REVIEW ARTICLE

Red Listing of Agricultural Crop Species, Varieties and Landraces

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ABSTRACT

Red listing mechanism has been developed for wild fauna and flora. There are several documents illustrating red listed wild fauna and flora. But there is a lack of information on the red list and red listing criteria of agricultural crop species, varieties or landraces. For initiating on- farm, *in situ* and *ex situ* conservations, red listing is helpful in locating region of crop species, varieties or landraces diversity. The paper reviewed the red listing criteria used for the categorization of wild fauna and flora. Categorization of on-farm crop species, varieties and landraces is based on population, ecological, social, modernization and use criteria. Among them ecological, social and modernization criteria are useful in selecting location for sampling materials for ex situ conservation and appropriate sites for in situ conservation. Modernization and use criteria are suitable for categorization of crop genotypes. Combinations of these criteria are proposed for red listing crop genotypes and areas.

Key words: Agricultural crops, conservation, on farm, red list category, red-listing criteria

INTRODUCTION

Genetic erosion of crop diversity is reported worldwide. Many crop species, varieties or landraces are being lost (Brush 2000). Importance of plant genetic resources is recognized worldwide to cope up with the biotic and the abiotic stresses. Genetic erosion is the common threat to the sustainable use of plant genetic resources to meet the present needs and aspiration of future generations (Chang 1985). There are many examples of genetic erosion in Nepal, even though it is rich in agricultural biodiversity. There are 200 cultivated species, 500 wild edible plants and 120 cultivated plants species reported in Nepal (Upadhyay and Joshi 2003). Tauli, Marsi and Thapachinia, the popular rice varieties of Kathmandu valley are no longer available (Upadhyaya 1995). The spread of high yielding varieties has contributed to the gradual disappearance of landraces besides loss of habitats, market forces and population pressure. Wild progenitors and other wild species depict the same story. Sherchand et al (1998) reported a loss of 145 rice landraces from Bara district alone. Chaudhary et al (2003) reported that genetic erosion was measured in terms of changes in the number of farmers growing each landraces and the areas covered by a landrace. Rijal et al (1998) reported 11 rice landraces under threat and 11 landraces have been lost in Seti River valley. Deforestation, land encroachment and urbanization have further increased the pace of genetic erosion. Realizing the plausible sites of the genetic resources for crop improvement, the concept of red listing of agriculture crop species, varieties or landraces are being proposed. Different genotypes have different values, which resulted in imbalance distribution. Realizing the importance of crops genotypes in present and future, different conservation and utilization strategies were developed. For effectiveness of

these strategies different treatments should be applied to different landraces, varieties or crop species. Therefore categorization of crop species, varieties or landraces in term of their extent and distribution is necessary for locating sites to better *in situ* management and to identify crop species, varieties or landraces for *ex situ* management.

NI Vavilov and H Harlan respectively in the 1920s and 1930s noticed that traditional crop varieties or landraces were lost from the fields and gardens around the world (Brush 2000). For the subsequent 60 years scientific efforts to conserve plant genetic diversity focused on collecting materials and placing them in *ex situ* storage. Institutions were created gene banks were constructed and millions of accessions were accumulated and preserved in low temperature low humidity gene banks. Many sampling strategy were developed for *ex situ* conservation. There is meager study about on- farm conservation. Criteria of landraces categorization under different groups were not reported. We have many survey data on crop varieties/ landraces related to socio-cultural aspects. Lost landraces are indicated based on name of genotypes. Study on frequency distribution of landraces is not common.

Red list is the list of crop species, varieties or landraces whose population are in decreasing trend (the nature of rarity) due to many factors and if such trend continue, these genotypes will disappear in future. A typology of rare species or variety is based upon the geographic range, habitat specificity and local population size (Rabinowitz 1981). Basis of categorizing agricultural crop species, variety or landraces whether these are under red list is necessary to develop strategy for initiating *in situ*, on-farm and *ex situ* conservation appropriately. Important consideration for making the red list of crop landraces is amount and distribution of genetic diversity, process used to maintain diversity, people who maintain diversity and factors that influence farmer's decision making maintaining diverse variety (Sthapit and Jarvis 2002). Red list categorization study is more common in wild fauna and flora. Since agricultural crops contribute economically more, their loss could lead to agricultural crises.

Under the red list, there may be many categories such as extinct, endangered, rare, endemic, no risk, etc. Here different criteria are discussed and simple method of categorizing agricultural crop genotypes is proposed as similar to wild flora and fauna. Such system of categorizing crop genotypes will be useful for developing conservation and utilization strategy.

