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Fatal gaps in seed security strategy

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Abstract Seed security initiatives are proliferating in both developmental and crisis contexts but the field as a whole is weak in critical thinking. Two gaps in particular are explored in this paper: the need to set explicit seed security goals and the need to ensure balance among the security elements of availability, access and quality. Differences in the planning and implementing of seed security initiatives are examined in some detail for programs that variously aim for: food production, nutritional enhancement, system resilience, and income generation. Results show that one seed security program is not like another and that features such as partner choice, product design, delivery and awareness-raising strategy need to be tailored to meet the overarching goals. The paper closes with five key policy and programming recommendations.

Keywords Food security · Seed security · Nutrition · Resilience · Climate change

Introduction

Food security is a pressing development issue and many development programs focus on seeds as a primary way to promote food security. As a result, seed security has become an important goal for development and is seen as a key driver of food security. It is widely appreciated that 'food security' includes multiple aspects, such as calorie production, nutritional quality, or resilience under stress (Maxwell et al. 2008), and there is a lively debate around strategies for achieving food security (e.g. around the emphasis on trade, production areas, crops, technologies). In contrast, concepts or strategies around 'seed security' are rarely subjected to the same critical scrutiny.

This paper assesses the scope for seed security initiatives to be linked to specific food security gains. The issue is key for several reasons. Seed security projects are fast proliferating and, in Africa alone, have consumed at least US$ 200 million of key donor funding in just a five-year period.[1] Is this scale of investment leading to a commensurate scale of positive impact? Further, seed security projects have become a central programmatic feature of those working in emergency and chronic stress contexts, as well as in more developmental ones (Sperling et al. 2008; van Mele et al. 2011). Thus, seed security programs are being implemented among some of the more vulnerable and least resilient of populations. Is the strategy guiding seed security vision and operations sufficiently sharp to serve the needs of those already compromised?

To-date, there has been relatively little strategic thinking around the elements critical for sustainable and impact-oriented seed security programs. Technical discussions dominate the professional discourse, such as how to scale up foundation seed production or establish national seed quality parameters (for example, FAO 2009). Seed security aims are presented as transparent and clear-cut, with more seed security assumed to lead directly to more food security (FAO 1998). Hence, in response to the food crisis of 2007–

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[1] This is an underestimate and results from author and public information on the seed-related budgets of programs funded by Alliance for a Green Revolution in Africa/Program for Africa Seed Systems (AGRA/PASS), Swiss Development Cooperation, McKnight and The Bill and Melinda Gates Foundations (which includes but goes beyond support to AGRA/PASS).

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2008, the UN FAO announced it would provide seeds, fertilizer and other supplies to smallholder farmers in 48 countries.[2] Seed initiatives are also commonly presented as a prime driver for modernizing smallholder agriculture, with the assertion that use of improved seed (i.e. released varieties, Certified Seed), coupled with fertilizers, will result in higher yielding and more efficient production environments.[3] Closer analysis of these assumptions shows that possible links (and non-links) between food and seed security are more subtle or less direct (McGuire and Sperling 2011). The centrality of both assumptions (that during food crises more seed is needed; and that improved seed drives such gains) also signals that overall seed security strategy and its possible variations, may be relatively under-examined.

This paper aims to move forward reflection on two types of gaps which shape seed security strategy: first, where to put emphasis among the varied possible features of a seed security intervention; and second, how to set seed security goals at the start.

(Im)balance among central features of seed security

Basic frameworks for thinking about seed security have been well formulated within the last 10 years (Remington et al. 2002) and broadly parallel food security frameworks. Seed has to be *available* (in reasonable proximity, quantity, and in time for critical sowing periods); it has to be *accessible* (people have to produce seed themselves or have other means such as gift, barter or cash to obtain it), and its *quality has to meet producer needs and preferences* (generally, it has to be healthy, adapted, and acceptable) (Remington et al. 2002; Sperling 2008).

