaceae	
Ardisia (3)	–
Myrtaceae	
Eucalyptus (48), *Eugenia* (1), *Melaleuca* (1), *Psidium* (1), *Rhodomyrtus* (1), *Syzygium* (7), *Callistemon* (1)	–
Nelumbonaceae	
Nelumbo (1)	–
Nepenthaceae	
Nepenthes (1)	–
Nymphaeaceae	
Euryale (1), *Nuphar* (2), *Nymphaea* (1)	*Euryale* (1)
Nyssaceae	
Camptotheca (1)	–
Oleaceae	
Forsythia (3), *Fraxinus* (1), *Jasminum* (1), *Ligustrum* (3), *Osmanthus* (1), *Syringa* (2)	*Fraxinus* (1), *Ligustrum* (3), *Osmanthus* (1)
Orchidaceae	
Anoectochilus (2), *Bletilla* (1), *Cremastra* (1), *Cymbidium* (6), *Dendrobium* (4), *Eria* (1), *Gastrodia* (1), *Holcoglossum* (1), *Luisia* (1), *Neofinetia* (1), *Nervilia* (1)	–
Orobanchaceae	
Cistanche (1)	–
Paeoniaceae	
Paeonia (7)	–
Palmae	
Calamus (4), *Caryota* (1), *Livistona* (1), *Raphia* (1), *Trachycarpus* (1)	*Trachycarpus* (1)
Papaveraceae	
Dactylocapnos (1), *Corydalis* (3), *Eomecon* (1), *Lamprocapnos* (1), *Macleaya* (1), *Papaver* (1)	–
Pedaliaceae	
Sesamum (1)	*Sesamum* (1)

Table 1 continued

Genera reported (number of species in brackets)	Genera reported by Zeven and de Wet (1982)
Phrymaceae	
Phryma (1)	–
Phytolaccaceae	
Phytolacca (2)	*Phytolacca* (1)
Pinaceae	
Cedrus(1), Pinus (6)	–
Piperaceae	
Piper (2)	–
Plantaginaceae	
Plantago (1), *Rehmannia* (1), *Veronica* (3)	*Plantago* (1), *Veronica* (1)
Podocarpaceae (Gymnospermae)	
Podocarpus (2)	–
Polygalaceae	
Polygala (1)	–
Polygonaceae	
Fagopyrum (2), *Persicaria* (4), *Reynoutria* (3), *Rheum* (5), *Rumex* (3), *Polygonum* (1)	*Fagopyrum* (1), *Persicaria* (2), *Rheum* (3)
Pontederiaceae	
Monochoria (2)	–
Primulaceae	
Lysimachia (1), *Primula* (1)	–
Ranunculaceae	
Aconitum (6), *Adonis* (1), *Anemone* (1), *Actae* (1), *Clematis* (1), *Coptis* (3), *Nigella* (1), *Pulsatilla* (1), *Ranunculus* (1), *Thalictrum* (2)	*Aconitum* (1), *Coptis* (1)
Rhamnaceae	
Colubrina (1), *Hovenia* (1), *Rhamnus* (3), *Ziziphus* (2)	*Hovenia* (1), *Ziziphus* (2)
Rosaceae	
Agrimonia (1), *Chaenomeles* (5), *Crataegus* (5), *Docynia* (2), *Duchesnea* (1), *Eriobotrya* (1), *Filipendula* (1), *Fragaria* (10), *Malus* (19), *Photinia* (1), *Prunus* (27), *Pyracantha* (1), *Pyrus* (9), *Raphiolepis* (1), *Rosa* (8), *Rubus* (12), *Sanguisorba* (1), *Spiraea* (1)	*Chaenomeles* (1), *Crataegus* (1), *Duchesnea* (1), *Eriobotrya* (1), *Fragaria* (1), *Malus* (8), *Prunus* (15), *Pyrus* (6), *Rosa* (1), *Rubus* (3)
Rubiaceae	
Gardenia (2), *Antocephalus* (1), *Morinda* (1), *Mussaenda* (1), Pentas (1), *Lucilia* (1), *Ixora* (1), *Serissa* (2)	*Gardenia* (1)
Rutaceae	
Atalantia (1), *Citrus* (21), *Clausena* (2), *Dictamnus* (1),*Tetradium* (3), *Fortunella* (7), *Orixa* (1), *Phellodendron* (2), *Poncirus* (1), *Severinia* (1), *Triphasia* (1), *Zanthoxylum* (8)	*Citrus* (3), *Fortunella* (4), *Triphasia* (1), *Zanthoxylum* (2)
Salicaceae	
Salix (5)	–
Sapindaceae	
Dimocarpus (2), *Koelreuteria* (3), *Litchi* (1), *Sapindus* (3), *Xanthoceras* (1)	*Dimocarpus* (1), *Litchi* (1), *Sapindus* (1)
Sapotaceae	

