

Crop Genetic Diversity and Rural Livelihoods

Minutes of a brainstorming session held in
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I. The Importance of *In Situ* Genetic Diversity: Why Conserve It?

1. *Ex situ* preservation is not enough. It provides insurance against the loss of crop genetic diversity, but it is not a substitute for *in situ* conservation. There are several disadvantages to relying solely upon *ex situ* collections:
 - a. They are too small. New germplasm is being constantly generated; there is a lot more genetic diversity present in the fields than the existing genebanks are capable of maintaining. Despite this shortfall, genebanks are currently *decreasing* the size of their collections.
 - b. Genebanks are a static form of preserving genetic diversity; they fail to capture the dynamism of *in situ* systems. The ongoing process of evolution cannot be stored in a genebank, it can only take place in the field. Although plant breeders can develop new crosses from the existing stock, they cannot replace the flow of new raw material from *in situ* evolution.
 - c. Genebanks only preserve the seed 'hardware.' They do not maintain the 'software,' or the location-specific knowledge of a particular variety's agronomic characteristics.
 - d. *Ex situ* collections are vulnerable to accidents and war.
 - e. Most genebanks are for specific crops. They ignore how crops co-adapt to one another. Maize, for example, is often cultivated in a *milpa* where it is intercropped with beans, squash, and other useful plants. The puzzle is fragmented/broken in *ex situ* collections.

- f. *Ex situ* saves genes that can be located and captured from landrace material. If seeds are regenerated, they are grown-out in habitats that are different from those where they were originally collected. This results in genetic shifts, especially of genes that are linked in a row on the chromosome.
 - g. *In situ* continues in the habitat of origin and preserves co-adapted gene systems that work in a particular habitat. *In situ* saves blocks of genes; it is especially important if a habitat is unique. The highlands of Chiapas and Mexico are a unique environment; maize from these localities often cannot be regenerated in other parts of Mexico.
2. Genetic diversity is valuable to farmers. This can be true even in industrialized agriculture, as illustrated by California's peach industry, where increasing diversity has been driven primarily by market factors. Increased wealth in urban areas has translated into an increased demand for diverse products. Farmers are also planting different varieties of their crop in order to extend the growing season. Diversification of crop varieties is employed to spread-out risks and to ensure greater stability over time.
 3. *In situ* genetic diversity helps to stabilize and/or increase the productivity of agriculture in 'marginal' and 'complex' environments. These areas are difficult to reach with Green Revolution technologies and other top-down development initiatives. Commercial breeders are not willing to invest in the development of seeds for marginal environments; their breeding efforts are targeted towards more homogeneous habitats.
 4. 'Modern' agriculture and long-term world food security are dependent upon the diverse 'raw material' obtained from evolutionary gardens.
 - a. In the long term, world food security requires that crops evolve with changing environmental conditions. The raw material bequeathed to us by generations of peasant farmers allows crops to adapt to new pests, emerging pathogens, and changes in the climate. The average lifespan of commercial maize varieties in the U.S., for example, is less than seven years. In order to develop varieties adapted to new environmental conditions (the 'varietal relay race'), crop breeders use genetic material the ultimate source of which is the fields of 'traditional' farmers.
 - b. To some extent, the short commercial lifespan of 'modern' varieties may be due not only to vulnerability to newly evolved pests and pathogens, but also to some degree of planned obsolescence in the seed industry. (The maize landraces from Chiapas are like stem cells for the human body).