While the theory suggests that all three features — availability, access and quality — have to be in place to ensure seed security, the practice often shows uneven balance, especially in programs among smallholder farmers whom many initiatives aim to address. At least four sets of imbalances seem to occur on a relatively routine basis.

a) *Seed security projects focus on producing increased quantities of seed, that is, how to render it more available, but give little attention to how the delivery will be organized*, a key issue linked with rendering seed accessible. Many of the community-based or artisanal seed based projects manage to get seed produced but neglect to develop sustainable distribution or marketing systems (Rohrbach et al. 2002; CIAT et al. 2010). Seed produced then becomes 'bought' by institutions (such as Non-Governmental Organizations, United Nation agencies, faith-based groups) in the context of development and emergency aid projects. The gap in creating real delivery systems, linked with the creation of an artificial market, is so widespread that some analysts point to the emergence of a new type of seed production mode, the Relief Seed System, where seed is produced solely to be given away within humanitarian initiatives (Bramel and Remington 2004). A recent inventory of seed security projects in Southern Sudan shows the practice of supply-side multiplication to be a dominant one. Among 20+ organizations multiplying seed, none had an articulated delivery or marketing component (CIAT et al. 2011).

b) *Seed security projects focus on producing high quality seed, but give scant emphasis to the economics of the costs of production, nor to the demand for such a refined product.* Here, another aspect of 'access' is ignored. Seed security projects focus on quality traits, especially promoting certified seed, but give little attention to whether farmers are willing to pay for such attributes. Analysis of bean seed production across multiple projects in the Great Lakes Region of Africa (Rwanda, Burundi, Democratic Republic of Congo) has shown certified bean seed to cost 100 to 300 % more than seed purchased in local markets, sometimes for the same varieties (CIAT 1992). Farmers simply cannot recoup these costs as the yield advantages are not commensurate.

c) *Seed security projects, especially those focusing on high quality seed, program in a delivery component but focus on formal sector delivery through agro-dealer networks* (for example, the AGRA/PASS programs in Africa). These projects do contain a delivery agenda, but a truncated one. Efficiencies on the supply side are carefully considered, but not necessarily service issues from the user side. Repeated analysis of formal agro-input dealer service providers shows that: i) their placement favors high density, better-off areas and can be unsuitable for those in more remote or marginal regions; ii) such dealers supply only a small range of products (for example, maize, vegetable seed, fertilizer and pesticides); and iii) such shops are utilized mainly by a set of more progressive farmers (Farrow et al. 2010; CIAT et al. 2010, 2011). Use of formal agro-dealers as the key delivery channel flags issues of constrained geography and product choice as well as issues of cost and accountability. Again, access concerns are brought to the fore, especially for poorer populations and for those in the more unfavorable farming zones, who are economically or geographically disadvantaged.

d) *Seed security projects rarely program in an information component*. In terms of access, farmers need information about the varieties and seed on offer in order to

[2] http://www.un.org/apps/news/story.asp?NewsID=27313&Cr=Global&Cr1=Food

[3] http://ngm.nationalgeographic.com/2009/06/cheap-food/bourne-text/1

make informed decisions about where, how or if to acquire them (McGuire and Sperling 2011). Such awareness-raising work, which eventually is a stimulus for demand, should be programmed systematically. Relatively few seed security programs have a budget and operational program highlighting seed security information: where to find seed, how to compare costs of different seed types, where to view samples in the field. Even fewer have two-way feedback systems, not just giving out information, but receiving, in turn, user insights on performance, the clarity of advice provided, or on product quality (especially if seed does not germinate or may be adulterated).[4] This marked gap in promoting access through a rich information base is especially lamentable as it is perhaps this seed security-related feature where advances have been quite dynamic in the last 5 years. Social networking, mobile phones, and SMS all offer good prospects for jumpstarting and reinforcing seed security initiatives.

In sum, seed security projects are proliferating. They generally focus on producing larger quantities of seed, producing higher quality or certified seed, or on promoting formal agro-dealer development. Access issues in all of the above may receive scant attention, with the 'access feature' being overlooked along multiple dimensions. A delivery or marketing strategy may be omitted entirely or be truncated to encompass only formal sector outlets for better off areas. Cost issues may be given low priority, including little attention to costs of production as linked to performance on-farm or cost of formal sector product as compared to seed on offer at local markets. Information outreach, allowing end-users to make informed decisions about product choice or feedback, is usually a void altogether. This overview suggests that seed security projects are generally characterized by a supply-side focus and a weak notion of who the users are or what they might want or need.

