IMPROVING FOOD SECURITY BY LINKING GENEBANKS TO FARMERS THROUGH THE DIRECT RELEASE OF TARGETED LANDRACE VARIETIES

EXECUTIVE SUMMARY

It is clear that landraces provide a demonstrable yield advantage over currently available improved varieties in marginal areas, that there is a significant demand for these varieties, and that landraces have become continually scarcer over time. Linking genebanks (i.e. cold storage repositories for seed varieties) with farmers through direct release of targeted landrace varieties (i.e. traditional farmer-bred varieties) can meet these demands and catalyze an increase in productivity and food security in the vulnerable populations inhabiting the marginal arid regions of Rajasthan and other places of a similar nature.

Though breeders and researchers are using germplasm (i.e. seed varieties) collections for crop improvement to some extent farmers and farmer representative organizations are not directly accessing and using crop varieties maintained in genebanks except in rare situations. However there is now evidence that shows the value of the direct release of targeted landrace varieties and many agricultural scientists are interested in the potential of returning landrace varieties to farmers that no longer have them.

The purpose of this policy brief is to demonstrate the value that linking genebanks to farmers can have for improving food security and enhancing livelihoods of small scale farmers. Through a case study of pearl millet production in Rajasthan India we illustrate the potential value added that landraces conserved in genebanks can provide farmers. We also discuss the constraints to *farmer-genebank linkages* and suggest mechanisms and policy options that could be implemented by both the National Government of India as well as the Governing Body of the International Treaty on Plant Genetic Resources for Food and Agriculture (i.e. ITPGRFA or "the Treaty") to bridge the gap that currently exists between farmers and genebanks.

Within the context of pearl millet, a number of research studies have shown that under marginal conditions, such as those prevalent in Rajasthan, landrace materials consistently outperformed conventionally bred materials, providing a better option to farmers than cultivation of "improved" varieties. There are over 30,000 pearl millet accessions (i.e. unique seed lots, usually composed of distinct varieties) conserved in the two major genebanks in India. These collections could potentially provide the supply to meet the demand for the restoration of lost landraces to farmers.

One of the greatest challenges to understanding how to effectively engage national policy makers in a discussion about linking farmers to genebanks through the integration of landraces into the seed supply chain is knowing where to begin. It is important that a linkage strategy is selected that will be both robust and complementary to current seed supply systems. There are a number of technical, administrative, and political considerations that affect direct release of germplasm for cultivation, including: lack of information about accessions held in the genebank, lack of pre breeding, heavily regulated seed supply systems, and harmonization of government structures.

Based upon the agricultural scenario as outlined in this work we identify three possible policy options: 1-Commission multi-disciplinary research in India and other contracting parties to the Treaty to understand the agricultural systems in which *genebank-farmer linkages* are most viable; 2-Form a multi-stakeholder Task Force to

discuss the benefits and potential mechanisms to mainstream the distribution of germplasm to farmers for direct use for cultivation; and 3-Mandate the creation of national apparatus which integrates genebanks and seed supply systems, both public and private, in order to create effective seed supply chains that reach farmers in marginal regions.

INTRODUCTION

Increasing scarcity of water and costs of fossil fuel-based inputs, as well as projected changes in pest dynamics, precipitation and temperature mean that future agricultural intensification will need to be built on different foundations. Crop genetic diversity can provide resistance to the climatic and soil fertility stresses common in marginal environments and reduce vulnerability to pests and diseases, increasing the resilience of harvests and reducing risks for resource-poor farmers.

Since the 1950's, thousands of landraces, which could potentially provide the source of genes for improved crop productivity, have been collected and conserved in genebanks. The purpose of these collections was to conserve varieties that were becoming extinct so that they could later be utilized largely by plant breeders and researchers for development of new and improved varieties (Engels, 2002). These activities have created diverse centralized collections of germplasm in many nations of the world. Though breeders and researchers are using germplasm collections for crop improvement to some extent, farmers and farmer representative organizations are not directly accessing and using germplasm maintained *ex situ* except in rare situations (Smale et al., 2002; Hodgkin et al., 2003). However, now scientists are recognizing the advantages of cultivation of landraces and the need for reciprocal trade in germplasm, which goes not just from farmers to genebanks, but also from genebanks back to farmers (Bramel-Cox, 2000; Ngoc De, 2000; Worede, 2000).