- c. The importance of *in situ* conservation to modern agriculture is concealed, to some extent, by the fact that plant breeders rely primarily on elite lines for the development of new varieties. Moreover, with the advent of biotechnology, some plant breeders are downplaying the importance of *in situ* genetic diversity.
 - d. Some participants maintained, however, that biotechnology is being oversold by molecular biologists. Recall that nuclear power was once seen as a panacea, too, but unforeseen problems arose. While biotechnology can be used to change food crops, that does not necessarily mean that humans will be able to digest the new biotech products. Biotechnology is often employed to facilitate marketing (via improved cosmetic appearances) and processing. There is little concern for nutritional ramifications or the sustainability of the crop over time.
 - e. Farms are managed on a long-term basis (e.g. soil improvement), yet seed companies are managed on a year-to-year basis. The ultimate concern for seed companies is profits for shareholders.
5. *In situ* conservation often is associated with ‘islands’ of balanced nutrition. The intercropping that takes place in small-scale, ‘traditional’ systems helps to ensure that basic nutritional needs are met. As the number of crops planted in the field has decreased, nutritional deficiency among peasant farmers has increased.
 6. *In situ* genetic diversity is dependent upon other natural systems (e.g., forests and watersheds). Conserving the local environment allows on-farm evolution to occur. Moreover, so long as it is viable, *in situ* conservation allows farmers to protect their local environmental systems. *In situ* conservation involves more than the farmers’ fields, it is a process situated within a larger ecosystem.
 7. Intellectual property rights have increased the cost of commercial seeds. *In situ* genetic diversity provides farmers with free access to genetic material, protecting them from rising costs. It enables farmers to exist outside of the global IP system.
 8. *In situ* conservation serves as a type of insurance policy. Not only does it insure against potential failures of *ex situ* conservation and of the modern agricultural system, it also guarantees that poor farmers will have access to genetic material should genebanks ever become privatized. Ultimately, it helps to ensure the survival of small-scale farmers.
 9. ‘Existence value’: regardless of its use values, the mere existence of crop genetic diversity may provide humans with an intangible sense of satisfaction. This sentiment is demonstrated by the heirloom variety movement in the U.S. and is reflected in slogans such as ‘Save the Seeds.’”

10. Recognizing the importance of *in situ* genetic diversity is a way to empower peasant farmers – to “Save the Seed Savers”. It helps to validate and reinforce cultural identity, which—like *in situ* farming systems—is dynamic and ever-changing.
11. *In situ* genetic diversity is also valuable to consumers, providing them with tasty and nutritious food products. Consumers also benefit, of course, from improved food security (see #4 above).
12. *In situ* conservation is a means of protecting the public domain. It augments the wealth held as common heritage, both the seed ‘hardware’ and the knowledge ‘software.’
13. *In situ* genetic diversity has proven its evolutionary value and effectiveness for thousands of years. Its benefits are not hypothetical: they are time-tested.
14. *In situ* supports wild and weedy crop relatives.

II. What Is *In Situ* Conservation?

1. One issue is what should be conserved/enhanced:
 - plant populations (or series of populations)?
 - landscapes?
 - communities?
 - culture/practices?
 - peasant livelihoods?
 - habitat?
 - knowledge systems?
 - mixed cropping systems?
 - agrobiodiversity, including not only crop genetic diversity but also soil micro-organisms and beneficial insect populations?
2. Since *in situ* genetic diversity is a dynamic system, it would be ideal to conserve/enhance all of the above. Conserving entire landscapes, however, is often difficult or impossible. It is important to remember agrobiodiversity is not like watersheds and other natural resources that can simply be left alone: its protection requires human interaction.
3. The appropriate spatial framework for *in situ* conservation efforts depends on a number of variables, including the value of local plant varieties and the social and political context in which the initiative is to take place.
4. One important variable is the biological characteristics of the crop that is targeted for conservation. Self-pollinating food crops such as rice and wheat may require

different initiatives than those directed at open-pollinated crops. There was some debate about how different these initiatives should be. This led to a discussion of the difference between self-pollinating and open-pollinating species:

- a. Self-pollinating crops: The germplasm within a self-pollinated species, such as wheat, is relatively unmixed. The genetic diversity of each variety could be held in a small bowl. Even inbreeders do some outcrossing, however.
 - b. Open-pollinated crops: The germplasm of open-pollinated species cannot be held in a small bowl. Rather it must be held in a large colander: some genes are always leaking out the bottom, but the colander is being refilled constantly at the top.
 - c. To further distinguish the two types of crops, a number of images were invoked:
 - (i) A wheat field can be likened to a bar graph, whereas a field of maize could be likened to a smooth curve: the differences among plants in a maize field are less sharply defined than those in wheat field.
 - (ii) The germplasm of maize in the field is like water in a big pool; the germplasm of wheat in the field is like water contained in a series of pipes.
 - (iii) Theoretically, a single farmer could maintain the *in situ* conservation of a self-pollinated crop in a given geographical area (although in practice this approach would be too risky). *In situ* conservation of an open-pollinated species, in contrast, requires a whole village/community. It is difficult, however, to determine the ideal spatial/social unit.
 - (iv) It is easier to 'fine tune' self-pollinating species for environmental conditions. Inbreeding the same line of an open-pollinated species will result in 'inbreeding depression,' or decreasing productivity.
5. One should not over-romanticize the role that farmers play in crop evolution. There is a false assumption that farmers know exactly what they are doing, and that they do not need any help. At the same time, the process of farmer selection is not fully understood.
6. Noting that it is futile to conserve 'islands of diversity' in a 'sea of genetic erosion,' one participant suggested that it was more important to combat the forces resulting in genetic erosion than it is to undertake location specific

conservation projects. Other participants maintained that both types of measures are important: one approach is direct, the other indirect. Another participant dismissed the notion of *in situ* conservation as protected islands of diversity. Instead of protecting something that is ineffective, he believes that the challenge is to maintain and encourage the viability of on-farm genetic evolution.

