Genetic Pump: A Possible Task for NGOs

R.L. (Dick) Tinsley[i]

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 excess the limited revenue funds and results in many programs being more on paper than in reality, and when possible important services are deferred to Non-Government Organizations (NGOs). Included among these is the variety development, seed multiplication and distribution efforts. This then provides an excellent opportunity for NGOs working with smallholder communities 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, multiplying them within the community for sale and distribution to the smallholder farmers at or near market seed prices instead of certified seed prices, typically costing twice as much.

Overall Problem – Financially Suppressed Economy & Financially Stalled Government

The overall problem and common denominator for most developing countries is the generally financially suppressed economy[ii] in which prices for locally produced consumer goods may be only 1/3rd to 1/5th of developed countries, but salaries and wages may be only 1/12th of developed countries. This results in considerable larger percent of income or subsistence production being used just to meet basic subsidence requirements. Typically this is stated at 80% of income compared to 12 to 15% of income for developed countries. Since taxes to fund government services must come from discretionary income and not for essential subsidence spending, there is a very limited tax base in most developing countries. Then, what taxes are collected are mostly committed to meeting the contractual personnel obligations for officers in terms of salary, fringe benefits such as retirement, healthcare and often housing. The bottom line is virtually no operating funds for managing programs, in terms of vehicle for travel, per diem, fertilizer for conducting trials and demonstrations, even paper, pens, printer cartridges, etc. can be in short supply. The result is governments are financially stalled[iii] with the officers spending most of their time in their offices, consuming prestigious amounts of tea, and looking for additional funding to hopefully do some field work. They also tend to focus on informal supplemental income[iv] opportunities, including supplemented salaries for being seconded to development NGOs for the duration of a externally funded project, gratuities for services provided, and consulting for larger farmers, who can afford to pay reasonable consulting fees. The latter would be a conflict of interest in most developed countries, but not in developing countries, and at least get officers in the field.

Impact on Variety Development and Seed Distribution

The highly financially stalled government can have serious consequences for variety development[v] and resulting seed multiplication and distribution. Without the financial resources from tax revenues to fully undertake a variety improvement programs, but still in need for fresh genetic material with the potential for higher yields and increased pest resistance countries defer virtually all 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 the well know centers such the International Rice Research Institute (IRRI), CIMMYT[vi], etc. Since the IARCs' outreach programs are on contract to some international donors, they have all the operating funds needed and do most of the work, although concentrating more on screening imported lines distributed by the IARCs core program such as IRRI's INGER[vii] program than any actual genetic crossing. However, this effectively gets new material into the country, evaluated under local research conditions, and ultimately released as various named varieties. These varieties are evaluated under ideal research conditions, and may not fully be fully suitable for the harsher farm condition. Host country officers do effectively assist and collaborate with this work. Without the collaborative programs with the IARCs variety development would virtually stall and research officer barely be able to maintain their limited germ banks collections. This was the case in both 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 the multiplication and distribution is left to the host government and gets 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 really do not have the capacity to provide more than a small percent of the seed requirements, nor the staff and operating funds for an international standard certified seed program to fully supervise seed farms. For example the Thai seed division was only able to produce enough soybean seed for 1/6th the acreage planted and even then were not able to sell all they produced. Thus over 5/6th the soybeans acreage was planted to market seed that was informally distributed and had long ago lost its varietal identity. In Kenya a couple years ago they released two new varieties of soybean developed in conjunction with IITA. However, inquires 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 the can obtain, either from their own retention of the previous harvest or purchased in the local markets and usually referred to as "market seed". This most like accounts for over 90% of all seed planted worldwide. It is also common in developed countries for self-pollenated crops like wheat. In Colorado it is estimated that only 25 to 30% 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 each season to each certified seed field that are usually less than a hectare. These visits are defined as:

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

This is an impossible herculean task for one team with limited operational resources and thus 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

certificate for this non-uniform sorghum field on a seed farm in Nigeria (Fig. 1). The seed certifications will double the value of the crop. This also questions if the certified seed produced under these administrative and budgetary constraints is substantially better quality then the market seed informally sold or distributed in village markets and local agro-dealers, to justify the nearly double price as well as the additional transportation costs including any off tarmac transport that can be triple the paved highway MT/km charges.

Fig. 1. Non-Uniform Field in Seed Farm in Nigeria, Expected to be Certified.

This results in farmers wisely being 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 best use, etc.

Genetic Pump

The net result is that virtually no fresh genetic material is entering most smallholder communities through designated channels, just limited amounts coming in from informal sources. However, particularly where old "traditional" varieties are being grown that are morphologically low yielding, and perhaps prone to pest attacks, as shown by these three meter tall sorghum fields in Nigeria (Fig. 2), 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. Demonstrating a potential yield advantage of certified seed over market seed can be difficult as shown in the comparison of project vs. farmer seed for three rice varieties in Tanzania (Table 1).