Throughout the world genebanks are for the most part government agencies that are housed in the Ministry of Agriculture. While each genebank has its own set of management regulations and protocols, all signatories to the Treaty are bound by a general set of rules defined by the Treaty. India's genebank is managed by the National Bureau of Plant Genetic Resources (NBPGR) and is under the direct supervision of the Indian Council of Agricultural Research (ICAR). However as a signatory to the Treaty, India has agreed to the rules established by the Treaty and has set up a system of *sui generis* laws to implement these rules.

While the Treaty has provided meaningful contributions to increasing access to plant genetic resources (PGR), it has not gone far enough to serve the ultimate beneficiaries for which genebanks were created: farmers. Currently the Treaty's Standard Materials Transfer Agreement (SMTA), which details the legal norms of germplasm transfer, states in article 6 "that the Material (germplasm) shall be used or conserved only for the purposes of research, breeding and training for food and agriculture." The SMTA, as it is currently structured, effectively prevents any recipient – famers included – from using materials acquired under the SMTA for direct use in production systems. The position of small farmers vis-à-vis the purposes explicitly mentioned by the Treaty is not clear. Are farmers breeders? Are they researchers? Do they use the materials they receive directly in production systems? The answer is, it will depend on the situation. Although the Treaty does not explicitly prohibit genebanks from providing useful varieties to farmers, neither does it provide a clear recognition of farmers as legitimate requesters of germplasm. Farmers often lack the skills and resources necessary to access genebanks and therefore it is necessary that systems be put into place which facilitate access to these resources. By fully implementing the Treaty and specifically recognizing the obligation of genebanks to distribute PGR directly to farmers, valuable landrace varieties, currently lost in the field, can again be restored to farmers and contribute to achieving food security.

The purpose of this policy paper is to discuss the value that linking genebanks to farmers can have for improving food security and enhancing livelihoods of small scale farmers. Through a case study of pearl millet production in Rajasthan India we illustrate the potential value added that landraces conserved in genebanks can provide farmers. We also discuss the constraints to *farmer-genebank linkages* and policy options that could be implemented by both the National Government of India, and other contracting parties to the Treaty. These policy options could also be considered and possibly endorsed by the Governing Body of the Treaty to bridge the gap that currently exists between farmers and genebanks. In this context, the Governing Body could consider the issue under the rubrics of both farmers' rights (article 9) and sustainable use of PGRFA (article 6).

INCREASING PEARL MILLET PRODUCTIVITY IN RAINFED REGIONS OF RAJASTHAN

Pearl millet is the 6th most important cereal cultivated world wide and is the main food source in some of the poorest regions of India and Africa (Board on Science and Technology for International Development, 1996). Due to its ability to withstand drought and high temperatures, low water requirement, and high nutrient content, pearl millet is an important crop for the future in light of climate change. Therefore it is necessary to both conserve and use the landraces that will be needed to be able to adapt agricultural systems to a changing climate.

India is the largest pearl millet producing country in the world. Pearl millet is cultivated on approximately 9 m ha producing over 9 m t per year (Khairwal et al. 2010). Rajasthan is the largest pearl millet producing state in India accounting for 51% of the total area under pearl millet cultivation and 36% of total production (Khairwal et al. 2010). Nevertheless, productivity levels (yield per ha) in Rajasthan are among the lowest nationwide due to the climatic and soil fertility challenges inherent to this mostly arid agroecological environment.

Pearl millet is an important crop not just for the economy and for food security, but also on a global level for biodiversity conservation. It is estimated that there are over 100 distinct pearl millet landraces grown by farmers in Rajasthan, especially in the rain fed areas where high yielding varieties and hybrids do not perform well (Mathur, 2009). Nevertheless, much of this genetic diversity has been lost because of persistent drought, replacement by more profitable crops, and genetic out-crossing from hybrid cultivars planted in close proximity to landraces.

