The Crop Genetic Pump: A Possible Task for NGOs

ECHO Asia Notes
A Regional Supplement to ECHO Development Notes
Issue 14, July 2012
By R.L. (Dick) Tinsley

Editor: Dr. Dick Tinsley is an Emeritus Professor with Colorado State University. With decades of experience as an advisor to smallholder agriculture development projects, he was worked in numerous locations across Asia and Africa. In this article, Dr. Tinsley draws upon his experience regarding locations where governmental certified crop seed development and distribution programs remain insufficient to meet agricultural demands and suggests a concept that he refers to as the "Crop Genetic Pump" to show how the non-governmental sector might facilitate access to seeds of improved varieties.

Introduction

In the overall economic environment common to most developing countries, the government usually attempts to provide civil services, including agricultural support services, similar to those provided by developed countries. This normally substantially exceeds the limited revenue funds and results in many programs being more on paper than in reality. When possible, important services such as these are deferred to Non-Government Organizations (NGOs). Included among these are crop variety development, seed multiplication and distribution efforts. NGOs working with smallholder communities have an excellent opportunity to informally provide a valuable and durable service by obtaining small quantities of advanced breeding lines for the important crops produced in their host communities. They can then multiply them within the community for sale and distribution to the smallholder farmers at or near market seed prices instead of at certified seed prices, which typically cost twice as much.

Financially Suppressed Economies and Financially Stalled Governments

The overall problem and common denominator for most developing countries is the generally financially suppressed economy in which prices for locally produced consumer goods may be one-third to one-fifth of developed countries, while salaries and wages may be only one-twelfth of developed countries (http://lamar.colostate.edu/~rtinsley/FinancialSuppressed.htm). Such disproportion results in considerably larger percentages of income or subsistence production being used just to meet basic requirements, typically stated at 80 percent of income in developing countries compared to 12 to 15 percent of income for developed countries. Since taxes to fund government services must come from discretionary income and not for essential subsistence spending, there is a very limited tax base in most developing countries. What taxes that are collected are mostly committed to meeting the contractual personnel obligations for officers in terms of salary and fringe benefits such as retirement, healthcare and often housing.

The bottom line is that there are virtually no operating funds for managing programs in terms of vehicles for travel, per diem, fertilizer for conducting trials and demonstrations; even paper, pens, printer cartridges, etc. can be in short supply.

This results in governments that are financially stalled with the officers spending most of their time in their offices, consuming copious amounts of tea and looking for additional funding to hopefully do some field work (http://lamar.colostate.edu/~rtinsley/FinanciallyStalled.htm). They also tend to focus on informal supplemental income opportunities, including supplemented salaries for being seconded to development NGOs for the duration of an externally funded project, gratuities for services provided, and consulting for larger farmers who can afford to pay reasonable consulting fees (http://lamar.colostate.edu/~rtinsley/InformalIncome.htm). The latter would be a conflict of interest in most developed countries, but is completely legal and encouraged in most developing countries and at least gets officers in the field.

Impact on Crop Variety Development and Seed Distribution

The highly financially stalled government can have serious consequences for crop variety development and resulting seed multiplication and distribution (http://lamar.colostate.edu/~rtinsley/VarietyImprovement.htm). Without financial resources from tax revenues to fully undertake crop variety improvement programs, but still in need for fresh genetic material with the potential for higher yields and increased pest resistance, many countries defer virtually all of their variety development work to collaborative programs with the International Agriculture Research Centers (IARC), most of which are part of the Consultative Group For International Agriculture Research (CGIAR). This would include well known centers such the International Rice Research Institute (IRRI) and the International Maize and Wheat Improvement Center (CIMMYT).

Since the IARCs' outreach programs are on contract to some international donors, they have all of the operating funds needed and do most of the work. Efforts concentrate more on screening imported lines distributed by the IARCs core program, such as IRRI's International Network for Genetic Evaluation of Rice (INGER) program, than on any actual genetic crossing. However, this effectively gets new crop materials into the country that are evaluated under local research conditions and ultimately released as various named varieties. Because these varieties are evaluated under ideal research conditions, they may not be fully suitable for harsher farm conditions. Host country officers do effectively assist and collaborate with this work. Without such collaborative programs with the IARCs, variety development would virtually stall and research officers would barely be able to maintain their limited germ bank collections. This was the case for rice in both Tanzania and Ghana where some research stations have not received any fresh genetic material for over 10 years.

