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Good Seed Initiative

a strategy for CABI-led work on seed systems
in Sub-saharan Africa and South Asia, 2014-2019

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ACRONYMS AND ABBREVIATIONS

AATF	African Agricultural Technology Foundation
ADP	Agro Dealer Development Program
AFSTA	African Seed Trade Association
AGRA	Alliance for a Green Revolution in Africa
AIV	African indigenous vegetables (AIVs)
ARI	Agriculture Research Institute, Tanzania
ASA	Agricultural Seed Agency, Tanzania
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ASBP	AU African Seed and Biotechnology Programme
AU	African Union
AVRDC	World Vegetable Centre
BARI	Bangladesh Agricultural Research Centre
CGIAR	Formerly the Consultative Group on International Agricultural Research
CILSS	Permanent Inter State Committee for Drought Control in the Sahel
CIMMYT	International Maize and Wheat Improvement Center
COMESA	Common Market for Eastern and Southern Africa
CORAF/WECARD	West and Central African Council for Agricultural Research and Development
CRP	CGIAR Research Program
CTA	Technical Centre for Agricultural and Rural Cooperation
DALDO	District Agricultural and Livestock Development Officer
DUS	Distinctness, uniformity and stability requirements/tests.
EACI	Education for African Crop Improvement
ECOWAS	Economic Community Of West African States
EIAR	Ethiopian Institute of Agricultural Research
FAO	Food and Agriculture Organisation of the United Nations
FIACC	Fund for the Improvement and Adoption of African Crops
HortCRSP	Horticultural Cooperative Research Support
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFDC	International Fertilizer Development Center
IPM	integrated pest management

ISSD	Integrated Seed Sector Development in Africa
ISTA	International Seed Testing Association
KARI	Kenya Agricultural Research Institute
KEPHIS	Kenya Plant Health Inspectorate Service
NaCRRI	National Crops Resources Research Institute
NERICA	New Rice for Africa
OECD	Organization of Economic Cooperation and Development
OPV	open pollinated varieties
PASS	Program for Africa's Seed Systems
QDS	quality declared seed
RDA	Rural Development Academy
SDC	Swiss Agency for Development and Cooperation
SEPATOSCI	Seed Production for AfricaTanzania Official Seed Certification Institute
USAID	United States Agency for International Development
WRC	Wheat Research Centre

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EXECUTIVE SUMMARY

This document outlines CABI's strategy for its work to strengthen seed systems in sub-Saharan Africa and South Asia over the five year period 2014 to 2019.

The strategy builds on CABI's experience of supporting farmer-led, quality seed systems in Africa and Asia since 2002. It also aims to exploit CABI's comparative advantage, especially in the fields of plant health, farmer training and communication, and to complement work being done by others in the seed sector.

At an organisational level, CABI's overall vision is for the world's poorest people to *grow more, lose less and improve their livelihoods*.

The purpose of this seed strategy, which is expected to make a significant contribution to this vision, is to improve the seed systems on which poor and small-scale farmers rely in sub-Saharan Africa and South Asia.

The strategy focuses primarily on landraces and improved varieties of cereals, legumes and vegetables[1] that smallholder farmers want to grow, either for consumption by their own households or for which there is a viable and growing market, either directly from consumers or from agribusinesses. These crops will mostly be open pollinated varieties (OPVs), although when and where appropriate hybrids will also be targeted. It is concerned principally with true seed, not crops which are vegetatively propagated (from cuttings and suckers), such as cassava, sweet potato and banana. However, the strategy will be sufficiently flexible to enable it to respond to other needs and opportunities that arise and for which CABI is well placed to respond. This means that in some situations other crops, such as coffee, and even vegetatively propagated crops can be included.

Geographically, the focus will initially be primarily on East and Southern Africa, where CABI has most experience to date, but opportunities will also be sought to roll-out/adapt successful models and interventions in the rest of sub-Saharan Africa and South Asia.

At the heart of the strategy are four complementary and overlapping strategic objectives:

Objective 1: Better farmer-saved seed. To improve the quality of farmer-saved seed, for either own use or for use by others in the local community, through non-commercial and unregulated (informal) systems.