A survey conducted in 2010 with 200 pearl millet farmers in the 10 largest pearl millet producing districts of Rajasthan showed that in the period from 2008-2010 landrace cultivation decreased by 21% in area; and from 2000-2010 the number of farmers cultivating landraces had decreased by 64% (Bonham, 2010). The major cause for the loss of these landrace varieties was recurring drought conditions and variety replacement by hybrids yet 86% of farmers surveyed expressed the desire to re-acquire their lost landraces (Bonham, 2010). Farmers also expressed a willingness to pay for the acquisition of these landraces at a rate on par with the market price of hybrid varieties (Bonham, 2010).

There are over 30,000 pearl millet accessions conserved in the two major genebanks in India (National Bureau of Plant Genetic Resource (NBPGR) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)) (Bonham et al., 2010). Additionally, NBPGR has identified about 298 landraces with great economic potential for developing new markets identified in 19 species (NBPGR, 2007). These collections could potentially provide the supply to meet the demand for the repatriation of landraces lost by farmers.

Within the context of pearl millet, a number of research studies have shown that under marginal conditions, such as those prevalent in Rajasthan, landrace materials consistently performed better than conventionally bred materials, providing a better option to farmers than cultivation of “improved” varieties (Yadav and Bidinger, 2007; 2008; Bidinger et al., 2008; Yadav and Weltzien, 2000; Witcombe and Weltzien, 1989). There have also been examples other than pearl millet where landraces have out yielded improved varieties developed by plant breeders. The yield of rice landraces from Uttaranchal state in India was compared to modern varieties and it was found that the yield from landrace varieties ranged from 4.3 to 5t/ha whereas the average yields from modern varieties was 2.8t/ha (Reddi, 1995, Singh, 1998).

Pearl millet farmers in Rajasthan provide an interesting example of an agricultural scenario in flux where many farmers have already lost their traditional varieties. Due to the current unavailability of local landrace varieties and the recommendations disseminated by agricultural extension officers, farmers are now transitioning to the use of hybrid varieties. Nevertheless in a marginal region such as Rajasthan where over 90% of the pearl millet area is under rainfed management (Commissionerate of Agriculture, 2010) it makes more sense to promote the use of landraces rather than to focus on seed replacement by hybrid varieties as most conventional agricultural development wisdom dictates.

It is clear that landraces provide a demonstrable yield advantage over currently available improved varieties in marginal areas, that there is a significant demand for these varieties, and that landraces have become continually scarcer over time. Linking genebanks with farmers through direct release of targeted landrace varieties can meet these demands and catalyze an increase in productivity and food security in the vulnerable populations inhabiting the marginal arid regions of Rajasthan and other places of a similar nature.

CONSTRAINTS TO FARMER-GENBANK LINKAGES

Technical considerations

Although the superiority of landraces compared to improved varieties has been proven in numerous cases (Bidinger et al., 2008; Reddi, 1995; Singh, 1998; Yadav and Bidinger, 2007; 2008), there exist doubts about how seed varieties conserved in genebanks will perform after having been removed from the natural process of selection for many years (van Hintum et al. 2007, Parzies et al. 2000). Since only a small quantity of germplasm is conserved in genebanks, multiplication of seed is necessary in order to maintain viability of seed and meet the potential demand for these varieties. The large scale multiplication of a small subset of a heterogeneous variety could potentially alter the unique genetic frequency of a variety thereby causing genetic drift and an alteration in its performance and adaptability. This problem requires that germplasm be re-evaluated in regional varietal trials after it has been identified as potentially useful and before it is distributed to farmers, so that its agronomic performance can be assessed as true to type or genetically compromised.

There is also great potential for genebanks to increase the value of accessions as well as their use by playing an active role in not only evaluating agronomic performance, but by also making preliminary selections and identifying the desirable traits of a subset of the germplasm conserved. Nass and Paterniani (2000) state that pre-breeding is the most promising alternative to linking genetic resources and breeding programs. Pre-breeding programs that develop subsets of germplasm useful for direct cultivation by farmers could also be undertaken to effectively link farmers to genebanks.

