Genetic Resources of Under-utilized Crop Plants in Asia

ZHOU, Ming-De*

Abstract

Plant genetic resources are important in initiating any crop improvement program. Significant advances have been made in the past in important food crops and other economic species by exploiting useful genetic variability. However, not much attention has been paid to relatively lesser-known, underutilized crop plants that are also of considerable food value.

Asia is rich in under-utilized crops. According to Dr. R. K. Arora, who has reviewed the genetic resources of lesser-known cultivated food plants in different parts of the world, the maximum diversity of lesser-known cultivated food plants occurs in the Chinese-Japanese, Indo-Chinese, Indonesian, South American and African centers. Of 990 lesser-known food plants, 36% occur in Asia. Arora divided 900 lesser-known food plants into several use-based categories viz. tuberous types, vegetables, fruits and seeds/nuts. According to his account, there were 48 tuber and root types, 135 kinds of vegetables, 30 types of fruits and 33 kinds of seeds/nuts plus 57 other miscellaneous lesser-known food plants in Asia. However, it seems difficult to define what actually are lesser-utilized crops. They vary from country to country and area to area. The major criteria for determining priorities of lesser-utilized crops are: the risk that genetically diverse material of the species and their wild relatives will be lost in the future as a result of change and development in agriculture and land use, including adoption of new varieties; the economic and social importance of the materials measured in terms of their present usefulness and their expected potential contribution to the development of mankind and the situation of existing collections of the species. Some lesser-utilized crops in Asia such as buckwheat, safflower, millets, sesame, minor food legumes and amaranths are described in this paper.

IBPGR has always attached great importance to plant genetic resources activities in Asia. Since its establishment in 1974, IBPGR has been heavily involved in collecting cultivated materials and then later shifted towards collecting wild crop relatives and forages. The major concern about the loss of primitive forms in the 1970 s was for cereals such as rice, wheat, maize, sorghum, etc. Since then, the priorities for action on crops determined by IBPGR have been expanded and genetic conservation activities initiated on a very broad range of materials. More recently much emphasis has been placed on lesser-utilized crops with good development potential.

The spread of high-yielding varieties and availability of better types suited to varied tastes are threatening many lesser-known native crops with extinction. The crops that are now called lesser-utilized crops will possibly have more importance in the future. There is an urgent need to take action on lesser-utilized crops to improve their conservation and utilization.

Introduction

Plant genetic resources are important in initiating any crop improvement program. Significant ad-

---

Presented at the 27th International Symposium on "Plant Genetic Resource Management in the Tropics", Tsukuba, Ibaraki, Japan, 25-26 August 1993, held by Tropical Agriculture Research Center (TARC).

* Coordinator, IBPGR East Asia Regional Office, c/o CAAS, 30 Bai Shi Qiao Road, Beijing, China.

vances have been made in the past in important food crops and other economic species by exploiting useful genetic variability. However, not much attention has been paid to relatively lesser-known, under-utilized crop plants that are also of considerable food value.

Asia is rich in under-utilized crops. According to Arora (1985), who reviewed the genetic resources of lesser-known cultivated food plants in different parts of the world, the maximum diversity of lesser-known cultivated food plants occurs in the Chinese-Japanese, Indo-Chinese, Indonesian, South American and African centers. Of 990 lesser-known food plants, 36% occur in Asia. Arora divided 900 lesser-known food plants into several use-based categories viz. tuberous types, vegetables, fruits and seeds/nuts. According to his account, there were 48 tuber and root types, 135 kinds of vegetables, 30 types of fruits and 33 kinds of seeds/nuts plus 57 other miscellaneous lesser-known food plants in Asia. However, it seems difficult to define what actually are lesser-utilized crops. They vary from country to country and area to area. The major criteria for determining priorities of lesser-utilized crops are: the risk that genetically diverse materials of the species and their wild relatives will be lost in the future as a result of change and development in agriculture and land use, including adoption of new varieties; the economic and social importance of the materials measured in terms of their present usefulness and their expected potential contribution to the development of mankind and the situation of existing collections of the species.