Table 1 continued

Genera reported (number of species in brackets)	Genera reported by Zeven and de Wet (1982)
Pouteria (1), *Xantholis* (1)	–
Saururaceae	
Houttuynia (1)	–
Saxifragaceae	
Saxifraga (1)	–
Schisandraceae	
Illicium (2), *Kadsura* (1), *Schisandra* (1)	*Illicium* (2)
Scrophulariaceae	
Paulownia (3), *Scrophularia* (2)	–
Simaroubaceae	
Ailanthus (2), *Brucea* (1)	*Ailanthus* (1)
Smilacaceae	
Smilax (1)	–
Solanaceae	
Capsicum (1), *Lycium* (2), *Przewalskia* (1), *Scopolia* (6), *Solanum* (3)	*Solanum* (1)
Stemonaceae	
Stemona (3)	–
Styracaceae	
Styrax (2)	–
Tamaricaceae	
Tamarix (1)	–
Taxaceae	
Taxus (1), *Torreya* (2)	*Torreya* (2)
Taxodiaceae	
Metasequoia (1)	–
Theaceae	
Camellia (13)	*Camellia* (3)
Thymeleaceae	
Aquilaria (1), *Daphne* (2), *Edgeworthia* (2), *Wikstroemia* (3)	*Daphne* (1), *Edgeworthia* (1)
Trapaceae	
Trapa (2)	*Trapa* (2)
Trilliaceae	
Paris (1)	–
Typhaceae	
Sparganium (1), *Typha* (2)	*Typha* (1)
Ulmaceae	
Ulmus (1)	–
Umbelliferae	
Angelica (14), *Bupleurum* (3), *Cnidium* (2), *Conioselinum* (1), *Coriandrum* (1), *Cryptotaenia* (1), *Daucus* (1), *Glehnia* (1), *Heracleum* (3), *Ligusticum* (2), *Nothosmyrnium* (1), *Oenanthe* (1), *Peucedanum* (1), *Pimpinella* (1), *Pleurospermum* (1), *Plectranthus* (1), *Sanicula* (1), *Saposhnikovia* (1), *Seseli* (1), *Sium* (1)	*Angelica* (2), *Cryptotaenia* (1), *Glehnia* (1)
Urticaceae	

Table 1 continued

Genera reported (number of species in brackets)	Genera reported by Zeven and de Wet (1982)
Boehmeria (8), *Oreocnide* (1), *Pilea* (1), *Urtica* (1)	*Boehmeria* (1)
Valerianaceae	
Valeriana (1)	–
Verbenaceae	
Clerodendron (6), *Vitex* (1)	–
Violaceae	
Viola (1)	*Viola* (1)
Vitaceae	
Cayratia (1), *Cissus* (1), *Pathenocissus* (1), *Leea* (2), *Vitis* (5)	*Vitis* (3)
Xanthorrhoeaceae	
Hemerocallis (5)	—
Zingiberaceae	
Alpinia (6), *Amomum* (5), *Curcuma* (2), *Hedychium* (2), *Zingiber* (5)	*Alpinia* (3), *Zingiber* (1)

Citations not present in this concise reference section can be found under references in this electronic appendix

These three countries have a long history for cultivating crops. Results suggest that diversification in agricultural production makes households less vulnerable because diversification protects food production against adverse environmental (Bentley 2003; Chibnik 2008) and economic shocks (Perreault 2005). In relatively remote rural settings, households diversify agricultural production in a variety of ways. Households plant several varieties of crops, scatter plots, stagger the planting season, and use mixed and intercropping (Altieri and Hecht 1990; Macdonald 1998).