Objective 2: New improved varieties from landraces. To increase access, especially by the poor, to traits and qualities found in promising landraces, such as disease tolerance, by taking them through the stages of testing and development of varietal descriptors to formal varietal release (from informal to formal systems), thus paving the way for commercialisation.

Objective 3: More effective pro-poor formal seed systems. To strengthen commercial and regulated seed systems in ways that are economically and environmentally sustainable, and which better meet the needs of the poor (formal systems).

[1]The term vegetable is used in the culinary rather than the strict biological sense: it includes crops such as tomatoes and chilli pepper, which are actually fruits.

Objective 4: **Sustained and growing demand for quality seed.** To create more dependable and growing demand for quality seed of improved varieties through strengthening agricultural value chains.

Objective 5: Addressing crop health issues that impact on seed systems. To exploit CABI's comparative advantage in the area of plant health to support others to address crop health issue that impact on seed systems.

1. BACKGROUND AND CONTEXT

This section gives a brief introduction to seeds and seed systems.

1.1. What is seed?

The term 'seed' is often loosely used to describe planting material for vegetatively propagated crops, including stem and root cuttings of cassava and sweet potato, and suckers of bananas, as well as 'true' seed. Here seed is used in the narrower sense, to mean a propagating organ formed in the sexual reproductive cycle of flowering plants, consisting of a protective coat enclosing an embryo and food reserves. Seed serves several functions for the plants that produce them: nourishment of the embryo, dispersal to a new location and dormancy during unfavourable conditions.

Seeds are therefore a means of sexual reproduction which produces a remixing of genetic material and phenotype variability on which natural selection acts, and which plant breeders make use of: within a seed lie the genes that determine the potential for quantity and quality of the final crop. The work of plant breeders is to pack seeds with that combination of genes that best meets the farmers' requirements and also the demands of the market.

But a seed is more than a packet of genes; it may also carry a whole range of different plant pathogens. So, before the seed has even germinated, the eventual harvest can already be destined to be less than the genetic potential. This is one of the reasons why CABI became involved in work on seed systems: many of the CABI-led projects had plant health as the entry point. Since its origins over 100 years ago, CABI has addressed plant health issues, and seed-borne diseases are one such problem. At the same time, seeds contain the genes that can provide resistance to other pests and diseases of the plant, so again plant health concerns can lead to consideration of seed systems[2].

1.2. Seed types: hybrid and open pollinated varieties

Seed of improved varieties are of two types - hybrid and open pollinated varieties (OPVs). During the past 40 years or so, many of the major crops grown in large-scale commercial agriculture throughout the world have shifted from OPVs to hybrid seed sources. This is especially true for maize, sunflower, cotton and some vegetable species. Hybrids are also gaining ground in sorghum and rice, but are not feasible in crops prone to self pollination like wheat and barley, or legumes like soybean, cowpea or bean.

Hybrid varieties

The simplest hybrids are produced by pollinating one genetically uniform parent line with pollen from another genetically uniform parent, while more complex hybrids can be derived from up to four parents. Hybrid seed is produced in large amounts by large-scale, often multinational, seed companies who mainly target medium- to large-scale farmers. These seed companies choose elite parental varieties that will produce first generation offspring (F1 hybrids) with the special characteristics they desire. Hybrid varieties usually have more uniform characteristics than non-hybrids, making crops more predictable in quality. They usually also have hybrid vigour, which

[2]For a glossary of seed biology and technology see Schmidt. L. and D. Jøker. 2001. Glossary of seed biology and technology. Technical note no. 59. August 2001. DANIDA Forest Seed Centre.

means they can yield more than open pollinated varieties, although their uniformity tends to make them less resilient to adverse conditions.

Hybridization is done in a carefully controlled manner so that all of the plants grown from the hybrid seed will be the result of the desired cross and will be nearly genetically identical. For some crops, pollination is done by hand, e.g. hybrid cucumbers; for others, such as maize, the male and female lines are inter-planted in the field and the tassels (male flowers) are removed from the female parent, or a self-sterile female is used and pollination is done naturally by the wind. Production of hybrid seed is therefore a specialist activity and there is likely to be a more limited role in the production of hybrid seed for small-scale farmers.