Some less-utilized crops in Asia

1 Buckwheat

Buckwheat is not a major but a important crop in Asia. It is considered that buckwheat was first cultivated in China more than 2,000 years ago. It has also long been grown in every country of East Asia and along the eastern part of the Himalayas. Due to its wide distribution, buckwheat exhibits enormous agroecological diversity. There is a wide diversity in cultivated species (Table 1).

Table 1 Buckwheat germplasm preserved in some countries of Asia

Country	No. of accessions preserved			
	F. esculentum	*F. tataricum*	*F. cymosum*	Total
China	897	550	64	1511
India	242	132	5	453
Japan	510	121	7	638
DRP Korea	200	—	—	200
R. Korea	241	—	—	241
Nepal	75	80	—	450*

In addition, India holds 52 accessions of *F. emarginatum*, 22 of *F. himalianum* and 100 introductions.

* Nepal has recently collected 295 new accessions which are now being characterized.

According to some authorities, the genus *Fagopyrum* has 15 species in the world, of which 10 are distributed in China. The annual cultivated types *F. esculentum* and *F. tataricum* and the perennial wild type *F. cymosum* are distributed widely in China. The other wild species *F. urophyllum, F. static, F. leptopotum, F. luneare, F. gracilipes, F. caudalum* and *F. gilesii* are mainly distributed in the Yunnan-Guizhou plateau. Those wild types mostly belong to the annual type but *F. urophyllum* and *F. stalice* belong to the perennial type (Ye Nenggan and Guo Guangqian, 1992).

Buckwheat has a great potential in both East and South Asia as a nutritious food crop and a livestock feed in marginal lands. And it also has the ability to fit into diverse cropping patterns. It is a staple food of the Yi nationality in Yunnan, Sichuan Provinces of China. Japanese people like "soba", which is a traditional noodle made from buckwheat (*Fagopyrum esculentum*). However, the planted area has decreased due to the low-yielding capacity and and lower price. It was reported that in the 1950s, the sown

area of buckwheat was 2,250,000 ha, but in 1986 it decreased to 723,333 ha (Yang Keli, 1991). In Japan, sown area of buckwheat in 1907 was 165,000 ha, but it has decreased to around 20,000 ha since 1975. Although it increased to 28,000 ha in 1991, the self-supply ratio is only about 20% at present (Komeichi *et al*., 1991).

2 Sesame

Sesame is an ancient oil crop. Sesame cultivation can be traced back to 5,000 years ago in India and 2,000 years ago in China. The sown area of sesame in Asia ranks first in the world, accounting for 67% of the total sown land of the world (Feng Xiangyun, 1991). Among the 66 countries of the world with sesame cultivation, 24 countries are located in Asia. Although economically, sesame is not a less-utilized crop, however, the cultivation of sesame has declined due to its low productivity. At present, China holds 3,121 accessions of sesame in the National Gene bank, Beijing as base collection. Around 2,000 accessions were collected in India and the Republic of Korea along with Kenya is responsible for the base collections of world sesame, comprising 1,457 accessions. In Japan, 119 accessions of sesame are preserved at the National Institute of Agrobiological Resources, MAFF, Tsukuba.

3 Safflower

Safflower is a minor but important crop in Asia. It has been grown for a long time in India, Middle and Near East and China. Safflower seed can be used as edible oil and its flower can be used as an herbal medicine. According to Dr. Li Dajue, among the total world collections of safflower, around one-third (or 783 accessions) originates from India. Safflower has also a long history of cultivation in China, recorded since 2,100 years ago. Safflower germplasm collections preserved in the gene banks of Asia are listed in Table 2.