The richest genetic pools are located in southwest China. Several hundred of rice cultivars have been cultivated in Yuanyang terraces, Yunnan; more than 60 cultivars of hulless barley have been cultivated in Shangri-La area; many tea plantations with long history of tea cultivation in Xishuangbanna area; Cha-hua (*Camellia reticulata*) is one of China's traditional ornamental flowers developed by the local people of Yunnan Province. Today, more than 500 cultivars and hybrids are recognized (Xin et al. 2015). These crop cultivars were planted by local people for hundreds of years. Some of them have been recognized as Globally Important Agricultural Heritage Systems (GIAHS) sites, relying on its unique land use, water conservancy facilities, traditional crops, and etc., forming unique production systems creating a better match with local natural conditions, such as Yuanyang terraces for paddy rice agriculture. The water requirement of millet, a drought-tolerant crop in Aohan Dryland Farming System (recognized as a GIAHS pilot site in 2012), has a better match with local water conditions. By reducing vulnerability of crops, agriculture survived healthily in semi-arid regions. Honghe Hani Rice Terraces System (recognized as a GIAHS pilot site in 2010), relying on the unique land and water use patterns, has successfully reshaped disaster inducing environments, and effectively reduce the risk/effects of droughts. Besides, due to the higher selling price of local varieties, rich crop diversity and variety of income channel, the Agricultural Heritage sites can ensure the health of economic incomes and agricultural-systems when facing environmental stress. Stress counter-measures of traditional agricultural systems make full use of the regulation and spontaneity ability of the natural systems, which is an important way to achieve sustainable development of ecological agriculture (Lu and Li 2006; Sun et al. 2014).

Previous researches also have shown that knowledge of local crops is related to household crop diversity (Bellon and Brush 1994; Brush 2004), probably because people with more knowledge of cultivated plants are better able to plant more crops than people with less knowledge of cultivated plants. The East Asiatic region is characterized by high cultural diversity too. Southwest China is known as the "kingdom of plants". So far, 25,998 species and intraspecific taxa have been recorded (Fu et al. 2001).

Of these 9190 are endemic. The medicinal flora of Southwest China is composed of approximately 5751 species, representing 80% of China's medicinal flora (Chen 1994).

Ethnobotanical importance

Ethnobotanical studies have been undertaken to document traditional knowledge, provide new plant materials for industrial development, screening for new plant drugs, and search for new genetic material and traditional landraces of crops.

In E Asian countries, there are many ethnic groups with very distinct traditional cultures. In southwest China, for example, people from 33 ethnicities have used plant genetic resources as food and traditional medicine for thousands of years, including Achang, Bai, Bulang, Buyi, Tibeten, Dai, De'ang, Dong, Dulong, Hani, Han, Hui, Jinuo, Jingpo, Lahu, Lisu, Lhoba, Maonan, Menba, Miao, Molao, Naxi, Nu, Pumi, Qiang, She, Shui, Tujia, Wa, Yao, Yi, Gelao, and Zhuang people (Yang et al. 2011). Twelve of these groups are unique to the region and the other 21 have more than 80% of their population here (Yang et al. 2011).

The research of crop plants is closely related to ethnobotanical studies. Most landraces of crops have been maintained by indigenous people. About 70–80% of people worldwide rely on traditional herbal medicine to meet their primary health care needs, especially in less well developed countries (Farnsworth and Soejarto 1991). The main income comes from traditional cultivation of crops, and also from agriculture and forestry cultivation. It is urgent to make a comprehensive inventory for E Asia.

Academic significance

A thorough inventory has been made to include most crops. Some narrow-distributed crops recorded in this appendix will be very important for further studies, especially for exploring more main plant sources, including grains, fruits, vegetables, forage, economy, green manure, and ornamental flowers.

Some newly recorded species such as seven *Actinidia* species as the close relative of kiwi fruit, the close relative can serve as sources of excellent crop genes. Wild relatives of crops often contain genes for resisting diseases and insects, adverse conditions and high yield, sources of cytoplasmic male sterility etc. With the development of biotechnology, crop wild relatives will be even more significant for crop improvement in the future (Liu et al. 2008).

So it is very important to study crop germplasm and to protect crop cultivars. The diversity of crops originated from East Asia was demonstrated in "Crop genetic pools for future crop development" section, and the important role of Crop Germplasm Resources in the world was also emphasized. There is no doubt that this will be of great benefit to the study of the origin and diversity of crops and the conservation of biodiversity, and will provide a reliable basis for the development of biodiversity conservation policies in E Asia.