7. As expanded upon below, this led to a short discussion about the possible ways to encourage the appreciation of crop diversity in the market system (thereby counteracting the market forces that encourage specialization and product uniformity). One suggestion was a “Corn Cookbook” that would promote different types of maize and emphasize their distinct culinary qualities. Another suggestion was to employ a denomination and/or center of origin strategy that emphasizes both varietal and spatial diversity.
8. Priority areas for *in situ* conservation:
 - Centers of diversity roughly correspond with centers of origin.
 - Wild relatives are important due to the gene flow through introgression (*e.g.* introgressive process between maize and teosinte).

III. Classes of Tools and Strategies to Foster *In Situ* Conservation

1. Increase agronomic value/competitiveness:
 - a. Improve yield of ‘traditional’ farming practices: both higher mean and lower variance.
 - b. Interactions with the agroecosystem to improve total productivity.
 - c. Participatory Plant Breeding (PPB):
 - (i) PPB was initially designed as a way to increase farmers’ acceptance of new rice varieties in Asia.
 - (ii) The fundamental idea of the program is that farmers should be involved in the breeding program that is intended to benefit them.
 - (iii) PPB does not necessarily entail the conservation of local germplasm. PPB initiatives can improve crop yields but reduce the pool of genetic resources. Under its current definition, PPB in fact could contribute to genetic erosion.

- (iv) Rather than being promoted as something that is inherently valuable, *in situ* conservation is (at best) only a side-benefit of PPB initiatives. PPB rewards ‘value added’ by new evolution, but does not directly reward the conservation of the existing stock of diversity.
- (v) PPB increases the diversity of commercially competitive varieties.
- (vi) Key links:
 - (a) Farmers should be directly involved in the breeding process
 - (b) Local materials should be used in the process of seed creation:
 - Include pre-harvest information: Rather than simply gathering seeds from the harvest pile, one should examine the characteristics of the plant when selecting seeds.
 - Compare among farmer varieties: Each farmer has a slightly different population. Let the farmers ‘pick the winner’ and encourage seed exchange.
 - Introgress known, non-local material into the local seed stock (*e.g.*, genes for disease resistance).
- (vii) Selection criteria should not be imposed upon communities. In addition to yield, characteristics such as flavor and color may also be important. There was some discussion about the importance of different characteristics. In his research, Hugo Perales has found that while farmers are indeed interested in characteristics other than yield, crop yield was the only selection criteria cited by all farmers. It was noted, however, that farmers with multiple crops may choose some crops based on criteria other than yield.
- (viii) Two fundamental questions about PPB:
 - (a) What are the payoffs to farmers?
 - (b) How can it be sustained over time?
- (ix) PPB improves the credibility of genebanks. It demonstrates the complementary role of *ex situ* conservation and *in situ* conservation, illustrating how each system supports the other.
- (x) There are two loops to plant improvement: Farmer-led variety improvement and the formal breeding system. Each loop should help the other when necessary. (It is also possible to envision a third loop represented by intermediaries, who can enhance the interactive process). As one participant noted,

most formal methodologies cannot be translated to farmers' fields. Nonetheless, they still offer something of value; the formal sector should not be discounted. The challenge is to encourage the complementarity of the two systems.

2. Increase the market/economic value of agrodiversity (including the demand side and processing chain):

a. 'Ethical Consumer Choice':

- (i) Arises from consumers' concern about the production process (environmental, labor, etc.).
- (ii) Products are differentiated along ethical lines (*e.g.*, organic, no child labor, living wages, fair trade).
- (iii) One challenge is to build consumer awareness and confidence. Building consumer confidence requires certification. The certification cannot be awarded by the growers themselves, but must be conducted by an independent third party. It is possible for a community to establish the criteria that they want to use, but they need independent certification to verify that they are adhering to those standards.
- (iv) To date, the movement has achieved some notable successes. Interestingly, it has been led not by consumers *per se*, but by advocacy groups.
- (v) In and of themselves, the ethical choices of consumers are rarely enough to achieve social goals. Big advances require that ethical choices are complemented with third-party certification and advocacy-group pressures on retailers.
- (vi) Challenges:
 - False labeling: Some industries have developed labels with lenient standards and they have invested millions of dollars in promoting these 'phony' labels. To date, however, they have met with only limited success. This is largely due to advocacy pressure on retailers not to sell the 'phony' label.
 - Cost of marketing: One advantage of the advocacy-led strategy is that it reduces the costs of promoting the label.