Why lack of attention to 'access feature' in seed security programs?

Of the three seed security features, it is the access one that is generally underdeveloped or not on the agenda at all. One might ask why this gap? Several initial forces seem to contribute to this omission.

1. Seed security programs are often led by seed technologists (as happens in 'Seed Unit' programs). Such professionals have an important grasp of the production logistics and especially of the technical challenge of producing high quality seed under variable field conditions. However, their training is weighted to product quality management rather than to the array of other skills which are also necessary, such as around building demand, or organizing delivery to maximize impact. Northern trained seed technologists may also have little familiarity with Southern smallholder farmer preferences and management conditions. A more comprehensive skill set is needed.
2. Seed security programs are frequently launched by goodwill development practitioners, particularly a variant labeled Community-Based Seed Multiplication programs (CBSM). They may be initiated to help the community get immediate access to new varieties (and especially to the legumes or orphan crops in which the formal seed sector has little interest). However, CBSM programs have not really been designed to be sustainable or to offer ongoing access to seed (Rohrbach et al. 2002). They often start from a premise of development assistance rather than from a business optic.
3. Seed security programs may arise in response to an emergency or chronic stress context. Their first aim is to get seed out in the short-term, with few constraints imposed by operating costs and relatively little attention to differentiating among clients (beneficiaries) reached. While linked to #2, this humanitarian thrust works on a larger but more intermittent scale. [In contrast, CBSM projects pepper many communities across Eastern, Central and Southern Africa (for example, Setimela et al. 2004)]. Thus, the issue of sustained access is even more acute than with CBSM.

On a positive note, there are inklings of change to put 'access features' front and central to seed security initiatives. As examples, in Malawi, placement of agro-dealers is being reviewed through Geographic Information System (GIS) mapping so as to increase accessibility of shops for those in more remote regions or who have only walking or bicycle transport (Farrow et al. 2011). In East, South and West Africa, private seed companies are being encouraged to pack seed in very small sizes of 50, 100, 200 g, so farmers can test varieties at little risk. Follow-up shows even poorer farmers and women willing to pay for small packs of beans, cowpea, groundnuts and soybeans (Sperling et al. 1996; PABRA/KARI/CIAT/TLII 2010; Ndeunga et al. n.d.). In Kenya, mobile phone feedback systems are being used so that smallholder farmers (and even old women) can phone in comments (complaints or appreciation) of varieties and seed they have purchased or have been given (D. Karanja, *personal communication).*

These are but isolated cases of giving greater attention and creativity to addressing the access feature of seed

[4] The Tropical Legumes II project, funded by the Bill and Melinda Gates Foundation (2007 and ongoing as of 2012) does contain some of these unique features, including programming 15 different methods for awareness-raising and demand creation (Tropical Legumes II Seed Systems Working Group 2009).

security. More advances are quickly required and access needs to be a core element of all programs. Simply, if one cannot construct profitable, cost-effective, information-rich seed delivery and demand creation systems, one might drop the rubric of security programs all together, as programs neglecting an access strategy operate, in practice, mainly as "seed give-away programs", and relatively expensive ones.

(Im)balance (invisibility) of seed security goals

Beyond the imbalance among seed security features, there is also an imbalance in goals around which security-related projects are constructed, especially if one considers the diversity of possible options and their potential for a range of positive impacts. At this point, the predominant rationale for promoting seed security projects is that they promote food security through brute production gains (FAO 1999).[5] In reality, the scope of agriculture is multifunctional and goes far beyond scaling up production of staples (Renting et al. 2009). To the extent that seed is one basis of agriculture, seed must also be multifunctional.

Seed security programs might potentially be designed to meet very different goals, beyond aggregate increases in food supply and subsequent calories. For instance, they could be linked to programs to enhance nutrition: crafted to move biofortified varieties, nutritious local varieties or to multiply and deliver planting material of a diversified set of dietary options. Seed security programs could be designed mainly to link with agro-enterprise initiatives in which income generation is the driving force: the seed system would be streamlined to provide large quantities of uniform material on a relatively continuous basis. Alternatively, promoting agricultural system resilience and 'climate smart' responses might serve as the overall development aim of seed security programs which are then tailored to offer a basket of options of varieties and crops to meet varied and flexible production niches. At the most basic level, seed systems designed to meet different program goals start with dramatically different crops and variety characteristics (Table 1).

