Application of Economic Criteria in Prioritization of Conservation Methods and Valuation of Plant Genetic Resources

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Biological diversity has been identified as a primary factor of production essential for sustenance and enhancement of crop improvement. Plant breeders' efforts towards crop improvement by way of identification and incorporation of traits from within the available gene pool has been estimated at 8 % per annum in case of rice. Nearly 70 % of the new varieties of hybrids that were developed in crops like wheat, had specific contributions from their wild/local ancestors. So are the cases of crop reinstatement in case of epidemic spell of diseases. This not only highlights the significance of landraces and local varieties, but also stresses the need for effective conservation of genetic resources for posterity. Multilateral Transfer Agreements (MTAs) were the main instrument of accountability for all the transfers involving plant genetic material till very recently. A series of international undertakings, conventions and counter actions starting from the 1983 Rome Convention to CBD have successfully paved the way towards new dimensions to the global use of Plant Genetic Resources (PGR).

Though CBD, through the exclusivity clause (articles 15 and 16) assigns ownership of all biological resources to the state, it is often considered to be the beginning of an end of the global free flow of PGR. It has also opened the way for more dynamic modes of knowledge sharing between the public and private research efforts. The future being focussed towards more frequent interaction leading to the value added products and the need for assigning value for the existing stock gains utmost significance. This preempts the application of economic principles of valuation at various stages of conservation of PGR. Estimates show that huge volume of genetic material from the south has already been transferred to the north block of nations over the last few decades through the free flow of genetic material. Added to this, the future technology transaction costs could be much higher in favour of the north block nations. The only recourse thereby for the south, is to assign value to the existing stock of genetic material, which has been placed outside the preview of any form of intellectual property protection measures, through the DUS criteria prescribed by WTO and TRIPS. Conservation is a common phenomenon in developing nations, but an economic perspective of the same is not yet a reality. This study attempts at an application of economic criteria for selection of suitable method for conservation as well as evaluation of conserved germplasm.

Economic Valuation of Genetic Resources: Economic principles of evaluation can be applied at various stages of conservation. First of all, the basic need for conservation of a specific resource or a species itself is debatable and is a subject for economic decision analysis. The methods of economic analysis, such as the hedonic pricing models or contingent valuation methods, which use subjective valuation of qualitative parameters, are of specific use for such evaluation. The mounting threat of extinction of species is yet another case for conservation. Due to their sheer existence value, conservation is opted as a preventive measure against species extinction.

Economic principle can be applied in the selection of a method as well as in deciding the appropriateness of a specific conservation method selected (Arora and Pandey, 1996). The need for such an analysis arises mainly due to the 'Limited capital' situations that are applicable to R and D expenditure. For example, decision on option between *in situ* vs *ex situ* conservation methods, selecting a specific method for a given species, or a habitat are subjects appropriate for economic as well as other factors while selecting and prioritizing research agenda on conservation of plant genetic resources. Economic criteria using 'directional scoring', fixing range and simple costs and return analysis have been adopted for judging the desirability of a specific method of conservation for PGR.

The economic criteria have been applied for selecting an appropriate method of conservation under the R & D conditions. The various *in situ* and *ex situ* conservation methods and their specific features have been presented in Table 1. Factors such as the applicability, extent and time of preservation may be important while choosing a specific method, while the cost of conservation and the associated level of risk and its quantification will form the parameters for economic analysis while selecting a method.

Based on the nature of the specific character in question and its quantification, appropriate method of judgment, such as a specific 'range' or a 'scale' have been assigned to that feature with an associated rank of 1, 2 or 3 *etc.* The method of ranking is 'directional' in the sense that the specific feature, which is most desirable, gets the highest rank and the next best the second and so on. The total of ranks irrespective of the priority of the factor considered, forms the decision criteria. The least total sum of all ranks is the most desirable followed by the next. To illustrate, among the various *in situ* and *ex situ* conservation methods under consideration, (Table 1) all the *in situ* methods and some of the *ex situ* methods have wider applicability and can conserve species for a longer period and hence are more desirable. Other *ex situ* methods such as the pollen storage and *in vitro* may provide conservation for a limited period of time and hence get a lower rank. Resource requirement in terms of manpower skill required for initiating and maintaining *ex situ* methods such as *in vitro*, pollen bank or cryopreservation may be high as compared to the *in situ* methods such as the botanical garden *etc.* In terms of initial capital out lay, the *in situ* conservation methods may be more demanding both from the point of availability of space and capital, depending on the geographic location and the economic status of the organisation in question.

In terms of global and local priority, the *in situ* conservation methods may be less in preference to the more modern methods. However, the most important of all factors is the ease of reinstatement for the conserved species. The *ex situ* methods of *in vitro*, pollen and cryopreservation provide an almost immediate access of the conserved material for future use, as against the time lag for bringing back or re-establishment for most of the *in situ* or traditional *ex situ* methods of conservation. Therefore, keeping in view, the preference for a specific feature, a score/rank of '1' is given to the most desirable feature and '2' or '3' for the others in that order of preference. The other important factor is the risk involved.