Additionally, there is a lack of passport and evaluation information associated with many of the accessions in *ex situ* collections, which makes the targeting of useful traits and germplasm more difficult. Passport data is the information gathered with every seed variety collected in the field and includes the geographic location of the collection site, physical plant characteristics, and agroecological habitat. Genebanks in India have not created relational databases that link evaluation data and passport data. This information would be useful in quickly targeting certain landraces for cultivation, but currently this data, even when available, is not integrated into a single searchable database. There are now tools and techniques using geo-spatial analysis and bio-informatics, such as GENESYS, FIGS, GRIN, DIVA-GIS and Maxent which can facilitate this process. However, this type of work requires an expert with knowledge of these tools to target accessions on a case by case basis.

In India there exists a highly sophisticated and well regulated system of variety release and development, which is presided over by the Central and State Seed Sub Committees (CSSC and SSSC). These institutional bodies along with coordination from the State Variety Evaluation Committee (SVEC) and the All India Coordinated Research Programs (AICRP) are responsible for the testing and authorization of released varieties. Additionally, through the Seeds Act of 1966 and the Seeds Amendment Act of 1972, all seeds must be registered with the National Seeds Board. It can take up to 5 years for a variety to be identified, released and notified by the CSSC (Vyas, 1998). This system also requires that all released varieties adhere to the distinctness, uniformity, and stability (DUS) standards established by the Indian Council of Agricultural Research (ICAR). Many landraces, although observably distinct and stable, are not always uniform (Halewood et al. 2006). It is this non-uniformity that enables them to adapt to local conditions and therefore useful and productive in marginal environments (Ceccarelli and Grando 1999). In order for landrace varieties to enter the official seed production chain they need to be released and notified by the CSSC. Strict adherence to the requirement for variety uniformity hinders the ability of landraces to satisfy this requirement and consequently be released. Therefore the DUS standard needs to be adapted in order to make exceptions for the release of landrace materials, which do not meet the uniformity requirement.

Relaxing DUS standards may be a long term goal in streamlining the process of landrace seed distribution to farmers since only varieties notified by the CSSC are able to be produced as certified seed and enter into the official seed supply chain, but another way that landraces could be introduced into the market by the genebank and its affiliated organizations is as “truthfully labeled seed.” This category of seed is not subject to a strict set of regulations and monitoring by a government certification agency such as the CSSC, but does guarantee that certain management practices were adhered to during its production. Truthfully labeled seed can be found under a variety of names in the market as “research hybrids,” “uncertified truthfully labeled seed,” or under a trade name particular to each company. This type of variety is “uncertified” in that it has not been officially notified and released by the central government. Nevertheless the production of this seed is guaranteed to have followed good management practices to maintain genetic purity, variety integrity, and other quality parameters such as germination rate as outlined in the Seeds Rule of 1988. This mechanism would allow farmers to acquire landrace varieties commercially without the need of government certification and varietal registration.

Genebanks alone cannot provide the quantity of seed needed for commercial planting, as they are at times hard pressed to be able to deliver even 200 grams of seed and often distribute a much smaller quantity depending on the particular crop and the need of the germplasm requester. The mean land holding of a pearl millet farmer in Rajasthan is approximately 10 ha (Bonham et al, 2011). In order to plant 1 hectare, 2.5 kg of seed is required. This means that 22.5kg of seed is required to meet the needs of one farmer; a quantity which is over 100 times greater than what genebanks customarily give to any one requester. One hectare of pearl millet at a stocking density of 180,000 plants per hectare can potentially produce 900 kg of grain per hectare under good management conditions. This means that in order to sow the 3,999,913 ha of land that were planted under rainfed conditions in the 10 largest pearl millet producing districts of Rajasthan in the 2008-2009 monsoon (kharif) season, 9,999,783 kg of seed and the cultivation of an estimated 11,111 ha of land devoted to seed production would be required. This large scale production is impossible with the resources that genebanks currently possess. Therefore it is necessary that seed production intermediaries are involved in the process that can assure the maintenance of the genetic purity of the seed lots as well as produce a quantity of seed which can meet the demand.