Table 2 Safflower germplasm preserved in Asia

Institute	pecies	No.
Inst. of Crop Germplasm Resources CAAS, Beijing, China	*C. tinctorius*	178
Beijing Botanical Garden, IB, CAS, Xiangshan, Beijing, China	*C. tinctorius*	2010
NBPGR, Pusa Campus New Delhi, 110012, India	*C. tinctorius*	1050
NBPGR, RS, M. P. Krishi Vidyapeeth, Akola, India	*C. tinctorius*	928
Inst. of Pyongyang Crop Genetic Resources, KAAS, Pyongyang, DPR. Korea	*C. tinctorius*	26

4 Minor millets

Foxtail millet (*Setaria italica*) is an ancient crop, probably domesticated in Asia and known to the Chinese as early as 2,700 BC. The main producing areas in the world are China, India, Japan and eastern Europe. At present, China holds 16,290 accessions of foxtail millet (Jiang Chaoyu *et al*., 1992), India possesses 1,751 accessions (A. Seetharam, 1989). Japan preserves 358 accessions (M. Kawase, 1991) and there are 329 accessions in Mongolia. In addition, foxtail millet is also grown in Bangladesh. Sri Lanka, Nepal, DPR Korea, and R. Korea.

Proso millet or common millet (*Panicum miliaceum*) is also an ancient crop. It was probably domesticated in central and eastern Asia. It has been grown in China for 5,000 years. There are 5,492 accessions of proso millet conserved at the National Gene Bank in Beijing, China (Jiang Chaoyu, *et al*., 1992), about 577 accessions in India (A. Seetharam, 1989), 272 accessions in Sri Lanka (S. Ponnuthurai, 1989) and 112 accessions in Japan (M. Kawase, 1991). More information is listed in Table 3.

Table 3 Millet germplasm conserved in some countries of Asia

Country	Foxtail millet	Finger millet	Proso millet	Little millet	Barnyard millet	Kodo millet	Total
India	1951	4490	577	644	816	965	9443
China	16290	—	5492	—	—	—	21782
Japan	358	119	112	—	205	—	794
Mongolia	329	—	—	—	329		
DPR Korea	54	—	—	—	54		

Including foxtail millet and proso millet.

5 Amaranthus spp.

Although amaranthus are of American origin, a rich diversity can be found in Asia and in the Himalayas in particular. Grain amaranthus are wildly grown in India and China as forage crop and leaf vegetable. Grain amaranthus assume considerable importance as an under-utilized food plant having potential for the future due to their value as a high protein diet. It was reported that India holds 3,000 collections of cultivated amaranths and their wild relatives at the Regional Station of the National Bureau for Plant Genetic Resources at Shimla (Paroda, R. S., 1991). About 400 accessions have been collected in China, including *Amaranthus paniculatus, A. caudatus, A. hypochondriacus* species, respectively used as grain food, vegetable and forage (Yue Shaoxian *et al*., 1993). In Mongolia and in the Korean peninsula, amaranthus are grown as a vegetable.

6 Lathyrus

Lathyrus sativus is a major pulse and fodder crop in South Asia and to some extent in West Asia. Due to its adaptation to marginal conditions and the presence of a neurotoxin known as BOAA, or OADP, the sown area is declining and landrace diversity is in danger of being lost. *Lathyrus* improvement activities are being carried out in India, Bangladesh, Nepal, Pakistan and Syria.

IBPGR activities on under-utilized crop germplasm

IBPGR has attached a great importance to plant genetic resources activities in Asia. Since its establishment in 1974, IBPGR has been heavily involved in collecting cultivated materials and then later shifted towards collecting wild crop relatives and forages. The major concern about the loss of primitive forms in the 1970 s was focussed on cereals such as rice, wheat, maize, sorghum etc. Since then, the priorities for action on crops determined by IBPGR have been expanded and genetic conservation activities have been initiated for a very broad range of materials. More recently much emphasis has been placed on lesser-utilized crops with good development potential.