Once varieties are released, multiplication and distribution efforts are left to the host governments and may get tied up in the overall financial stall. While virtually all developing country governments have seed multiplication and certification programs in place or on paper, they often really do not have the capacity to provide more than a small percentage of the seed requirements, nor the staff and operating funds needed for an international standard certified seed program to fully supervise seed farms. For example, during the late 1990s Thailand's seed division was only able to produce enough soybean seed for one-sixth of the acreage planted. Even then they were not able to sell all that was produced. This left over five-sixths of the soybean acreage planted to market seed that was informally distributed and had long ago lost its varietal identity. In Kenya a couple years ago, two new varieties of soybean developed in conjunction with IITA were released. However, inquiries to various research stations of the Kenya Agricultural Research Institute (KARI) failed to identify any seed multiplication effort to make the new varieties available to farmers, large or small.

Farmers are thus mostly left on their own to plant whatever seed they can obtain, either from their own retention of the previous harvest or seed purchased in the local markets (usually referred to as "market seed"). Such practice most likely accounts for over 90 percent of all seed planted worldwide, including self-pollinated crops like wheat in developed countries. For example, in Colorado it is estimated that only 25 to 30 percent of the wheat acreage is planted to certified seed, with the balance planted to retained seed.

Similarly, in Nigeria there is only one seed certification team in Kano State, the major agricultural state in the north of the country, and none in other states. This team is expected to make three field visits per growing season to each certified seed field, usually less than a hectare in area. These visits are scheduled for:

1. The beginning of the season to make certain different varieties are physically sufficiently separated to avoid accidental contamination,
2. The middle of the season to check for crop uniformity, and
3. The end of the season to check cleanliness and collect a germination sample for testing.

Fig. 1. Non-uniform field in a seed farm in Nigeria expected to be certified

This is an impossible task for one team with limited operational resources, whose members are almost beholden to their clients just to get around. Thus one has to wonder how much of this certification program is on the honor system, perhaps assisted with some nice gratuities to provide the certification (such as for the non-uniform sorghum field on a seed farm in Nigeria shown in Fig. 1). As seed certification will double the value of the crop, this also raises the question as to whether certified seed produced under

these administrative and budgetary constraints is substantially better in quality than seed informally sold or distributed in village markets and by local agro-dealers, particularly to justify the nearly double price as well as the additional transportation costs.

The situation results in farmers being wisely reluctant to invest in certified seed and relying almost entirely on market seed. It also means the variety identity is usually lost, although some local distinctions may be possible related to the best use, etc.

Table.1. Yield Comparison of Project and Farmers' Seed for 3 Varieties

Subarimati		**Zambia**		**IR 54**	
Source	**Yield (t/ha)**	**Source**	**Yield (t/ha)**	**Source**	**Yield (t/ha)**
Project	1.72	Project	0.61	Project	1.44
Farmer 1	2.24	Farmer 4	1.11	Farmer 7	0.97
Farmer 2	2.01	Farmer 5	1.01	Farmer 8	1.68
Farmer 3	1.56	Farmer 6	0.42	Farmer 9	2.28
Ave.	1.89	Ave.	0.79	Ave.	1.59
Std. Dev.	0.57	Std. Dev	0.57	Std. Dev	0.80

Source: Developing Smallholder Agriculture: A Global Perspective

The net result is that virtually no fresh genetic material is entering most smallholder communities through designated channels; only limited amounts arriving through informal sources. However, particularly where "traditional" varieties are being grown that are morphologically low yielding, and perhaps more prone to pest attacks, there is a continual need for fresh genetic material to be introduced to farming communities. Also, unless a clear yield difference between certified seed and market seed of the same variety can be demonstrated, seed can easily be multiplied within a community, avoiding the need to import large volumes of nationally certified seed.