In addition, as the next section suggests, beyond the first step of crop and variety type, aiming for different seed security goals implies the use of radically different strategies for addressing production, delivery and distribution (for access), and quality-linked concerns.

[5] A step by step expansion of this logic might run as follows: increased seed availability will drive increased and widespread adoption of new varieties; increased production of staple crops will then result; increasing staple grain production will increase food availability; and increased availability is *the* way to address food security.

Table 1 Broad crop and variety types in relation to diverse seed security goals

Goal	Crop/variety issues
Food Production (aimed especially at home consumption)	• Major staple crops • Crops/varieties responsive to high inputs
Nutrition	(Focus not just on calories but on nutritive elements) • Varieties biofortified with micro-nutrients • Crops contributing to dietary diversity/dietary complementarity • Specialty crops: leafy vegetables, Orange-fleshed sweet potatoes
System resilience 'climate smart'	• Crops which tolerate abiotic stress - Heat tolerant crops/varieties - Water-efficient crops/varieties • Crops which add value to resource base/landscapes - Legumes to fix nitrogen - Fodder crops
Income generation	• Crops geared to developed or emerging markets ('high value crops') • Crops linked to value-added/ processing chains • Crops linked to non-food livelihood activities (e.g. fiber production)

Note that some crops will allow for interlinked seed security goals: for example, select vegetables (offering nutritional gains) may be tied to new emerging markets (income generation possibilities)

Seed security goals and implications for action

Diverse goals imply diverse seed security-linked program strategies. Moving towards these diverse goals goes well beyond changing the title of a seed security project from, for example, seed security for food security to 'seed security for system resilience'. To suggest the degree of divergence arising from an emphasis on different strategic goals, sample issues of partners, delivery mechanisms and recipient groups are sketched below in reference to distinct seed security goals. Beyond the fact that each has a seed component, these security projects may have relatively little in common.

Seed security linked to nutritional enhancement

Seed security projects linked to nutritional enhancement might cluster around diverse technical options: for instance, promoting biofortified varieties of crops already known in the area, making more accessible local (traditional) nutritious varieties or promoting a basket of nutritious foods for which seed systems or agronomic management might be reinforced. What is common among these 'nutrition focused seed security projects' is that their concerns go well beyond those of routine agricultural research and development programs.

We sketch a range of features below to suggest some of challenges of a seed security project with a nutritional enhancement goal.

Partners Seed projects focusing on a nutritional product have to link with specialists who know about and manage the subject, from the government ministries to field level, for instance: health/nutritional departments; home economic groups; mother and child constituencies; and perhaps even those who develop ready-to-use therapeutic foods (RUTF). Partners may also come from Non-Governmental Organizations/Community-based Organizations that do not usually collaborate with agricultural research. Planning how agricultural, health, home economics and nutritional institutions and personnel can truly be integrated is also key, as having one sector focus on the 'seed part' and the other on 'the nutrition part' can create inefficiencies, frictions and even technical gaps in information shared with end-users. A cohort needs to be developed of seed sector people who know and act 'nutrition' and vice-versa. This seamless integration is no easy challenge, even at the field level, where one might expect the closer social and geographic distances to allow for multi-theme integration. Agricultural extensionists, often liaising with progressive farming males, may not often interact with home economics workers who make weekly visits to the vulnerable households or expectant mothers. More broadly, women farmers are seldom the primary targets of agricultural extension services although they may figure centrally in nutritional outreach programs.

Select design features Nutrition products, moved through seed, need to be at least 'as good', as less explicitly nutritional ones. From the plant breeder's point of view, this means having to add another trait - enhanced levels of micro-nutrients - to the normal agronomic and organoleptic characteristics (yield, time to maturity, grain quality, processing and post-harvest qualities). HarvestPlus, for example, is working on selectively enhancing levels of three vitamins and minerals (iron, zinc and vitamin A) in seven crops (www.harvestplus.org). From the farmer-producer point of view, seed of nutritional products probably has to have added agronomic or quality advantages (taste, marketing) over existing varieties in order for it to be adopted. As with any new crop or technology, it must fit in with existing elements of a household's farming system and livelihood strategy (e.g. amount and timing of labor, resource demands).