An IBPGR workshop on less-utilized Crop Genetic Resources of East Asia was held in April 1991, in Beijing, China. The Workshop brought together national coordinators/curators of plant genetic resources and specialists in particular less-utilized crops and discussed priorities for action in the future. As mentioned above, under-utilized crops may vary from country to country. However, common interest in under-utilized crops focussed on buckwheat, millet, food legumes and some small fruits, e. g. persimmon and prune in East Asia, (Zhou Ming-De, 1991). The IBPGR Workshop on Buckwheat Genetic Resources in East Asia was held at the National Institute of Agrobiological Resources, Tsukuba, Japan in September, 1991. Buckwheat specialists from East Asia and neighbouring countries, India and Nepal, and IBPGR Acting Director, Dick van Sloten and other staff attended the workshop. Following this workshop, IBPGR, In collaboration with Shanxi Academy of Agricultural Sciences and Chinese Cooperative of Breeding, Cultivation and Utilization of Buckwheat, organized the 5 th International Symposium on Buckwheat in August 1992 in Taiyuan, China.

IBPGR was one of the organizers of the Third International Conference, held in Beijing, China during 14-18 June 1993. Dr. Ramanatha Rao was elected Chairman of the International Safflower Germplasm Advisory Committee.

IBPGR is organizing a "Regional Workshop on Sesame Evaluation and Improvement" in collaboration with India, which will be taking place in September 1993 at Nagpur/Akola. Twelve participating coutries have sent 30 accessions of local germplasm and advanced materials to India. NBPGR Regional Station has grown over 4,000 accessions of sesame including most of the sesame world collection in its farm. The participants will be able to select promising accessions for use in their national program.

No doubt, all these workshops/conferences have raised public awareness of the importance of under-utilized crop genetic resources, promoted exchange of germplasm and their related information, and promoted the sharing of the latest research results. These activities will eventually improve conservation and use of such crop genetic resources.

Assembly of a germplasm collection representing the genetic diversity in a crop species is a prerequisite for its effective study, conservation and utilizaion for crop improvement. IBPGR had supported a number of germplasm collecting missions for various crops and related wild species, including safflower, millet and food legumes. Taking safflower as an example, systematic collection of safflower germplasm was initiated by Knowles and his coworkers (Knowles, 1969 ; Knowles, 1977). However, safflower variation from China was under-represented. IBPGR supported a safflower germplasm collecting mission during May-June, 1990 in China. The area explored included Fujian, Zhejiang, Anhui, Jiangsu and Shandong provinces and 48 accessions were collected.

Characterization and evaluation of these safflower collections will help the user to identify accessions with desirable traits for use in crop improvement programs. IBPGR has supported a number of efforts by national programs to characterize and evaluate germplasm. In East Asia, such activities included the project on characterization and evaluation of world safflower germplasm, implemented by the Beijing Botanical Garden, Institute of Botany, Chinese Academy of Sciences. Under this project, about 2,000 accessions were characterized and evaluated in Beijing, Inner-Mongolia, Xinjiang and Yunnan Provinces or Autonomous Region for 50 characters. Seeds and related data are available to users. Another project on multiplication and characterization of buckwheat was supported by IBPGR and implemented by the Institute of Crop Germplasm Resources, Chinese Academy of Agricultural Sciences. About 300 accessions of Chinese buckwheat were evaluated for agronomic and biological characters. The seeds are available from the Institute. In Nepal, IBPGR supported studies to characterize, evaluate and regenerate over 1,000 accessions of hill crops in 1991.

For efficient studies and use of genetic resources, information on the materials being conserved should be analysed and be available for use by interested collaborators. IBPGR has supported the publication of the results of the characterization and evaluation carried out by Beijing Botanical Garden in the form of a book "Characterization and Evaluation of Safflower Germplasm" which is now available from the Garden.