Table 1. Economic criteria for selecting conservation method

	In situ		*Ex situ*						
Criteria/Methods	Biosphere Reserve	Gene sanctuary	On farm	Botanical garden	Field gene Bank	Seed storage	Pollen	*In vitro* storage	Cryo
Applicability	Wide (I)	Wide (I) (I)	Wide (2)	Restricted (2)	Res.	Res (2)	Res (2)	Res (2)	Res (2)
Eetent and time of preservation	Unlimited (I)	Unlimited (I)	Limited (2)	Un limited (I)	Limited (2)	Limited (2)	Limited (2)	Limited (2)	Infinite (I)
Resources needed									
i) Manpower Skill	Low (I)	Low (I)	Low (I)	Low (I) (2)	Medium	M (2)	Medium (2)	Medium (2)	Medium (2)
ii) Initial capital	High (3)	High (3)	Low (I)	High (3)	Low (1)	M (2)	Medium (2)	Medium (2)	Medium (20)
iii) Recurring contingencies	Low (I)	Low (I) (2)	Medium	Medium (2)	Low (I) (2)	M (2) (2)	Medium (2)	Medium	Medium
Future access of conserved material	Takes time (20	Takes time (2)	Takes	Takes time (2) time (2)	Takes	Immediate access	Immediate access (I)	immediate access (I)	Immediate access (I)
Risk									
i) Cost hike due to failure in maintenance	Low (I)	Low (I)	Low (I)	Low (I)	Low (I)	High (3)	High (3) (20	High (3)	medium
ii) Change in conserved germplasm	High (3)	High (3)	High (3)	High (3)	Low (I)	Low (I)	Low (I)	Low (I)	Low (I)
iii) Success rate in	Low (3)	Low (3)	Low (3)	Low (3)	M (2)	M (2)	High (I)	High (I)	High (I)
iv) Risk due to high cost	Medium (2)	Medium (2)	Low (I)	Low (I)	Low (I)	Low (I) (20	Medium (2)	Medium	High (3)
Total score	18	18	17	19		15	18	18	18 17
Mean score	1.8	1.8	1.7	1.9	1.51	1.8	1.8	1.8	1.7
Preference ranking			II			I			II

Risk of cost hike due to failure of maintenance is very high for some of these methods; risk of getting back the conserved material true to type after a time lag in conservation, risk of loss or inability to reinstate the conserved material, risk of high costs involved in the process of conservation have also been ranked as 'low', medium and high and scored based on the desirability of that feature.

The total of the scores indicated that *ex situ* methods were more preferable than the *in situ* methods due to the wider option available for selection. Among the various *ex situ* methods, the field genebank stood first followed by the on farm and the cryopreservation methods getting similar scores. However, they indicate distinct variations. The on farm conservation method provides limited period conservation, cryopreservation offers for infinite time period. The reinstatement of conserved germplasm requires time in on farm while it is almost instantaneous in cryopreservation. The reinstated material is 100% true to type in cryo, which may not be so in on farm method. These features weigh in favour of modern method such as cryopreservation. Further, the other features such as the land and infrastructure availability and the current priority of a specific method of preservation in terms of global vs local priority also need to be considered while selecting a method. An exercise of this nature would be of great significance in judging the appropriateness of specific methods of conservation. Based on the nature of the product developed, the actual valuation can be done for estimating the cost involved in its development.

References

Arora RK and Anjula Pandey (1996) *Wild Edible Plants of India; Diversity, Conservation and Use.* National Bureau of Plant Genetic Resources, New Delhi.

Do Moisture and Temperature Play an Interactive Role on Seed Longevity?

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Do moisture and temperature exert independent effects on seed longevity ? A question which seed biologists or genebank managers would like to have an answer. A correspondence published in Seed Science Research (Ellis *et al.* 1991) says "There is no interaction between the effects of temperature and moisture on seed longevity when these relations are quantified by the seed viability equations (*e.g.* Ellis and Roberts, 1980a,b; Ellis *et al.* 1982; Kraak and Vos, 1987), *i.e.* there is no evidence that the relative effect of moisture content on longevity varies with temperature." On the other hand, Vertucci *et al.* (1994) concluded the analysis of their experiment on pea seeds that moisture content and temperature do not exert independent effects on seed longevity.

In light of the abovesaid comments, this paper re-examines and makes an in-depth study of the already published data on *Lupinus polyphyllus* (Dickie *et al.* 1985). It also explains the role of log transformation used in the longevity models in relation to predictive capabilities of the model as well as with respect to the interactive behaviour of the effects of moisture and temperature on seed longevity.

The physical meaning of interaction is that the two factors are said to interact if the effect of one factor changes as the level of other factors changes, and their interaction effect can be measured only if the said factors are tested together in the same experiment. In other words, if we plot the seed longevity (days) against the moisture at various levels of temperature (or against the temperature at various levels of moisture) curves should not be parallel. When data in Table 1 was plotted, the curves at three temperatures levels were found to be non-parallel indicating that the effects of moisture and temperature are non-additive in nature. Whether this non-additivity is significant or not, can be tested through Tukey's non-additivity theorem.