Delivery/access issues Seed security projects normally aim to reach an unspecified 'large number of farmers', or the more progressive ones who may be forerunners in valuing and adopting use of high quality seed. In the case of a nutrition enhancement goal, the seed delivery system has to be able to reach those in special need (i.e. the mal- or undernourished) or those who make the nutrition-linked and seed acquisition decisions, which for many crops and locales are women. In terms of delivery design, provision and sales units might best be placed in venues which women/mothers frequent: open markets, small neighborhood shops, health centers. Mal- and undernourishment is also often associated with poverty and provision and sales of seed has to be within the financial reach of even the very poor. Delivery design might consider: packaging seed in smaller units for sale at real cost; or building on programs which offer seed with partial subsidy; or making it accessible through aid coupons.

Awareness-raising /information sharing The added value of seed that may have enhanced nutritional advantage is invisible. A farmer can see 'more yield' but not more 'micronutrient and vitamin value.' The hidden quality of nutritional seed security projects means that awareness-raising and demand creation campaigns have to be explicit, intensive and geared to the right user audiences. Enhanced information, with messages such as 'this particular bean is very good for your health' (or in an East African vernacular, 'this bean gives you more blood') may well be <u>the</u> driver for adoption. Social marketing may also be needed to stimulate demand for nutritious food, particularly in urban areas (Gotor and Irungu 2010). This information component should not be underestimated as lack of information may be the main constraint for select seed use, rather than lack of physical planting material (McNiven and Gilligan 2011; Tripp 2001).

What all this suggests is that seed security projects, focusing on routine production gains are very different entities from those linked to nutrition enhancement. We now turn to seed security aiming for enhanced resilience of farming systems, where the programming differences may be even more marked.

Seed security linked to promoting system resilience or 'climate- smart' programs

Creating resilience in rural systems is an increasingly central goal in agricultural research and development (R+D) work yet current seed system security designs will not naturally respond to the needs of a resilience agenda. Resilience implies not having an optic of seed stocks of individual varieties, but rather one of entire seed system strategies in reserve so farmers can access 'smart diversity' relatively quickly which can then be targeted for variable production scenarios (McGuire and Sperling in preparation. Making seed systems more resilient). Diversity of agricultural systems has to be managed at one point in time as well as through time, as farmers' strategies around crop or variety choice may reflect the exigencies of a particular season, rather than a predetermined plan (Fujisaka 1997). Further, recognition of the multi-functionality of agriculture, noting direct as well as indirect services rendered (including ecosystem services), has to be factored into strategic planning. Additional insight into seed security programs design geared to resilience enhancement appears below.

Partners Partners here need not only to be production-oriented, but environmentally savvy, with an orientation that encompasses years of environmental fluctuation and possible stress trends, and not just seasonal gains or cumulative production increases. Parallel to nutrition above, a specialized cohort will need to be engaged: from governmental ministries down to field-based professionals who have embraced the broad climate change ken (water, soils, trees, socio-ecological systems) as well as that associated with sustainable agricultural production. Many countries now have National Action Plans for Adaptation (NAPAs), supported by the UN Climate Change Convention, which coordinate projects aimed at adaptation, including agriculture ones. These are obvious forums for engagement, though, as above, environmental networks and institutions do not always interface with agricultural ones (although rural farming families may straddle the divide relatively easily). This is why a systems perspective is important, to understand how components of an individual livelihood fit together, and interact with wider-scale processes such as land use in neighboring areas, labor markets, and patterns of environmental change. Clear also may be a divergence in goals: stability, and longer-term incremental gains, versus sharp production increase season by season (see also the section below on evaluation criteria).

Select design features Key here is a move away from notions of seed for one crop or stable crops or 'best bet crops' and towards a seed security strategy that makes available to farmers multiple crops, multiple varieties, mixes of options that let farmers anticipate variability and respond rapidly to emerging stress and opportunities. The economies of seed production will be particularly demanding here as a drive to adaptation to many narrow niches has to be added to the current wide adaption perspective (for big profit) of seed multipliers. Multiple response sets [what we call 'seed system strategies in reserve' (McGuire and Sperling in preparation. Making seed systems more resilient)] will need to be catered for in practical terms. This will mean more and diversified foundation seed sets, and decentralized seed production and marketing groups working within niche agro-ecological zones, being <u>the</u> organizational production principle. This decentralization should go beyond 'deconcentration' of administration (Ribot 2003) to allow real local agency in expressing localized, and varied, demand for seed. This degree of bottom-up demand is usually absent from large-scale seed projects that focus on promoting a few technologies.