Fig. 2. Nearly Three Meter Tall Sorghum in Nigeria Compared to Modern Varieties Typically Less than Two meters.

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

In the general absence of an effective reliable 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 variety improvement with the national 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 IARCs offices are conveniently located at the major agriculture research station and, more so than host research offices, are happy to share small quantities of seed, perhaps a kilo or half kilo, of promising lines. They may request that you participant in a verification or validation trial. This is generally the last formal stage of variety development prior to release, is expected to be done on famers' fields throughout the country, and the IARCs are often looking for volunteers to conduct them. The opportunity should be welcomed and encouraged, and the data requested collected and readily returned.

Once the various lines have been acquired it is than a simple task to multiple the seed within the community, possible working in conjunction with one of the community based family enterprises already serving as agro-dealers. While the initial seed is being growing the farmers should be encouraged to review and appraise the plant type, yield, and quality of the seed, and advise the responsible person on their likes and dislikes. It is important that variety or breeding line identity be maintained and clearly labeled in the field. At the end of the first season, those lines the farmers like 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, as least to the extent farmers are interested growing it. It is important 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 prevents a complete catastrophe when pest resistance breaks down for one variety as periodically happens, as pest mutate to combat breeders mechanism for resistance.

The process only needs to be done every three or four years as the variety development process is a fairly slow process, and there would not be major changes in available lines in less than four years.

Operating a genetic pump for the benefit of community members should provide a NGO a durable impact on the community with only limited effort and risk, just some patience for a couple seasons as the initial seed multiplication is done. If the genetic pump results in replacing some traditional lines with modern high yielding lines, with the seed continually being distributed in the community the impact will endure well past the typical time for NGO facilitated poverty alleviation projects.

The genetic pump is really enhancing and expediting the informal flow of genetic material that takes place around official channels. This takes place slowly as farmer move around visiting distant relatives, participating in farmer study tours, etc. or verification trials are conducted in a community. The examples are IR 1561, an early IRRI developed line that was used in several on-farm verification trials in

the mid-1970s, the farmers liked it and it became widely used in the Philippines and persisted for over 20 years, even though never formally released or recognized as a variety and thus no certified seed is available. In Southern Tanzania a popular rice variety is Zambia mentioned in Table 1 above. However, the neither the Zambian nor Tanzanian rice program have any varieties so designated. Apparently someone crossed the border on some kind of visit, like the variety, grabbed a small amount of seed, but lost track of the variety name, took it back to Tanzania and started referring to it as Zambia. Similar 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 Norman Borloug cross made over 60 years ago prior to the project he was working on in Mexico evolved into CIMMYT. It was intended for use in Pakistan but apparently leaked across the border. Again it is not recognized by the Afghanistan government. The local officials may not appreciate this, but the reality is they cannot do anything about it.

Managing A Genetic Pump

Avoid Hybrids: One restriction on the genetic pump concept is that it is restricted to self-pollenated crops, and not hybrids. This quickly reduces the prospects for maize and sunflower that cross pollenate. Hybrids varieties are F1 initial crosses and are still segregating with each generation, thus, the need for fresh certified seed each season or the crop will be highly non-uniform and low yielding. For this reason it is normally ill-advised to emphasis using 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 sunflowers that have been grown and rouged for several generations until they are uniform. The yield potential maybe 10 to 15% less than hybrids, but they will be stable from season to season. More appropriate crops would be rice, wheat, most legumes, etc. Also appr opriate would be those vegetatively propagated like cassava and sweet potatoes.

Involve Local Agro-Dealers: It might also be desirable to get some 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). They are a permanent part of the community with vested interest in remaining part of the community. They also tend to still have some land remaining for seed multiplication. These are and have always been the most effective support providers for smallholders, and have more a symbiotic relationship with the farmers than predatory/prey as often perceived. They are also the default providers once a development project concludes. Very few smallholder communities don't have several of these small family businesses. They are often vilified for presumed excessive charges, but this is done without any supporting data, and 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 but generally to administratively cumbersome[viii] to be competitive with the family enterprises. Family

Fig. 3. Typical Family Run Agro-Dealership in Thailand

enterprises are also and better qualified to deal with any government objections including paying any gratuities if occasionally necessary.