For seed companies an important advantage of hybrid varieties is that farmers have to purchase new seed every season if they are to benefit from the improved genetics: self-saved seed does not produce plants with the same characteristics as the original hybrid seed and, in the vast majority of cases, will produce inferior crops.

The major issues limiting larger scale uptake of hybrid varieties by poor and small-scale farmers are limited distribution systems targeting small-scale farmers, especially in remote and marginal areas; poor farming practices and conditions which do allow the full benefits of the hybrids to be expressed; and poor farmers' inability and unwillingness to pay for seed every season, as well as the chemical and other inputs needed to take advantage of the hybrid vigour.

Open pollinated varieties

In contrast to hybrid varieties, open pollinated varieties are produced as a result of natural pollination via the wind, insects, birds or other natural means. Open pollinated varieties are more or less stable in their characteristics: they remain fairly consistent, generally producing viable seed that will grow into plants more or less like the parent plants (though less uniform than hybrids) so farmers can collect and save their own seed. Sometimes, however, due to genetic mutations or cross-pollination, offspring of open pollinated plants can be significantly different from their parents. Seed producers need to remove these 'rogues' from their fields.

1.3. Seeding rate and multiplication rate

Other important seed-related characteristics of crops are the seeding rate and the multiplication rate. The seeding rate refers to the weight of seed needed to sow a unit area; if seeds are large, a greater weight and volume of seed will be needed than if seed is small. This has implications for the cost and logistics needed to transport and store seed.

The multiplication rate refers to the ratio of the seed crop obtained relative to the seed planted, which varies widely; for example, for sorghum it is more than 100, but for groundnuts as low as eight[3].

[3]http://seednet.gov.in/Material/SMR.pdf

Table 1: Typical multiplication rates for crops

Crop	Typical multiplication rate	Crop	Typical multiplication rate
Pearl millet	200	Sunflower	50
Sorghum	100	Cowpeas	40
Pigeon pea	100	Wheat	20
Rice	80	Soya bean	16
Maize	80	Groundnut	8
Cotton	50	Beans	8

Source: http://seednet.gov.in/Material/SMR.pdf

Crops with high seeding rates and low multiplication rates, especially when the crop has a low market value, are mostly unattractive to seed companies.

1.4. Seed systems

Seed systems are generally considered to be either formal (commercial) or informal (farmer-led).

Formal seed systems usually consist of public and private sector research (plant breeding) institutions, public and private sector agencies bulking up seed, mostly private sector companies distributing and marketing seed, and mostly public sector organisations responsible for seed certification and quality control. In formal seed systems, all parts of the seed production, processing and marketing chain are subject to regulation, inspection and certification.

Within formal seed systems, the seed produced by plant breeders is referred to as *breeder seed* (or pre-basic seed), which usually exists only in small amounts. When the breeder seed is first bulked up the result is known as *foundation seed* (or basic seed). When foundation seed is bulked up further, to provide seed that can be sold to farmers, the resulting seed is known as *certified seed*, *standard seed* or *quality declared seed* (QDS).

Certified seed and standard seed both have to meet the same quality standards: the difference is that certified seed is produced when formal varietal release has occurred while standard seed is produced when the regulatory agency recognises that there is demand for the seed but formal varietal release has not occurred. Standard seed is also used in emergency situations so that the most appropriate types of seed can be supplied, even if varietal release has not occurred.

Quality declared seed (QDS) is an alternative system for seed quality assurance, developed by the Food and Agriculture Organisation of the United Nations (FAO) in 1993 for countries with limited resources. It is less demanding and less expensive than full seed certification systems yet promotes a satisfactory level of seed quality. Not all countries permit QDS: in East Africa, it is currently allowed in Tanzania and Uganda, but not Kenya.

Quality Declared Seed (QDS) in Tanzania

The FAO QDS system was modified and adopted by Tanzania in 2000. It was incorporated into the formal seed system in the National Seeds Act of 2003, along with its Seed Rules, Regulations & Procedures (2007), and Guidelines for control for the QDS production (2007).