Delivery/access issues Speed of access (quick, last minute), ability to provide locally-adapted (and high performing options) are the driving concepts. Farmers need delivery channels that can cater to their a) potentially diverse strategies at one point in time (within and among households), and b) need to shift/adapt (or stay the same course) through time. Note that the current operational mode of formal agro-dealer networks, generally working in more populated towns, is to provide a narrow repertoire of goods, largely unadapted to stress conditions. So the current dominant model differs from a model of a 'potpourri' seed supplier that would be needed for a 'climate-smart' future.

Awareness-raising /information sharing Decision-making tools and developing of seed security strategy options will be as important here —maybe even more important— as farmers getting the actual planting materials themselves. Given a prediction with X possibilities for the season's unfolding, farmers will require information to guide portfolio management, some elements of which will only become important during stress or highly variable periods In terms of specific information needs, the following will be central for 'climate-smart' farmers: i) awareness of new varieties; ii) knowledge of their suitability for stress, iii) access to this information along with material, iv) an ability to assess material in timely manner and v) ability to share information with others to build repertoires over time. Also note that climate change exigencies will demand that planting materials themselves be much better characterized, with the limits as well as potential for performance better defined, particularly for clarifying the ecological and abiotic margins of adaptation. More refined information on individual entries as well as on complementary clusters of crops and varieties will need to be developed and moved through vigorous outreach channels.

The two examples above give a sense of the inherent diversity of seed security projects aiming for different goals. Table 2 juxtaposes the two above, seed security for nutritional and resilience enhancement, and adds two more: seed security for food production gain (which is the classic aim) and for income generation. Again, differences are quite marked. For instance, varieties used in income generation projects often revolve around high consumer demand, but not necessarily high yield or even medium adaptation: the basmati rice is low yielding and the preferred commercial bean variety in eastern Kenya is susceptible to drought. Such trade-offs are not uncommon, and have implications for the design of seed security programs (S. Beebe, *personal communication).*

Table 2 Select features in planning and implementing seed security projects with four diverse goals

Goal	Partners: broad profile	Select design features	Awareness-raising /information strategy
1. Food production	• National Agricultural Research Systems (NARS) and agriculture + food production ministries (from field level to centralized offices) • Formal seed producers (private companies/ gov't parastatals) • Community-based seed multiplication groups • Local seed/grain market traders • NGOs/Farmers' organizations interested in general seed multiplication	• Preferred agronomic traits (often yield, early maturity, resistance to specific stresses) • Preferred end-user traits for consumption, especially post-harvest processing and cooking qualities • Preferred end-user traits for local market acceptance	• Use of 'Classic channels' - Agricultural extension visits - posters - field days - rural radio with agronomic messages (should increasingly use: social networking, mobile phones, SMS)
2. Nutrition	As above in #1 *plus* • Government nutrition, home economics and health programs (from field level to centralized offices) • NGOs/CBOs linked to mother-child health and nutrition programs • Emergency feeding programs, and others supplying ready-to-use therapeutic foods	• Key agronomic acceptance traits as well as targeted nutritional traits (such as high micronutrient content)	• Needs an information- rich outreach strategy (e.g. social marketing) • Information strategy geared to showing value of the 'invisible', and possibly to guidance on food preparation • Geared to nutrition managers, including mothers! • Requires sophisticated demand-creation techniques (possibly to reach an unconventional buyer: malnourished, especially vulnerable)
3. System Resilience 'climate smart'	As above in #1 *plus* • Government environment- and climate change-linked programs • Environmental NGOs • National Adaptation Programmes of Action (NAPAs)	• Diversity that is 'useful': multiple products; allowing for staggered sowing; robust to challenging conditions • Seed that has been precisely characterized in terms of adaptation domains, and considering multiple stresses (e.g. moisture, heat, pests, fertility) • Links across scales, to connect areas of provenance of adapted varieties to areas of emerging demand	• Needs information rich outreach strategy, linked to range of providers • Information geared to 'portfolio-management' scenarios • Requires key decision-making tools, including features such as real-time farming system scenarios, adaptation zones of available seeds, channels and time for supply, and prior evaluation information
4. Income generation	(#1 government actors to be informed, *plus)* • Those along market chain • Public or private sector buyers	• Products that meet rigorous market requirements, including uniformity (note that varieties may be suboptimal in agronomic terms) • Volumes for intermediary buyers that are guaranteed • Enterprise models that lower individuals' risk of market exposure	• Needs sophisticated demand creation techniques across full value chain (including processors as well as users and buyers of raw products) • Needs successful branding of seed product (i.e. outward-looking information component) • May need clear information strategy on the trade-offs between yield and market value