Fig. 2. Nearly three-meter tall, less productive traditional sorghum in Nigeria compared to modern varieties typically less than two-meters tall

Demonstrating a potential yield advantage of certified seed over market seed can be difficult, as shown in Table 1 with a comparison of yields from seed sourced by the project (institutional) vs. regular farmer-produced seed for three rice varieties in Tanzania.

The Crop Genetic Pump

In the general absence of an effective, reliable and official channel for seed multiplication and distribution, the introduction of needed fresh genetic material to smallholder communities can be fairly easily done by NGOs working with

host communities. The process would be to simply contact the local office of any IARCs collaborating with the national variety improvement research programs for the crop in question, ask them for small amounts of seed for promising varieties, and take the packs of seed back to their host communities for multiplication and distribution. Most IARC offices are conveniently located at major agriculture research stations and are often happy to share small quantities of seed, perhaps a kilo or half kilo, of promising lines. They may request that you participate in a verification or validation trial. This is generally the last formal stage of variety development prior to release, and is expected to be done on famers' fields throughout the country; IARCs are often looking for volunteers to conduct such trials. The opportunity should be welcomed and encouraged, and the requested data should be collected and readily returned.

Once a number of new varieties have been acquired, seed can be multiplied within the community, possibly in conjunction with one of the community-based family enterprises already serving as agro-dealers. While the initial seed is being grown, encourage farmers to review and appraise the plant type, yield, and quality of the seed, and to comment on their likes and dislikes. Be sure to maintain identities of the varieties or breeding lines, and clearly label them in the field. At the end of the first season, the farmer-preferred lines can be further multiplied, while those not appreciated can be quietly discarded. With most grains and grain legumes, the multiplication ratio is over 50 to one. Thus if you start with a kilo of seed, the first season will yield 50 kg, and the second season 2500 kg. In three seasons there should be sufficient seed to blanket a community, at least to the extent that farmers are interested in growing the crop.

Be sure to keep varieties separated and clearly identified. The ultimate objective is to have three or four different varieties of major crops being grown in a community in nearly equal amounts. Growing several varieties of the same crop within a community can prevent a complete catastrophe when pest resistance breaks down for one variety (which periodically happens as pests can mutate and overcome a crop breed's mechanism for resistance).

The process of introducing and evaluating potential new crops only needs to be done every three or four years. It takes time to develop new varieties, and there would not be major changes in available lines in less than four years.

By operating a genetic pump for the benefit of community members, an NGO can have a durable impact on the community with limited effort and risk; just some patience for a couple of seasons as the initial seed multiplication is done. If, in the process, some traditional lines are replaced with modern high yielding lines, and if the seed is continually saved and planted in the community, the impact will endure well past the typical time for NGO-facilitated poverty alleviation projects.

The genetic pump is really about enhancing and expediting the informal flow of genetic material that takes place around official channels. This takes place slowly as farmers move around

visiting distant relatives, participating in farmer study tours, etc. or through verification trials that are conducted in communities.

An example includes IR 1561, an early IRRI-developed line that was used in several on-farm verification trials in the mid-1970s. Farmers liked the line and it became widely used in the Philippines and persisted for over 20 years, even though it was never formally released or recognized as a variety (and thus no certified seed is available).

Another example is the popular rice variety called Zambia in southern Tanzania, mentioned in Table 1 above. Neither the Zambian nor Tanzanian rice programs have any varieties so designated. Apparently someone from Tanzania who crossed the border into Zambia liked the variety and grabbed a small amount of seed. Having lost track of the original variety name, after taking the seed back to Tanzania, the variety was referred to as 'Zambia.' Similarly, in Nigeria farmers were growing a rice variety they referred to as Cameroon. In Afghanistan the most commonly identified wheat variety is MexiPak. This is an original that Nobel laureate Norman Borlaug developed over 60 years ago, prior to the project he was working on in Mexico having evolved into CIMMYT. The variety was intended for use in Pakistan but apparently leaked across the border. Again, it is not recognized by the Afghanistan government. Local officials may not appreciate this, but the reality is that they cannot do anything about it.