Early this year, an IBPGR project "Improved Conservation and Use of Under-utilized (crops of regional or local importance) Crops" was implemented in Asia, the Pacific and Oceania region. The under-utilized crops selected for this project are buckwheat, sesame, safflower, minor millet and lathyrus. The project aims at improving the conservation and use of such crops of local importance, under-utilized/ under-exploited which have no regional or international center of expertise for their improvement. The major objectives of this project are to develop a methodology for assessing the potential impact and benefits from improved conservation and use of such crops, to assess their present and latent genetic diversity and to help organize conservation strategies in the region. A number of activities are presently being carried out in collaboration with national programs in the region. This project has made progress.

Future considerations

The increase of the population requires an increase in food supply. On the one hand, we need to use the available rich diversity and wide genetic base to improve the existing cultivars to achieve high yield. On the other hand, it is necessary to look for lesser-utilized food crops and we need to exploit them as future food plants. The crops that are now called lesser-utilized crops will possibly become more important in the future. It is said that grain amaranth may become a major food in the twenty first century. However, in most cases, under-utilized crops are considered to be minor crops, and in some cases, are impor-

tant only in rural areas for subsistence. The sown area for such crops has declined, often due to their low productivity, and also due to the lack of research attention to improve these crops. The diversity of many under-utilized native crops is being threatened. Therefore, there is an urgent need to take action on such under-utilized crops to improve their conservation and utilization.

References

1) Arora R. K. (1985): Genetic resources of lesser known cultivated food plants. New Delhi. pp. 1-7.
2) Fang Xiangyun (1991): Sesame, in Chinese agricultural encyclopaedia (Chinese). Agricultural Publishing House, Beijing, China. pp. 811-817.
3) Jiang Chaoyu *et al*. (1992): The progress of research work on crop germplasm resources in China, Genetic Resources and Crop Evolution. 39, 55-58.
4) Kawase, M. (1991): Less utilized crop genetic resources in Japan. Proceedings of the IBPGR workshop on Under-utilized Crop Genetic Resources of East Asia. April 1991, Beijing.
5) Koreichi, M. *et al*. (1991): Genetic resources of buckwheat in Japan. Papers of the IBPGR Workshop on Buckwheat Genetic Resources in East Asia. September 1991, Tsukuba, Japan.
6) Paroda, R. S. (1991): Foreward. *In*: Grain amaranthus; The future food crops. (Eds) Joshi, B. D. and R. S. Rana, New Delhi.
7) Ramanatha Rao and Zhou Ming-De (1993): Safflower genetic resources - IBPGR Activities. *In*: Proceedings of the Third International Safflower Conference. June, 1993, Beijing, China.
8) Seetharam, A. (1989): Genetic resources of small millets in India, *In*: Small Millet in Global Agriculture. (Eds) A. Seetharam, K. W. Riley & G. Harinarayana, Oxford & IBH Publishing Co, New Delhi.
9) Yang Keli, (1992): Genetic resources of buckwheat in China. *In*: Buckwheat Genetic Resources in East Asia - Papers of the IBPGR Workshop held in Tsukuba, Japan, September 1991. IBPGR, Rome. pp. 3-18.
10) Ye Nenggan and Guo Guangqian (1992): Classification, origin and evolution of geneus *fagopyrum* in China, Proceedings of the Fifth International Buckwheat Symposium. August, 1992, Beijing, China. Agriculture Publishing House, Beijing. pp. 19-28.
11) Yue shaoxian *et al*. (1993): The research and development grain amaranthus in China. *In*: Research and Development of Grain Amaranthus in China. Chinese Agricultural Publishing House, Beijing. pp. 1-10.
12) Zhou Ming-De (1991): Summary of IBPGR Workshop on less utilized crop genetic resources of East Asia. *In*: Proceedings of IBPGR Workshop on Less Utilized Crop Genetic Resources of East Asia. April, 1991, Beijing.