Different goals, different expected results, different evaluation criteria and processes

The four goals above all revolve around seed security, and, to some degree, around seed itself. The choice of evaluation criteria matters, as indicators reflect how goals are framed, and can lead to conclusions of 'success' that are undeserved (Wallis *et al* 2011). In monitoring their success, projects often focus on parameters like 'quantity of seed produced' to suggest that they have made progress. However, this simplistic parameter tells little about the immediate or future contributions of a project as the amount of seed produced is usually in direct relation to the money available in the original funding (so the more fund allotted, the more seed produced). Further, seed produced is a supply-side indicator at a single time point, and gives little insight in sustainable seed security from the farmer perspective, such as whether seed is available on an ongoing basis, whether it is accessible and whether it meets farmers' quality needs and preferences.[6] In following the logic that the setting of goals needs to be more transparent and specific, below, we suggest how the setting of indicators to meet those goals needs also to be more transparent and specific, if we are to understand whether projects are enhancing the seed security of smallholder farmers. Table 3 presents a first set of indicators that might be used to measure advances in diverse seed security projects.

Table 3 also presents a set of possible indicators that could cross-cut seed security projects, but which are often omitted within the classic seed security programming and operations. Among these cross-cutting issues, we signal that seed delivery channels and their accompanying information channels are often gender-linked (see Smale 2011). For select crops and varieties, men *have* to be the target audience. For many others, women are *the core drivers* for seed and variety use, and for subsequent seed management. Ignoring the gendered-ness of seed security issues at best lessens potential impacts, but, can severely halt gains altogether, especially when seed security may be linked with sensitive nutritional or health concerns.

Finally, in reviewing Table 3, it becomes clear that, while success indicators may be linked to specific seed security project goals (for example, needing a rich information component to help farmers 'see' nutritional advantages), considerable cross-fertilization of approaches could bring even more important gains. For instance, nutritionally-linked seed security projects can only benefit by having some of the skills needed for projects geared to income generation and market development. Similarly, food production-focused projects increasingly might incorporate some of the seed security–for-resilience perspectives.

Policy issues/implications for proposal development and programming

This paper has aimed to make more visible the different features inherent in achieving seed security for farmers and the diverse goals in seed security initiatives that might be pursued. We argue that a narrow perspective on seed security can arise due to a lack of links between institutions (e.g. between agronomic and nutritional activities), or to tightly-defined programmatic goals (e.g. in crisis response). Additionally, national seed policies may also contribute to narrowed perspectives – for example by allowing only Certified Seed to be sold commercially. While a detailed examination of seed laws lies outside this focus of this paper, it is important to note that national laws often permit sales of farmer-produced seed under certain conditions (e.g. crops outside the formal research system), and intermediate standards such as Quality-Declared Seed are starting to emerge in some countries to promote wider sales of farmer-produced seed. So, while we recognize that seed policies can be problematic, we contend that institutional and conceptual gaps remain key reasons for the seed security gaps outlined here.

Several compelling policy and programming recommendations emerge as a result of an enhanced visibility of different seed security features. Five specific recommendations are listed below that need to be considered starting from the stages of project/program development and proposal review. Donors and senior managers need to help drive the change towards more effective seed security strategy and more focused seed security programs on the ground.