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Compliance with ethical standards

Conflict of interest We declare that we have no conflict of interest.

References

Allaby RG (2008) The rise of plant domestication: life in the slow lane. Biologist 55:94–99

Altieri MA, Hecht SB (1990) Agroecology and rural development in Latin America. Agroecology and small farm development. CRC Press, Boca Raton, pp 113–118

Bellon MR, Brush SB (1994) Keepers of maize in Chiapas, Mexico. Econ Bot 48:196–209

Bentley JW (2003) Economic and ecological approaches to land fragmentation: in defense of a much-maligned phenomenon. Ann Rev Anthr 16:31–67

Brush SB (2004) Farmers' bounty: locating crop diversity in the contemporary world. Yale University Press, New Haven

Bu M (1981) The discussion about cultivated crops origin. Sci Agric Sin 14(4):86–96

Candolle AD (1912) Origine des plantes cultivees. Librairie Felix Alcan, Paris (In French)

Chang KC (1970) Food in Chinese culture. Yale University Press, London

Chang CS, Kim H, Chang KS (2014) Provisional checklist of vascular plants for the Korea Pennisula Flora (KPF) (Version 1.0). Designpost, Korea

Chen SK (1994) Exploitation and utilization of medicinal plant resources in Southwest China. J Nat Resour 9(2):107–111

Chibnik M (2008) Changing fortunes: biodiversity and peasant livelihood in the Peruvian Andes. Revi Estu Soc 99:182–184