- Production (Q/Q/D): It has been particularly challenging to get a large enough quantity (Q) of a product, produced at an adequate level of quality (Q), that can be delivered (D) in a timely manner.
 - World Trade Organization (WTO): The WTO limits the ability of individual governments to become involved. For example, if the government of Belgium were to allow only imports of FSC wood products, or of Fair Trade coffee, that would be considered a violation of WTO rules. Similarly, New York City's recent requirement that all contractors with the City government use FSC products is being challenged under WTO rules by the Canadian government.
 - Cost of setting-up a certification system.
- (vii) WTO rules could establish an '*in situ* box': WTO negotiations allow for 'boxes' that allow countries to restrict imports based on established criteria. For example there is a 'green box' that corresponds with certain environmental criteria and a 'blue box' that corresponds with watershed protection. India is currently pushing for a 'food security box,' while Korea, Japan, and Norway are pushing for a 'multi-functionality of rural space' box. It might be possible to establish an 'in situ conservation' box that would allow Mexico, for example, to restrict imports of maize, Turkey to restrict imports of wheat, etc.
- (viii) The low profit margin on staple food products presents yet another challenge to this type of initiative. At the same time, the large size of the market for staples presents an opportunity. There is a potential to segment the food market. In Mexico, for instance, there is a push to distinguish domestically produced maize from maize produced in the US that may contain transgenic material.

b. Denomination of Origin for Collective Biological Resources.

- (i) Three dimensions should be considered:
- Product (*e.g.* Mezcal)
 - Resource (*e.g.* Papalote)
 - Territory (*e.g.* Chilapan)

- (ii) A Cluster of IPR possibilities emerges from these dimensions:
 - Denomination of origin
 - Collective trademarks
 - Commercial trademarks
 - Certification trademarks
- (iii) The first step is to define the distribution of the resource and the relevant collectivity. This does not define ownership of the resource, but protects the use of the resource name in trade.
- (iv) Denomination of origin is designated by an established territory and is largely self-regulated.
- (v) Collective trademarks are also self-regulated.
- (vi) Commercial trademarks represent the identity of a particular business.
- (vii) Certification trademarks are owned by outside actors who give their seal of approval for the product. This requires that the market values that particular seal and the standards that it represents.
- (viii) This system works well when there is processing, producing a high value-added product. Its applicability to the production of local staples, however, is questionable. It creates value via exclusivity; this is difficult—if not impossible—to establish for staple crops.

3. Promote seed exchange, recovery of seeds that are not available.

4. Payments for Environmental Services (PES):

- a. Payments for environmental services can include services other than agrodiversity (*e.g.* the protection of water quality). One participant was concerned about whether the conservation of biodiversity should really be interpreted as the provision of an environmental service: Is it pushing the soccer ball onto the football field?
- b. Types of payments:
 - (i) Cash:
The Dutch government provides payments to farmers cultivate diverse grasses for pasture in the Netherlands; the Finnish government provides direct payments to farmers who employ traditional practices.

- (ii) Non-cash:
The form of the payment should not be predetermined. The farmers who cultivate genetic diversity should be able to decide what is most important to them.
 - (iii) Community nurseries and germplasm banks
- c. There are a number of problems with providing direct payments to individual farmers:
- (i) The number of farmers involved promises to reduce the size of the payments to negligible amounts.
 - (ii) Exclusivity
 - (iii) Corruptibility
 - (iv) May lead to social divisions
- d. Premium in price support for underrepresented varieties: ‘affirmative action for seeds’
- e. PES can be linked to the provision of public goods
- f. Developing a functioning PES mechanism will require educating the northern countries, informing them of the importance of *in situ* genetic diversity. This could occur on public radio and/or public television.

5. Sectoral Policies (*e.g.* credit, extension, trade)

- a. Sectoral policies (especially under the neo-liberal agenda) are often anti-agriculture, anti-peasant, anti-diversity, and they rarely address the issue of land reform.
- b. Broad alliances are needed
- c. Redirection:
 - Credit: Subsidized credit is almost always used to introduce new technologies. Marginal farmers rarely receive credit.
 - Maseca
 - Irrigation
 - Prices
 - Technology/research/extension/education

- d. Education Campaigns: For example, promoting maiz mexicano in Mexico and the US.
- e. Tourism: For example, the cultural revival of indigenous people in Oaxaca has led to increased tourism associated with food and clothing. Such movements might be used to influence the direction of agricultural extension initiatives. There is a type of ‘agrotourismo’ in Mediterranean countries. A similar type of initiative might be employed to support *in situ* conservation efforts.
- f. Cookbooks and cooking shows.
- g. Changing sectoral policies requires informing the debate. The importance of *in situ* genetic diversity needs to be popularized in print publications, radio stories, and educational campaigns.