Farmers produce QDS seed under a semi-regulated system in which staff from district offices trained by Tanzania Official Seed Certification Institute (TOSCI) are authorised to act as inspectors. Village Extension Officers are responsible for extension in the villages where they operate and are also trained in good seed production. District Agricultural and Livestock Development Officers (DALDO) supervise inspectors and channel reports on seed production to the ministry and TOSCI. The Agricultural Seed Agency (ASA) provides foundation seed and undertakes field inspection using inspectors acting under the authority of TOSCI, often only twice rather than four times during the growing season as for certified seed. After seed is harvested samples are submitted to TOSCI for testing and, if germination and purity are satisfactory, then farmers are allowed to sell. Sales are limited to the administrative area (ward) where the seed is produced.

A minimum of 10% of district registered QDS production is checked and inspected by TOSCI. Seed sampling is done in accordance with QDS and International Seed Testing Association (ISTA) rules. The seed lots are tested by TOSCI using ISTA Rules and Procedures. Lots passing the quality test are registered as QDS and can be sold. A declaration is completed for each seed lot and the farmer/ producer labels the QDS bags.

In contrast, ***informal seed systems*** comprise large numbers of farmers who produce both traditional (landrace) and modern (improved) varieties with no regulatory oversight. They save, process and store seed for their own use as well as sharing it with their relations, neighbours and other local community members through exchange, barter, gifts and sales. Tied up with these practices may be complex socio-cultural practices and obligations which, even in today's rapidly changing world, many farmers still observe and respect. As a consequence, for some farmers paying for seed is an alien concept, which makes shifting from informal, traditional seed systems to more formal, commercial systems even more challenging.

Other important sources of seed are local open-air markets, in which grain (for consumption) and seed (for sowing) is often not differentiated, and also emergency and developmental interventions by national governments, international agencies and non-governmental organisations, often in response to natural and manmade disasters. In both these situations farmers have little or no choice in the seed they can access and grow and, in the latter case, one-off interventions can disrupt and threaten the viability and sustainability of on-going local initiatives involving local seed companies and their local distribution networks.

The advantages of traditional seed systems are that they support the management and conservation of local agrobiodiversity, and make seeds of locally valued landraces and varieties available close by and when needed. Disadvantages are that seed will not be available after droughts and other causes of crop failure; storage facilities can be lacking; and seed quality can be very variable, often poor. Informal systems are best suited to remote areas where seed distributors find access difficult and farmers cannot easily reach seed and output markets; narrow agro-ecological zones where the seed

market is limited and widely marketed varieties may not be suitable; and areas where the major crops have a low seed multiplication rate (such as groundnuts), implying high transport costs.

In practice the boundaries between formal and informal systems are often fuzzy, especially where NGOs and other organisations intervene to increase the capacity of actors in the informal system and linkages are forged between actors in the formal and informal systems. However, the policy trend in seed systems in developing countries is to shift away from informal systems towards more formal ones. Many NGOs and others are concerned that this is shifting the balance away from systems that focus on farmers' interests, favouring systems that prioritise the interests of plant breeders and seed companies.

This section shows that a diversity of strategies is needed to cover the highly diverse needs of farmers with regard to seed. A smallholder farmer may, for example, use the formal seed system to obtain exotic vegetable seeds or maize, while at the same time saving her own seed of local vegetable and legume varieties, and obtaining seed of millet from a neighbour who had a good harvest. A variety of interventions may contribute to good seed and policies need to accommodate this to stimulate commercial seed provision while at the same time increasing seed quality of farm-saved seed and assuring seed security in emergency conditions.

1.5 Key players in seed systems

Some of the major public and private sector players in seed systems in developing countries include the following organizations and programmes:

African Union-African Seed and Biotechnology Programme: The AU African Seed and Biotechnology Programme (ASBP) arose from the Ordinary Session of the Assembly of the African Union (AU), held in Libya in 2005. In discussing the importance of improved seeds for increasing agricultural productivity and food security in the continent, the assembly recognized that individual African governments acting alone cannot confront the challenges represented by developments in the international seed industries and by legal and technical issues, which restrict access to genetic resources and biodiversity.