Dong YC (2006) Crops and their wild relatives in China. China Agricultural Press, Beijing
Farnsworth NR, Soejarto D (1991) Global importance of medicinal plants. The conservation of medicinal plants. Cambridge University Press, London, pp 25–51
Fu LG, Chen TQ, Lang KY, Hong T, She ML, Liu SL, Fu FD, Li BT (2001) Higher plants of China. Qingdao Publishing House, Qingdao
Fuller DQ (2007) Contrasting patterns of crop domestication and domestication rates: recent archaeobotanical insights from the Old World. Ann Bot 100:903–924
Hammer K (1991) Checklists and germplasm collecting. FAO/IBPGR Plant Gene Resour News 85:15–17
Hammer K (2005) Korea's importance in the East Asiatic gene center. Genet Resour Crop Evol 52:115–116
Hammer K, Ri JDZ, Hoang HDZ (1990) Additional notes to the check-list of Korean cultivated plants. Kulturpflanze 38:173–190
Hammer K, Gebauer J, Al Khanjari S, Buerkert A (2009) Oman at the cross-roads of inter-regional exchange of cultivated plants. Genet Resour Crop Evol 56:547–560
Hammer K, Laghetti G, Pignone D (2011) Linguistic Islands and plant genetic resources—the case of the Arbëreshë. ARACNE, Rome
Hammer-Spahillari M, Xhuveli L, Hammer K (2011) A short history of the cultivated plants of Albania and their annotated checklist. In: Hammer K, Laghetti G, Pignone D (eds) Linguistic Islands and plant genetic resources—the case of the Arbëreshë. ARACNE, Rome, pp 71–99
Hanelt P, Institute of Plant Genetics and Crop Plant Rsearch (IPK) (2001) Mansfeld's encyclopedia of agricultural and horticultural crops. Springer, Berlin
Harlan JR (1971) Agricultural origins, centres and noncentres. Science 144:468–474
Hawkes JG (1998) Back to Vavilov: Why were plants domesticated in some areas and not in others? In: Damania AB, Willcox G, Qualset CO (eds) The origins of agriculture and crop domestication. Proceedings of the Harlan symposium, ICARDA, Aleppo, pp 5–8
Ho P (1977) The indigenous origins of Chinese agriculture. In: Reed CA (ed) Origins of agriculture. Mouton Press, Hague
Kubitzki K, Krutzsch W (1998) Origins of east and Southeast Asian plant diversity. In: Chang AL, Wu SK, Raven PH, Iwatsuki K, Kubitzki K, Wu CY (eds) Floristic characteristics and diversity of East Asian plants. China Higher Education Press, Beijing, pp 56–70
Lang KY (1994) Studies on the distribution patterns of some significant genenera in Orchid flora. Acta Phytotax Sin 32:328–339
Li HL (1970a) The origin of cultivated plants in Southeast Asia. Econ Bot 24(1):3–19
Li HL (1970b) The origin of cultivated plants in Southeast Asia. Econ Bot 24:3–19
Li XW, Li J (1997) The Tanaka-Kaiyong line—an important floristic line for study of the Flora of East Asia. Ann Miss Bot Gard 84:888–892
Li CY, Zhang GY, Hammer K, Yang CY, Long CL (2011) A checklist of the cultivated plants of Yunnan (PR China). Genet Resour Crop Evol 58:153–164
Liu X, Zheng DS, Dong YC, Zhu DW, Fang JH, Fei YL, Jia JX, Jiang YQ, Yang QW, Wang SM (2008) Diversity assessment of crops and their wild relatives in China. J Plant Genet Resour 9:411–416
Long CL, Ni YN, Long B, Zhang XB, Xin T (2015) Biodiversity of Chinese ornamentals. Acta Hort 1087:209–220
Lu JB, Li X (2006) Review of rice–fish-farming systems in China—one of the globally important ingenious agricultural heritage systems (GIAHS). Aquaculture 260:106–113
Macdonald KI (1998) Rationality, representation, and the risk mediating characteristics of a Karakoram mountain farming system. Hum Ecol 26:287–321
Mansfeld R (1959) Vorläufiges Verzeichnis landwirtschaftlich oder gärtnerisch kultivierter Pflanzenarten, suppl. 2. Kulturpflanze, Berlin
Meng HF, Jin GL, Weng ZY (2003) Investigation on resource of ancient *Torreya grandis* trees in Zhuji City, China. J Zhejiang For Coll 20(2):134–136
Mien C (1984) The floristic relationship between Eastern China and Japan. Acta Phytotaxon Sin 22(1):1–5
Perreault T (2005) Why chacras (swidden gardens) persist: agrobiodiversity, food security, and cultural identity in the Ecuadorian Amazon. Hum Organ 64:327–339
Schultze-Motel J (ed) (1986) Rudolf Mansfelds Verzeichnis landwirtschaftlicher und gärtnerischer Kulturpflanzen (ohne Zierpflanzen). Akademie-Verlag, Berlin
Scociety of Crop Genetic Resources (1994) Crop genetic resources in China. China Agriculture Press, Beijing
Sun XP, Min QW, Bai YY, Fuller AM (2014) Analyzing environmental stress counter-measures in agricultural heritage sites in China. J Resour Ecol 5:328–334
Takhtajan A (1986) Floristic regions of the world. University California Press, Berkeley, pp 39–78
Tanaka T (1954) Species problem in *Citrus.* A critical study of wild and cultivated units of Citrus, based upon field studies in their native homes. Japanes Society for the Promotion of Science, Ueno
Thompson JL, Gebauer J, Hammer K, Buerkert A (2010) The structure of urban and peri-urban gardens in Khartoum, Sudan. Genet Resour Crop Evol 57:487–500
Vavilov NI (1935) Theoretical bases of plant breeding. General principles of plant breeding, vol. I. Kolos, Moscow
Vavilov NI (1940) Origin and geography of cultivated plants. Cambridge University Press, Cambridge
Wu CY (1993) Delineation and unique features of the Sino-Japanese floristic region—a speech at the XV International Botanical Congress, Tokyo
Wu ZY, Raven PH, Hong DY (2003) Flora of China, vol. 1: Introduction. Science Press, Beijing
Xin T, Riek JD, Guo HJ, Jarvis D, Ma LJ, Long CL (2015) Impact of traditional culture on *Camellia reticulata* in Yunnan, China. J Ethnobiol Ethnomed 11:74
Xue DY (2005) Status and protection of bio-genetic resources in China. China Environmental Science Press, Beijing
Yang YQ, Fang L, Ma KJ, Jin J, He ZZ (2011) Research status and development for cross-border ethnomedicine in Yunnan. J Med Pharm Chin Minor 17:1–4
Zeven AC, de Wet JMJ (1982) Dictionary of cultivated plant and their regions of diversity. Centre for Agricultural Publishing and Documentation, Wageningen