Categorization of wild fauna and flora

The World Conservation Union (IUCN), Convention on International Trade in Endangered Species of wild flora and fauna (CITES) and Birdlife International have developed their own criteria for wild fauna and flora for red listing (BPP 1995). They have studied many wild species and listed in respective categories. IUCN classifies species in 9 categories. These are extinct, extinct in the wild, critically endangered, vulnerable, conservation dependent, low risk, data deficient and not evaluated. CITES which aims to establish worldwide control over trade in the endangered wild life has listed species within three categories, Appendix I, Appendix II and Appendix III. Appendix I included all species threatened with extinction, which are or may be affected by trade. Appendix II includes those species although not necessarily threatened with extinction now, may become so if the trade on those species is not subject to strict regulation. Additionally CITES classifies species as near threatened if in the near future, they could appear on any of the three lists. Birdlife International at a workshop held in Coimbatore, India 1995 classified the birds of South Asia into three types, 1. Candidate threatened species. 2. Possible candidates for threatened status and 3. Species excluded from candidate list. There are also other institutions that have their own categorical system for red listing. This classification is however difficult to use in on-farm management of cultivated crop varieties.

Categorization of on farm crop landraces

In situ team working in the global project (Strengthening the scientific basis of in situ conservation of agricultural biodiversity – Nepal component) has developed a method of

classifying crop landraces based on number of farmers and areas growing such landraces in particular Village Development Committee (VDC). Rana et al (2000) classified the rice landraces of Kachorwa VDC, Bara into four different cells depending on the average area cultivated and the number of households (HHs) cultivating them (Figure 1). The cut off point for average area used by Rana et al (2000) was less than or more then 0.2 ha (derived from overall average of all landraces at Kachorwa) and the number of HHs was less than or more than five HHs (derived from average of all landraces). The idea behind this categorization was that at least one representative each from four cells would be included in the participatory plant breading program (Joshi et al 2000). Sthapit et al (2001) used this method to understand the farmers' rationale of allocating land area for each variety and distribution pattern based upon socio-economic and ecological factors. Khatiwada et al (1999), Joshi et al (2000), Yadav et al (2003a) and Chaudhary et al (2003) in rice, Yadav et al (2003b) in sponge gourd, Tiwari et al (2003) in finger millet have used this system to categorize landraces. Similar system of landraces and crop species classification was used in Vietnam (Hue et al 2003, Hien and Nguyen 2003).

Figure 1. On farm landrace categorization

Population criteria (Based upon distribution patterns)

Population criteria described by Brush (2000) based on sampling design discussed by Marshall and Brown (1975) are also useful to categorize landraces. This is similar to the method of categorizing on-farm crop landraces. Population criteria are based on the measurement of variation and the number of population to be sampled (Figure 2). Marshall and Brown (1975) identified two critical population parameters, i. the extent of genetic divergence among population and ii. the level of genetic variation of a population. The basis of describing divergence among populations is frequency and distribution of alleles, leading to four different types of alleles. A population with locally common alleles is the primary targets for collection and conservation. Common and widespread alleles are likely to be found wherever a crop is grown and the rare alleles are hard to capture given the limits of collecting. These guidelines may be additional way of classifying crop landraces.

Figure 2. Genetic divergence among population/s

Ecological and social criteria

Brush (2000) has summarized ecological and social criteria by integrating them in a single matrix that is useful in selecting location of *in situ* conservation areas (Figure 3). Ecological criteria are expressed as complex. Places where altitudes, soil and biomes are varied with seasonally and the pressure of wild crop relatives would be judged maximally complex, while locations without these would be classed as having limited complexity. Likewise cultural autonomy and subsistence orientation can be expressed as local vs non-local social integration. The locations for *in situ* conservation using ecological and social criteria are local socio cultural integration and ecological complexity. These selection criteria can then be weighed against two other criteria ie crop population and logistical criteria (physical and social access to the farm region). The selection of regions for an on farm conservation program is suggested with conservation of the population, ecological and social criteria. These ecological and social criteria can also be useful to classifying landraces in the red list.

Figure 3. Ecological and social criteria for selecting *in situ* sites

Modernization criteria

Modern technology directly influences the diversity of landraces and continuation of cultivating local landraces. If availability of modern technology is high, there is more likely to replace local technology. Similarly, landraces cultivated by poor farmers are more likely to be replaced by modern technology than the landrace grown by rich farmers. These criteria (wealth status of farmers and availability of modern technology) are also helpful to classify landraces that are or may be endangered (Figure 4). Another criterion is the existence of specific production environments. The pattern of changing the land use system should also be considered to identify the landraces that are likely to be endangered. Some landraces evolve to adopt to specific environment eg *Bhathi* rice landrace to water logged areas of Bara in situ site.