Administrative considerations

Since genebanks alone will not be able to produce the necessary quantity of seed in order to meet demand and impact agricultural systems in a meaningful way, there is a need to coordinate between genebanks and the seed production agencies such as the National Seed Corporation, State Farm Corporation of India, the State Seed Corporation, and the Central and State Seed Sub Committees so that there is a streamlined authorization process that avoids duplication and confusion. However, calibrating the public sector agencies with regards to landrace seed production only solves one side of the equation. Public sector seed production only satisfies part of the overall seed demand in Rajasthan. Unless the public sector (i.e. Rajasthan State Seed Corporation) was given more funding and a mandate to produce landrace seed derived from genebank collections the demand could not be met by these institutions alone. Nevertheless, production and marketing of landrace seed by the public sector may be a necessary first step to show the existence of a market and to make seed available. As private seed companies begin to recognize the market potential for landrace varieties they will enter, expanding production and creating efficient distribution networks.

Currently, the majority of pearl millet seed on the market in Rajasthan is produced by private companies (Tripp and Pal, 2000). Since the liberalization of seed laws in the 1980's the private sector has grown and now has a larger capacity for meeting the demand for seed than does the public sector (i.e. national and state seed corporations). However, the private sector focuses mainly on the commercial market, which includes producing high yielding hybrids that require good management (eg. mechanization and line sowing) and conditions (i.e. irrigation and fertilizers) for proper cultivation. Involving the private sector in the production of landraces is problematic because the private industry is not interested in producing seed for smaller, less input oriented markets comprised by famers in marginal areas. From a profit perspective, it would be a disincentive for private companies to produce landrace varieties that can be used year after year without replacement. Hybrids lose their heterotic vigor (i.e. yield gains) after the first generation, which requires farmers to buy new seed every year. This loss of heterosis is advantageous from the commercial perspective because it increases sales Private companies would require some form of incentive or public private partnership to produce landrace varieties. However, this sort of partnership may only need to be a one time partnership project; in that once these varieties were acquired by farmers the responsibility of maintenance and distribution of the varieties could be assumed by the farmers networks and informal seed supply systems already in place.

There are two main hurdles to connecting famers with genebanks: lack of knowledge on the part of farmers about genebanks, and the lack of orientation of genebank managers to the needs of farmers. Currently, farmers do not know that genebanks exist, much less have an idea about which varieties may be useful to them. Changing this would require that genebanks look for ways to facilitate access to collections not just for plant breeders and researchers, but for farmers as well. At present genebank managers are not mandated to facilitate a linkage with farmers. The genebank is believed to exist to serve breeders and scientists. The farmer is thought only to be the consumer or recipient of improved germplasm and not an active part of crop improvement. Neither the system for information dissemination about genebank holdings, nor the ability of farmers to negotiate bureaucracy is sufficiently well developed. Facilitating this exchange on a small scale would require an intermediary to take the necessary steps to target and request appropriate germplasm. However, in order to achieve a measurable impact germplasm distribution to farmers needs to happen on a large scale. This would require a well organized and funded initiative to integrate targeted landraces into the seed supply chain.

Political considerations

Current policy maintained by Indian genebanks requires germplasm requesters to be fully non-profit. This effectively outlaws the distribution of germplasm to farmers for direct use for cultivation, since cultivation is a commercial, "for profit" activity. Additionally, national policy requires that germplasm requesters be affiliated with registered research and development organizations under the Department of Scientific and Industrial Research (DSIR). In light of these restrictions it is unlikely that many farmers would qualify to receive germplasm. Without the appropriate modifications to the national policy on germplasm exchange, the likelihood of scaling up an effort to distribute large quantities of germplasm to farmers is low.