6. IPR Policies and Farmers Rights

- a. Farmers’ Rights were originally framed as a transfer of funds from the North to the South. They are now conceived as direct payments to farmers. The earlier version may be preferable since it implies payments to a system that supports *in situ* conservation (e.g. a network of NGOs) rather than direct payments to farmers. Payments should not be made to government entities.
- b. Rather than developing *sui generis* regimes as under the WTO and TRIPS, most countries are signing on to the 1991 version of UPOV. Indigenous rights are recognized in the Philippines, but it’s more like a preamble. IPGRI has a not-so-good publication on *sui generis* regimes.

7. Increase non-pecuniary value (e.g. pride)

- a. Might GEF funds be used to fund projects that enhance the pride of farmers?
- b. Seed fairs: They are like county fairs; the fact that farmers have seeds helps to strengthen community bonds. It is something that they all have in common. The reality is that many farmers do not know what their neighbors are growing. The Jala fair is a unique example of such a fair. It started about nine years ago in Guadalajara, Mexico and is now shown on television.
- c. Conservation of *teosinte* requires that a village set aside land. The farmers cannot be paid to do this, it requires recognition. Perhaps farmers could be provided with plaques acknowledging their contribution to *in situ* conservation.

- d. Studies show that farmers in Mexico are not motivated by pecuniary motivations alone. The growth of the Pan-Mayan movement demonstrates the importance of cultural identity. One way of recognizing farmers and identifying them with *in situ* conservation would be to initiate a traveling television show that highlights varieties of maize and the farmers who grow them.
- 8. Encourage South/South exchanges of genetic material and *in situ* conservation strategies. Conservation strategies designed to benefit the South are arguably more valuable than those undertaken to benefit the North.
 - 9. Research.

IV. Next Steps

- 1. Existing Initiatives
 - a. Knowledge of existing initiatives would help foundations to leverage their limited funding.
 - b. Global Environment Facility (GEF):
 - (i) GEF funds for *in situ* conservation are likely to materialize.
 - (ii) The problem, however, is that the GEF has a small staff. There only about 20 people who work for GEF: 4-5 of them work on issues of biodiversity, but none of them are particularly knowledgeable about agricultural issues. They do not know what an *in situ* conservation program should look like.
 - (iii) They do not know where to allocate their funds; most of their money has been spent on research.
 - (iv) The GEF did fund a project in Turkey in 1992. The Turks did not want to include a proposed study of landraces in the project, though. They only wanted to study the wild relatives of wheat.
 - (v) Another project was undertaken in Ethiopia in 1994. It has dealt primarily with building institutions.
 - (vi) Yet another GEF project was initiated in Peru. As a result of structural adjustment, however, the Peruvian government has virtually dismantled the Ministry of Agriculture. The program

is now being administered by CIP; almost all the funding is being allocated to NGOs.

- (vii) Most GEF projects are doomed to fail because they are too big. There is too much national-level involvement, and an attempt to spread the projects across the entire country.
 - (viii) About 80% of GEF funds go through the World Bank. The remaining 20% goes through the UNDP (for smaller projects). There is some contention between the World Bank and the GEF, though. Rather than promoting *in situ* conservation, the Bank is funding projects that are contributing to genetic erosion.
 - (ix) At this juncture, foundations might do better to fund initiatives that help design the tools for *in situ* conservation rather than directly fund conservation programs. The GEF could really use the input.
 - (x) Marc Malloch Brown at the UNDP is trying to fund local projects. He has invited suggestions from the Ford Foundation on how to direct those types of projects.
- c. The FAO is putting together a large database on classification and valuation of crop diversity.
 - d. IPGRI acts as a broker, teaming-up donors with projects to fund.
2. Work with NGOs and educational communication groups.
 3. A publication: it might be worthwhile to use the insights gathered from this meeting to put together a piece for public education.
 4. *In situ* genetic diversity is disappearing. There is still time to research and implement a solution. The biggest challenge is to develop the political will to address the issue. Small successful projects can help to foster political support.

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