Use criteria

Value given by farmers to each landrace is an important factor for maintaining landraces. If landrace is tightly linked to socio- cultural system, such landrace is likely to continue in cultivation, provided social-cultural systems are valued. Crop varieties having multiple use value may have less chance to extinct. Similarly landraces with unique traits adapted to specific environment, unless the environment is changed would not be replaced. *Ex situ* conservation and use in breeding program are also important criteria for listing landraces under threatened group. Landraces conserved *ex situ* or used in breeding program may be considered as no risk. With use criteria, Smale et al (2001) proposed least cost sites for on-farm conservation (Figure 5) based on Smale and Bellon (1999) concept. We can relate this similarly as previous criteria to classify crop landraces, varieties or species.

Figure 4. Modern technology and wealth status criteria

Figure 5. Least cost sites for on farm conservation (redrawn from Smale et al 2001)

Proposed red list categories for agricultural crop species, varieties, landraces

Single or combinations of above discussed criteria are being proposed for classifying crop genotypes. Based on the criteria, following categories are proposed to classify landraces, varieties or crop species under the red list data.

Practical analogy of the red list category

1. Extinct (Seed is locally not available for exchange or planting)
2. Endangered or threatened (Few HHs growing varieties in a small areas)
3. Conservation dependent (Many HHs growing variety in a small areas or vice versa)
4. No risk (Commonly grown by many HHs)
5. Not evaluated or data not available

1. Extinct

Landrace is extinct when there is no reasonable doubt that its last individual has died. This is generally reported based on farmer's perception of particular area and landraces. Landrace available in past for many years but no more available in present in a particular area of a VDC is considered an extinct. If such landraces are being conserved *ex situ* these fall under conservation dependent. For example Thapachini variety is extinct from Kathmandu but it is still grown in small areas in Pokhara valley.

2. Endangered or threatened

A genotype is endangered when it is facing a very high risk of extinction in particular area in the medium term. Such genotypes are supposed to be conserved ex situ and/ or use in breeding program. A genotype, which falls under, the cell number 4 of the Figure 1, 2, 3, 4 and 5 is considered as endangered. Among the 4 cells of these Figures, last cell number 4 is considered risky from most of the factors that affect negatively the survival of the genotypes.

3. Conservation dependent

A genotype, which is not, endangered but little effort for on farm conservation can conserve effectively is conservation dependent. The genotypes, which fall under cells number 2 and 3 of Figure 1, 2, 3, 4 and 5 are conservation dependent. Awareness program or value addition is to be necessary for conservation.

4. No risk

A genotype is no risk when it has been evaluated and does not qualify for any of the categories. Crop species, varieties or landraces, which comes under the cell number 1 of Figrue 1, 2, 3, 4 and 5 are considered as No risk.

5. Not evaluated or data not available

A species, variety or landrace is not evaluated when it has not yet been assessed against the criteria.

One example of categorization of on-farm crop landraces based on their areas and number of HHs growing is cited from Rana et al (2000) in Figure 8. There were 6 landraces under endangered category, 10 under conservation and 5 under no risk.

Farmer	Area: Large	Area: Small
Many	Mutmur, Nakhisaro, Muturi, Nakhi and Lalkafaram	Basmati, Satwa and Sathi
Few	Mansara, Batsar, Bhathi, Dudhraj, Ashanni, Karma and Nat Musari	Lalka Basmati, Sokan, Sarho, Satraj, Lajhi, Rango, Gajar, Gaur, Ratrani, Katush, Latongad, Matura, Dushisaro, Lalka Kartik, Gudhani, Anadi, Khera, Mansari and Anga

Figure 6. Rice landraces categorized under four groups based on area and number of households growing them

Assessing status of agricultural crop species, varieties or landraces is necessary to take action against the genetic erosion or to develop site specific or genotype specific conservation strategy. Among different criteria, need based suitable criteria can be used to categorize crop genotypes. Most common criteria would be based on categorization of on-farm crop landraces. Farmers' response is prerequisite and scientific assessment of agricultural crop resources should be added for red listing. For the simplicity and practicality, four categories are being proposed to group the genotypes, which help proceed further for conservation and utilization. In Nepalese context, landrace can be categorized based on areas and number of farmers growing landraces within village development committee or agroecological zones of each district.

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