Managing a Crop Genetic Pump

Avoid Hybrids: One restriction on the crop genetic pump concept is that it is for self-pollinated crops and not hybrids. This quickly reduces the prospects for hybrid maize and sunflower varieties that cross-pollinate. Hybrid varieties are F1 initial crosses and are still segregating with each generation, so fresh certified seed is needed each planting season. Otherwise, the resulting crop will be highly non-uniform and low yielding. For this reason it is normally ill-advised to emphasize the use of hybrids in smallholder communities since the logistical supply will be difficult to maintain once a project with external support ends. However, there are composite varieties for maize and sunflower that have been grown and rogued (i.e. selecting out any undesirable non-uniform plants) for several generations until they have become uniform. The yield potential is maybe 10 to 15 percent less than hybrids, but yields will be stable from season to season [Ed: *The EDN 88 article 'Hybrid Maize Revisited' discusses how hybrid corn varieties have been recycled or creolized over a number of years by Mexican farmers; http://www.echocommunity.org/resource/collection/CAFC0D87-129B-4DDA-B363-9B9733AAB8F1/edn88.pdf*]. More appropriate crops for genetic pumps would be rice, wheat and most legumes, as well as plants that are vegetatively propagated like cassava and sweet potato.

Involve Local Agro-Dealers: It might be helpful to get local agro-dealers involved, particularly those indigenous to the community and what may best be referred to as "Community-Based Family Enterprises (CBFE)" (Fig. 3). Dealers such as these are a permanent part of the community with a vested interest in remaining as such. They also tend to have land

that may be used for seed multiplication. Agro-dealers are and have always been the most effective support providers for smallholders, and have a more symbiotic relationship with farmers as opposed to the predatory/prey roles that are often perceived. They are also the default providers once development projects conclude. There are very few smallholder communities that do not have several of these small family businesses. Agro-dealers are often vilified for presumed excessive charges, but such claims are without any supporting data. In reality they are operating on very small profit margins. They are also more durable than cooperatives or other socially desirable multiple-owner enterprises promoted by donors (which are generally too administratively cumbersome to be competitive with the family enterprises). Agro-dealers are also better qualified to deal with any government objections, including paying any gratuities if occasionally necessary.

Fig. 3. Typical family run agro-dealership in Thailand

Seed Quality: One of the main reasons for official objection to a crop genetic pump program would be concern for seed quality. There are basically three components to seed quality: genetic purity, good germination rates and cleanliness. All three components can be easily dealt with in a smallholder community through the facilitation of an NGO.

Of these, the most important is **genetic purity**, which is easily maintained with self-pollinated crops provided that seed from different varieties does not get mixed. While often stated as a concern, genetic impurity is most likely rare with anyone interested in getting into the village seed business (as envisioned with the genetic crop pump approach).

For genetic purity, it is recommended to remove any off-types (i.e. plants with undesirable traits). This is usually done in the field just before harvest by removing the off-types that are typically unusually tall. Or it can be done after harvest if plants are cut with a sharp sickle at a uniform height from the ground as the Lao farmer is doing in Fig. 4. However, note that even after training many seed providers do not bother to rogue out their seed crops. Perhaps the increased value is not worth the effort.

Fig. 4. Lao farmer roguing out off-types for seed. Photo Credit: IRRI

The next seed quality component is **good seed germination**. Normally, most crops, if stored in a reasonable manner, will bridge the off-season with sufficiently high germination to be of

acceptable quality. If grain weevils are a problem, they may be controlled without resorting to fumigation simply by sun-drying the seed on mats. The resulting heat will cause the weevils to become uncomfortable and drive them to seek the shade under the mat. Afterward, when the seed is re-bagged, the weevil population will be drastically reduced [Ed: *For more tips on controlling post-harvest pests, click on the following ECHOcommunity.org link* *http://www.echocommunity.org/resource/resmgr/a_to_z/azch10st.htm#Table*].