The ASBP was therefore proposed to provide a strategic approach for the comprehensive development of the seed sector and related biotechnology in Africa, taking into account the different needs of countries and regions. The programme's focus was on germplasm management and development, crop research and variety release including farmer testing/selection activities, dissemination of varieties, and production and supply of seed and planting materials through informal and formal seed systems. ASBP also supported development of improved disaster preparedness.

The programme pursues an integrated approach to enhance capacities for seed policy development and implementation, strengthen linkages between informal and formal seed sectors, ensure further adherence to international norms and standards, stimulate transfer of appropriate technologies, including biotechnology tools and products applicable to the seed sector, and encourage public-private partnerships to promote development of local seed enterprises. It also recognises that

coordination is needed at all levels to enhance the collection, conservation and use of important germplasm for Africa to overcome the problem of the progressive loss of germplasm.

The AU provides overall coordination for the implementation of the ASBP, complementing its leading role in the framework of the New Partnership for Africa's Development (NEPAD).

African Seed Trade Association (AFSTA): AFSTA was established in March 2000, arose out of a need identified by the seed industry to have a regional representative body which could also serve to promote the development of private seed enterprises. The AFSTA Secretariat is located in Kenya and the association enjoys diplomatic status. It represents national seed trade associations (such as STAK, see below) in over 26 countries, each with an average of 30 local seed company members; in addition 84 mostly African companies are direct members.

AFSTA is formally recognized by the AU as the apex private sector seed organization for Africa. It has formal agreements with both ECOWAS and COMESA with whom it is executing public-private partnerships. It is a board member of the International Seed Federation (ISF) and has MOUs with several international research centers, as well related organizations such as African Agricultural Technology Foundation (AATF) and International Fertilizer Development Center (IFDC). It also works in collaboration with regional African institutions such as ASARECA and CORAF/WECARD and CILSS.

AFTSA's mission is to promote trade in quality seed and technologies in Africa for the benefit of members and farmers. The association activities include to:

- promote the use of improved quality seed
- strengthen communication within African seed sector and with the world
- facilitate establishment of national seed trade associations in Africa
- provide market and technical information and capacity to members
- interact with regional governments and NGOs involved in seed activities in order to promote the interests of the seed industry
- promote activities that lead to regulatory harmonization throughout Africa to facilitate movement of seed
- maintain a statistical database on African seed production and trade.

Alliance for a Green Revolution for Africa (AGRA) Program for Africa's Seed Systems (PASS): AGRA is an Africa-based non-governmental organization that works in partnership with governments, agricultural research organizations, farmers, private sector, civil society and other rural development stakeholders with the overall goal of significantly and sustainably improve the productivity and incomes of resource poor farmers in Africa. Its programmes focus on four key areas: soils, policies, markets and seeds. AGRA's Program for Africa's Seed Systems (PASS) aims to provide African farmers with seed of higher-yielding varieties and focuses on formal seed systems.

The rationale for PASS is that farmers' productivity in Africa is limited because farmers have a limited choice of improved variety of seed: most farmers plant either varieties that were released more than 30 years ago or landraces. To increase yields, PASS is establishing breeding and seed systems across the continent.

PASS supports country-level crop breeding teams who work closely with farmers to develop new varieties: by 2013, 430 improved varieties of a wide range of crops had been officially released with PASS support. PASS also funds and trains local entrepreneurs who establish and grow private, independent seed companies to produce and distribute the seed. This seed is distributed through a network of local, rural enterprises dealing in agricultural.

To ensure that research continues over the long term on African crops and maintains a steady pipeline of new varieties, PASS supports the education of African crop scientists: to date PASS has funded 240 Master of Science degrees and PhD fellowships in plant breeding and seed science.

PASS operates through four integrated sub-programmes across the seed value chain. These are: Education for African Crop Improvement (EACI); Fund for the Improvement and Adoption of African Crops (FIACC); Seed Production for Africa (SEPA); and Agro Dealer Development Program (ADP).