1. Any seed component of a food security program needs to address all aspects of seed security, including the particularly challenging access feature. This latter feature is key for on-farm impact and equity gains. Developing an effective access component involves careful consideration of issues such as delivery options, cost, awareness-raising and information strategy. This access component often has not received central attention, undermining impact.
2. Goals of seed security programs have to be defined explicitly a priori, as goals shape general and specific programming, including but not limited to: choice of partners, product design features, choice and design of delivery thrusts, awareness-raising and information approaches.
3. Seed security initiatives need to be designed and managed as synthetic integrated programs. It is not obvious that they should be based in seed units or be led primarily by seed technologists. Achieving seed security is about a diverse range of improvements in more comprehensive development outcomes (in nutrition, resilience, income etc.). It is not really about 'seed' or 'seed production', but rather about strengthening commercial and livelihood bases.
4. Measures of success for seed security programs need to be directly allied to the specific overall goals envisioned. For instance, a project aiming for 'climate-smart' seed systems needs to have success indicators tailored to this specific goal.

[6] We stress here farmers as the pivotal actors in determining quality needs, both the seed quality and the desired varieties. Some farmers strive for certified seed and commercial variety use. For others, non-certified seed that has some social certification is optimal (Catholic Relief Services in Sperling et al. 2008) and local varieties may be preferred, for agronomic, cultural or organoleptic reasons.

Table 3 Select indicators to indicate (more durable) success in seed security projects

Seed security goals	Select availability issues	Select access issues	Select quality issues
Across seed security projects (includes classic food production focus)	• kg/mt seed produced by collaborators (farmers, private companies) after direct funding (grant) ends	• # channels supplying seed on ongoing basis	• ability of production /delivery system to make on offer to farmers a quality of seed they find acceptable (considering both variety and seed quality)
	• cost-effectiveness of seed production (and if subsidy needed, is cost offset by social benefit?)	• ability of channels to serve range of targeted clients (geographic and socio-economic spread); # clients reached • ability of channels to build on those routinely used by poor farmers (e.g. local open markets) • ability of channels to reach gendered audiences (as seed acquisition worldwide is gender-linked, by crop and variety type) • # information conduits used by farmers to receive information and, give feedback	• ability of production/delivery system to make on offer to farmers quality of seed they are willing to buy (so not just 'ideal' quality but that which is cost-effective)
Nutrition	• evidence that the nutrient quality is kept 'at 'sufficient levels' through the multiplication and procedures used, across production cycles	• ability of channels to deliver dietary diverse options to farmers (portfolio of choices) • # channels accessible to populations who are micro-nutrient deficient or undernourished (health clinics?) • ability of channels to provide 'less costly' options (e.g. small size seed packets) • construction of seed channels which are 'information rich' as added nutritional value may not be visible • consideration of product processing as a means to extend reach of nutritional seed, e.g. - diet rich food baskets - enriched flours - ready to use therapeutic foods	• evidence that product(s) on offer address farmers' agronomic and market wants as well as giving nutritional gains (yield+money+ health)
Resilience	• diversity of crops/varieties produced that is adapted to stress	• ability of channels to be 'nimble'—providing baskets of options	• Evidence of product performance under stress above that of 'normal' crop options
	• degree to which decentralized production has spread geographically, i.e. coverage of different vulnerable agro-ecozones	• degree to which information channels allow for rapid, and informed decisions on appropriate seed types and sources • degree to which channels can link vulnerable regions to possible alternate supply areas for adapted crops/varieties	• Evidence of complementarity of product(s) supplied with rest of livelihood portfolio
Income generation	• ability to produce 'high' volume and regularly (timely) in concentrated set of seed production operations	• whether instruments and institutions facilitate market involvement for the poor (e.g. credit supply, marketing information.)	• evidence for uniformity of high quality product (to feed into market chains)

5. Seed security proposals, programs, communiqués and other public information-sharing documents might refrain from using a general phrase of 'seed secure'. Seed security should be referenced in relation to a specific goal: for example: 'Seed secure to ensure income generation.' Only then can the merit of a program or approach be understood and critically evaluated.

Overall, this paper has demonstrated that a seed security initiative is a means to an end and that the end goals are potentially quite diverse. Such programs need to shift focus beyond the material itself- seed-to *the systems* that allow for the material to be accessed, used and valorized in effective ways.

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