Ideally, the desired germination rate should be in the order of 90 percent or more. In the case of lower germination (e.g. down to about 60 percent), it is recommended to simply increase the seeding rate during planting to compensate for lower germination. Germination can be easily tested with a simple ragdoll test (ftp://ftp-fc.sc.egov.usda.gov/GA/PMC/JLW/ragdoll.pdf). The results of such a simple test may not be up to the standards of temperature-/humidity-controlled seed labs, but would be sufficient for rural communities just interested in producing the next crop.

Fig. 5. Simple hand operated seed/grain cleaner from Ghana. These are usually manual operated; it can be difficult to gear down powered ones sufficiently to prevent the grain from being blown away.

The last major concern would be cleanliness and seed that is free of foreign material. Contaminated seed is not really a major problem as much as an inconvenience. Unless a seed drill is used for planting, which is rare for smallholder communities, any foreign materials simply increase the bulk that has to be handled. Weeding requirements may also increase if part of the foreign material is weed seed. However, simple grain cleaners could be used to clean the seed and remove any chaff and weed seed, as well as stones or mud clods (Fig. 5). This technique could also be used to clean grain and perhaps command up to a 10 percent bonus in grain sales (this is the amount that traders often have to discount grain purchases to compensate for both the amount of trash and the cost of removal). A clean bag of grain may represent the first value added to a grain crop and can be done right in the community by the family enterprises dealing with seeds and grain purchases (http://lamar.colostate.edu/~rtinsley/CleanBag.htm). Again assisting the CBFE to obtain such seed- and grain-cleaning equipment would be a good task for an NGO and provide a lasting contribution that would assist in increasing income in the community.

All of these seed quality concerns can easily be included in simple training programs for those interested in becoming involved. This might also be a good opportunity for micro-credit programs to assist with some of the initial costs for multiplying the seed or equipment for cleaning the seed.

Official Reaction

Official reaction to a crop genetic pump initiative that effectively bypasses government programs may be a blunt rejection and general condemnation about the quality of the seed, with all kinds of potential concerns for genetic contamination, poor germination and impurities in the seed. Those promoting government programs, including the regular use of certified seed, have a vested interest perspective. However, governments generally do not have the manpower or financial resources to undertake and effectively provide the necessary services or the resources to enforce or restrict such programs. Thus, while there may be verbal protests, nothing more should be expected. The overriding need is to get the fresh genetic material into the community and available to the farmers so that they can benefit from the wider choice of varieties and prospects for higher yields and income.

Intellectual Property Rights

Many new varieties and specific genes are now being patented by the large international agro-business, with an expectation of royalties being paid for their use, even from impoverished smallholders. As a result, there has to be some concern for violation of patent rights, etc. However, the IARCs are supposed to be supported primarily by public funds from donor countries and operate in the public domain. Thus the variety plant material that they generate is assumed to be public domain and freely available to anyone in need, particularly host developing countries; both public and private sector alike.

Summary

While the crop genetic pump concept discussed in this article is mostly conceptual, it is worth trying where national programs do not have the financial or personnel resources to provide comprehensive variety improvement, seed multiplication and seed distribution programs. The key component is for NGOs working in smallholder communities to obtain small amounts of seed for different varieties and breeding lines and to work with indigenous family enterprises to multiply the seed within the host community for sale to farmers through the normal village marketing channels. This may require some minimum training on how to manage seed in a rural setting [Ed: *An excellent ECHO resource related to seed storage is "Seed Saving Tips & Technologies" by Dr. Tim Motis; http://www.echocommunity.org/resource/collection/E66CDFDB-0A0D-4DDE-8AB1-74D9D8C3EDD4/Seed_SavingTips_&Technologies.pdf*]. If the government or other public institutes do not have the capacity to provide an influx of new varieties, then they should allow the NGOs to assist. Such an undertaking could have positive long-term impact on the host communities that will extend well beyond the limited duration of NGO externally-funded projects.

Ed: *Dick Tinsley is the author of the book Developing Smallholder Agriculture: A Global Perspective. He also manages the website www.smallholderagriculture.com, and teaches the*

continuing education internet course Challenges to Smallholder Agriculture (http://villageearth.org/training-and-consulting/online).