Another political consideration that affects the ability of the Indian national genebank to provide crop varieties to farmers is related to the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). Since India is a signatory of the ITPGRFA and pearl millet is included in its list of annex 1 crops, the pearl millet varieties held in genebanks are under the management of the national government, and is in the public domain. Therefore it is available to all germplasm requesters through the Multi Lateral System (MLS) and should be made available to these requesters through the genebanks. The treaty requires that prior informed consent and mutually agreed terms be established vis-à-vis a standard material transfer agreement (SMTA) before germplasm can be released to requesters. Nevertheless, according to the Treaty, germplasm can only be used for “research, breeding and training” (FAO, 2009). This stipulation again casts doubt over the legality of releasing germplasm to farmers on a large scale for direct cultivation, as they are inherently engaged in commercial production. However, the fact that a farmer receiving a small packet of seeds from a genebank would have to spend several cycles of planting and selecting before having enough material to go into full scale commercial production *per se* implies that during that time, the farmer may well have modified the material such that it is not what was originally received. In which case, the farmer was actually carrying out a function akin to a breeder/ researcher and not just using the material for direct production. Under this scenario a farmer should be entitled to germplasm transfer under the SMTA.

In addition, the *Ad Hoc* Advisory Technical Committee on the Standard Material Transfer Agreement and the Multilateral System of the ITPGRFA (2010) has made some helpful recommendations. First, it recommends that germplasm be made available to farmers for direct use for cultivation if there is a separate express permission – over and above that which comes with supplying the materials under the SMTA -- from the original provider allowing for such re-distribution to farmers for their own direct use. The Committee also suggests that when a provider (i.e. genebank) does have a legal right to provide plant genetic resources to farmers for direct use, some other instrument should be used because of the complex nature of the SMTA . This instrument can be as formal or informal as need be in order to facilitate the transaction process for farmers, but at the same time provide legal backing and accountability. Additionally, the Committee recommends that in the case of “restoration,” where farmers have lost local varieties, the SMTA should again not be used. By circumventing the use of the SMTA, farmers would be able to avoid bureaucratic hurdles inhibiting access to materials that in many cases they contributed to the system initially. If India were to integrate these recommendations into its plans for implementing the Treaty’s MLS, farmers may be able to more easily gain access to germplasm conserved in genebanks.

One of the greatest challenges to understanding how to effectively engage national policy makers in a discussion about linking farmers to genebanks through the integration of landraces into the seed supply chain is knowing where to begin. In India there are several entities that may be responsible for the review and authorization of requests for access to biodiversity, in general, and germplasm, specifically: the Indian Council of Agricultural Research (ICAR), the National Bureau of Plant Genetic Resources (NBPGR), the National Biodiversity Authority (NBA), and the Plant Variety Protection and Farmer’s Rights Authority (PVPFRA). Navigating the bureaucracy and developing the political will to facilitate such an initiative requires clarification of the roles of each of these authorities.

The proliferation of new institutions that govern biodiversity creates ambiguity with regard to jurisdiction. The agency responsible for taking decisions about the direct use of germplasm by farmers for cultivation is unclear. The NBPGR is most directly linked to the distribution of germplasm vis-à-vis the Exchange Division; however it operates under the oversight of ICAR. The ICAR is the supreme authority with regard to agricultural development in India. It also is involved in the review of proposals that concern the use of germplasm through a high level committee that reviews germplasm export/import. The National Biodiversity Act mandates the creation of State Biodiversity Boards (SBBs) and Biodiversity Management Committees (BMCs). The SBBs and BMCs function on a local level to both authorize and restrict access to and use of biodiversity by Indians for commercial purposes (NBA, 2004). Since these bodies are in the process of formation it is not clear whether they will either facilitate or restrict the use of germplasm by farmers. The PVPFRA is charged with registering landraces and depositing samples in the genebanks maintained by NBPGR. It is responsible for assuring that adequate benefit sharing agreements are in place, should a registered farmer's varieties be used in breeding programs or for commercial purposes. With such a multitude of agencies overseeing the use of biodiversity, a complicated scenario unfolds that is difficult to comprehend.

Finally, the genebanks themselves may resist the large scale distribution of germplasm to farmers for fear that germplasm may come under the control of private seed companies who would incorporate those materials into their breeding programs. This would negate the benefit sharing provisions in the ITPGRFA. Some biopiracy of this kind is already thought to have occurred in the past between the public and private sector and a relationship of trust needs to be re-developed. These difficulties are inherent within complex governmental structures and need to be fully addressed in order to make possible the mutually beneficial linkage between farmers and genebanks.