AVRDC – The World Vegetable Center is an international non-profit research and development institute committed to alleviating poverty and malnutrition in the developing world through the increased production and consumption of nutritious and health-promoting vegetables.

The Center mobilizes resources from the public and private sectors to disseminate AVRDC's improved varieties and production methods in developing countries. It aims to help farmers increase vegetable harvests, raise incomes in poor rural and urban households, create jobs and provide healthier, more nutritious diets for families and communities.

The Center's work is built around four global themes: germplasm, breeding, production and consumption, thereby addressing the entire vegetable value chain. The first two themes are particularly relevant to seed systems.

The AVRDC genebank maintains the world's largest public vegetable germplasm collection with around 60,900 accessions from 156 countries, including about 12,000 accessions of indigenous vegetables. Collecting and conservation work is done in collaboration with national partners who maintain duplicate collections. Since its founding, the Center has distributed more than 600,000 seed samples to researchers in the public and private sectors in at least 180 countries. This has led to the release of hundreds of varieties, especially in developing countries.

The Center currently has active breeding programs in tomato, sweet pepper, chilli pepper, onions, garlic, leafy crucifers, vegetable soybean, mungbean, cucumbers, summer and winter squash, and okra. Selection programs are also improving the quality of indigenous African and Asian vegetables.

Specific areas of expertise includes development of vegetable variety testing networks and improved seed systems in conjunction with the public and private sectors.

ASARECA (Association for Strengthening Agricultural Research in Eastern and Central Africa) is an organization of the NARS of ten member countries in East and Central Africa, with the objective of developing policies and programs aimed to deepen co-operation in agricultural research and policy, in order to support the reduction of poverty and to improve food security and nutrition in the region. ASARECA supports work on seed systems under their programmes, including work on Farmer Led Seed Enterprises under their Knowledge Management and Upscaling programme and work to influence harmonise seed policy in the region.

The Centre for Development Innovation (CDI), Wageningen University in conjunction with a broad range of international and national partners, has been engaged in two phases of the Integrated Seed Sector Development in Africa (ISSD) programme. A recent expert meeting to explore the third phase (ISSD Africa) was held with KIT (Royal Tropical institute, Netherlands) and The Bill and Melinda Gates Foundation. ISSD was a project which initially ran from January 2010 to January 2014 in partnership with KIT, African Union Commission, Royal Tropical Institute (KIT, Amsterdam), Self Help Africa, IFDC, CTA, Agri-ProFocus and Future Agricultures Consortium. The rationale is that seed is an essential input for crop production and that physical access to the right seed at the right time for the right price is critical and that both the formal and informal seed sectors should play a role. Regardless of the dominance and importance of the public or private seed sector development, the informal seed system remains the major source of seed annually planted by farmers. Recognizing the complementarities of the two major seed systems, as well as roles and responsibilities of the public and private sectors, ISSD has aimed to forge better links between the informal and formal seed systems, and balance public and private sector involvements.

The ISSD programme's belief was that creating enabling and evolving policies would stimulate farmers, community-based seed producers, cooperatives and small to medium entrepreneurs, as well as international seed companies, to enter into the seed sector, thereby greatly contributing to seed supply. It also explored variation among seed value chains, with the aim of making seed programmes and policies more coherent with farmers' practices and more effective at reaching food security.

ISSD Ethiopia, for example, is implemented by CDI with a consortium of universities in Ethiopia (Mekele, Haromaya, Hawassa and Bahir Dar universities); Oromia Seed Enterprise (OSE), and Ethiopian Seed Growers and Processors Association, and WUR/CDI. Partners also include federal government departments such as Ministry of Agriculture and EIAR, regional governments and NGOs. In accordance with the ISSD framework, it aims to improve links between informal and formal seed systems, and balance public and private sector involvements. Its objective is to strengthen the development of a vibrant, commercial and pluralistic seed sector in Ethiopia and currently seeks to scale up local seed businesses, many led by cooperatives, to 340 operational businesses across the country. At the same time, it has established a multi-stakeholder platform as a mechanism to solve institutional and policy issues.