Seed Quality: One of the biggest concerns and reason for official objections to a genetic pump program would be concern for seed quality. There are basically three components to seed quality. They are genetic purity, germination and cleanliness. All of which can be easily dealt with in a smallholder community by a facilitation NGO

Of these the most important is genetic purity. This is easily maintained with self-pollenated crops, provided the seed from different varieties doesn't get mixed. While often stated as a concern, it mostly like would be rare with anyone interested in getting into the village seed business as envisioned with the genetic pump. Similarly for seed it is desirable to remove any off types. This is usually done in the field just before harvest by removing the off-types that are typically unusually tall. It can be done after harvest, if harvested with sharp sickle at a uniform height from the ground, as the Lao farmer is doing (Fig. 4). However, it has to be noted that even after training many seed providers do not bother to rouge their seed crops. Perhaps, the increase value is not worth the effort.

Fig. 4. Lao Farmer Roughing Out Off-Types For Seed. Photo Credit: IRRI (Should get permission to print)

The next problem is germination. Normally, most crops, if stored in reasonable manner, will bridge the off-season with sufficiently high germination to be acceptable quality. Care might have to be taken to reduce grain weevil infestation, if this is a problem, but that can be controlled without resorting to fumigation, simply by sun drying the seed on mats that will heat the weevils to become uncomfortable warm an encourage them to seek the shade under the mat, so when re-bagged the weevil population will be drastically reduced. The desired germination would be in the order of 90% or more. In the case of lower germination down to about 60% it is possible to simple increase the seed rate to compensate for lower germination. Germination can be easily tested with a simple ragdoll[ix] test. Perhaps, not the standards of temperature/humidity controlled seed lab, but sufficient for rural community just interested in producing the next crop.

The last major concern would be cleanliness and seed free of foreign material. This is not really a major problem as much as an inconvenient. Unless a seed drill is used, which is rare for smallholder communities, any foreign simple increases the bulk that has to be handled, and perhaps increase the weeding requirements, if part of the foreign material is weed seed. However, simple grain cleaners could be used to clean the seed and remove any chaff, weed seed, as well as any stones or mud clods (Fig. 5). This could also be used to clean the grain and perhaps command up to 10% bonus in grains sales. This is the amount grain 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[x]

to a grain crop and can be done right in the community by the family enterprises dealing with seeds and grain purchases. Again assisting 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 program of those interested in getting 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.

Fig. 5. Simple Hand Operated Seed/Grain Cleaner From Ghana. These are usually manual operated as it can be difficult to gear down power ones sufficiently to prevent the grain from being blown away.

Official Reaction

The official reaction to the genetic pump that effectively by-passes government programs, may be a blunt rejection, and general condemnation about the quality of the seed with all kind of potential concerns for genetic contamination, germination, and impurities in the seed. However, this has to be viewed from a vested interest perspective of those promoting government programs including the regular use of certified seed. However, the government just does not have the manpower or financial resources to undertake and effectively provide the necessary services or the resources to enforce or restrict the program. 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, as they can benefit from the wider choice of varieties and prospects for higher yield and income.

Intellectual Property Rights

With many new varieties and specific genes that go into varieties being patented by the large international agro-business with an expectation of royalties being paid for their use, even from impoverished smallholders, there has to be some concern for violation of patient 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 material they generate is supposed to be public domain and freely available to anyone in need particularly host developing countries, both public and private sector alike.

Summary

While the genetic pump concept discussed above is mostly conceptual, it is worth trying where national programs don't 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, work with some 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. The important thing is if the government or other public institutes do not have the capacity to provide an influx of new varieties, than allow the NGOs to assist. Such an undertaking could have some positive long term impact on the host communities that will extend well beyond the limited duration of NGO externally funded projects.

Biodata

Dick Tinsley is Prof. Emeritus in the Soil & Crop Sciences Department at Colorado State University. He spent his entire professional career working with smallholder and their communities. He is the author of the book **Developing Smallholder Agriculture: A Global Perspective**, manages the website: www.smallholderagricultue.com, and teaches the continuing education internet course **Challenges to Smallholder Agriculture**.

---

[i] This article has been submitted for publication by Echo on-line magazine. It is included here in advance of publications as needed reference for some reports. This will be replaced with the final published version as soon as it is available.

[ii] http://lamar.colostate.edu/~rtinsley/FinancialSuppressed.htm

[iii] http://lamar.colostate.edu/~rtinsley/FinanciallyStalled.htm

[iv] http://lamar.colostate.edu/~rtinsley/InformalIncome.htm

[v] http://lamar.colostate.edu/~rtinsley/VarietyImprovement.htm

[vi] Spanish Acronym for International Center for Maize and Wheat Improvement

[vii] International Nursery for Genetic Evaluation of Rice

[viii] http://lamar.colostate.edu/~rtinsley/Cooperatives.htm

[ix] ftp://ftp-fc.sc.egov.usda.gov/GA/PMC/JLW/**ragdoll**.pdf

[x] http://lamar.colostate.edu/~rtinsley/CleanBag.htm