POLICY OPTIONS

The benefits of landrace cultivation are clear. There is a high demand for landraces and farmers are willing to pay for them. Formulating an initiative to link genebanks with farmers through direct use of germplasm for cultivation will add value to the genebanks, increase farmers' incomes, and improve food security. From a range of policy options three recommendations are most viable. These recommendations are aimed at both the Government of India via the Indian Council of Agriculture Research (ICAR) and the contracting parties of the International Treaty on Plant Genetic Resources for Food and Agriculture, of which India is a signatory, and can be implemented independently or in concert, as a more comprehensive initiative.

1-Commission multi-disciplinary research in India and the nations of the contracting parties of the ITPGRFA to understand the agricultural systems in which *genebank-farmer linkages* are most viable. This research should also include a pilot study to assess the benefits to farmers of targeted landrace variety distribution; an assessment of mechanisms for seed distribution; extensive evaluation of the agronomic performance of landraces compared to currently available cultivars; and the targeting of potentially useful accessions using bioinformatics and geo spatial technology. This research and its implications would be shared with the director of the Indian national genebank, the deputy director general of seeds of the Indian Council of Agriculture Research (ICAR), and the contracting parties at the annual meeting of the ITPGRFA. Time costs could be up to 5 years for proper implementation of the pilot study and its corresponding impact assessment, as well as varietal evaluation. Financial costs would depend on the scale of the research undertaken and could be covered by the Benefit-sharing fund of the ITPGRFA with the national agricultural research systems (NARS) as implementing agencies.

2-Form a multi-stakeholder Task Force to assess potential mechanisms to mainstream the distribution of germplasm to farmers for direct use for cultivation. The Task Force should consist of representatives from the Treaty Secretariat, regional representatives of the contracting parties of the ITPGRFA, researchers, community members, and other interested parties. Within a Treaty framework the Task Force would provide policy options and recommendations to signatory nations. Within a national framework the Task Force would advise the Indian Council of Agricultural Research (ICAR) and the State Departments of Agriculture. The discussions of the Task Force and the implications of these discussions would then be shared with the director of the Indian national genebank, the deputy director general of seeds of the Indian Council of Agriculture Research (ICAR), and the contracting parties at the annual meeting of the ITPGRFA. Time costs would be high, but financial costs would be low.

3-Mandate the creation of a national apparatus that integrates genebanks and seed supply systems, both public and private, in order to create effective seed supply chains that reach farmers in marginal regions. A new division within the national government with the authority and resources to initiate public and private projects, specifically aimed at linking farmers to genebanks should be created. A complementary mechanism to educate agricultural extension agents and farmers about availability of germplasm stored in genebanks would be needed to realize an initiative of large scale. This initiative could be incorporated into the 12th 5-year Plan (2012-2017) composed and implemented by the Indian Planning Commission. Financial costs for this intervention would be high and coordination of multiple agencies on a national level would be complex, but potential impact would be significant.

We believe the Government of India and the Governing Body of the International Treaty for Plant Genetic Resources for Food and Agriculture should pursue a combination of options 1 and 2 in the immediate term. Option 3 could be considered in long-term plans or immediately in those countries that have yet to develop strong breeding or seed supply systems. In India this is not the case and the addition of further agencies governing germplasm exchange may prove unwieldy in the short-term. More research is required in order to understand where and when creating *farmer-genebank linkages* are feasible and effective. Additionally, consensus building through Task Force negotiations will be required in order to counter well entrenched dogma held by agricultural research systems that landrace varieties are always unproductive and seed replacement by “improved” varieties is always favorable.

It makes sense to link genebanks to farmers. Where landraces have been lost, their genetic purity has been compromised, and the demand as well as the advantages of cultivating landraces have been clearly demonstrated, the potential for increasing productivity and food security for farmers in marginal regions, through *farmer-genebank linkages* is enormous.

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