However, ISSD activities are currently expanding with new funding from Bill & Melinda Gates Foundation and the Dutch government and they are keen to develop new partnerships to support scale up of seed system work. The concept of ISSD is also consistent with the views embraced by the African Union in its African Seed and Biotechnology Programme.

CGIAR Research Programs (CRPs): The CGIAR consortium arranges its projects and programmes into interdisciplinary CGIAR Research Programs (CRPs) as a way of maximising the collaborative nature of their work. Among the sixteen Programs, several include focus on, or aspects of direct relevance to, seed systems work. The ***CRP on Grain Legumes*** is a 10-year program for genetic improvement of the eight most important grain legume food crops of the developing world: chickpea, common bean, cowpea, faba bean, groundnut, lentil, pigeonpea and soybean. Specific targets for improvement include drought and heat tolerance, short duration/early maturing, high nitrogen-fixing, 'insect-

smart', herbicide tolerant and hybrid varieties. For improving uptake of these materials, the CRP states that currently, there is a need for stronger public-sector seed production of legumes as the involvement of private seed sector is very limited. In addition, seed production by informal seed systems (individual farmers, communities and farmers' groups) needs to be strengthened.

The ***CRP on Maize*** is designed to ensure that publicly-funded international agricultural research helps most effectively to double the productivity of maize-based farming systems, making them more resilient and sustainable and significantly increasing farmers' income and livelihood opportunities, without using more land and as climates change and fertilizer, water, and labor costs rise.

One of the three key research strategies is called 'new maize varieties for the poor'. Specific research outputs relevant to seed systems include: The development of stress tolerant maize varieties that reduce hunger and production shortfalls for 90 million people in the face of climates change and abiotic and biotic stresses. Public-private partnerships with the local seed sector and agro-industry aim to provide better adapted and diverse maize hybrids to smallholders in emerging markets. Cutting-edge research to open the 'black box of maize genetic diversity' permitting researchers to mobilize its full potential in breeding programs worldwide. New tools and methods for national institutions, entrepreneurs, and farmers. Novel tools to enable small- and medium-scale public and private seed enterprises to access the opportunities and niches not attended by multinational enterprises.

The ***CRP on Wheat*** is guided by the challenge 'to increase the yield potential, reduce its vulnerability to globally important diseases and pests, enable it to grow in warmer climates, reduce the input needs' for more efficient and sustainable production while meeting quality and nutritional requirements. Strategic Initiatives are heading towards generation of productive wheat varieties, with durable resistance to diseases and insect pests, enhanced tolerance to heat and drought. Greater diversity in wheat seed systems will offer quicker access to improved varieties and alternative and innovative seed production and marketing by farmer groups and communities. A data platform to provide technical support to researchers and breeders in utilizing native diversity of wheat and its wild relatives will be established to accelerate breeding gains. In addition, the program includes capacity development of wheat professionals to enable national improvement programs to improve the efficiency, impact, and sustainable intensification of wheat-based cropping systems themselves.

Other CRPs include seed systems work amongst their key objectives, including the ***CRP on Dryland cereals*** which includes promoting effective seed dissemination for better delivery of improved cultivars as one of its 5 components. The ***CRP for Climate Change***, Agriculture and Food Security integrates promising approaches, tools and technologies to agriculture in the face of climate change. The objectives include breeding strategies and deployment of genetic diversity to increase productivity and resilience, including identifying interventions to enhance seed systems to facilitate uptake of germplasm. The aforementioned CRP for Managing and Sustaining Crop Collections covers the collections held by CGIAR centres, for the benefit of members and partners.

Global Crop Diversity Trust was founded in 2003. Its mission is to ensure the conservation and availability of crop diversity for food security worldwide. The Trust's aim is to raise an endowment,

the interest from which will be enough to guarantee the effective conservation, and the ready availability to those who wish to use it, of the 'biological basis of all agriculture'.

By 2018 the Trust aims to have raised US$850 million for its endowment fund, which will generate around US$34 million annually, in perpetuity, to support long-term conservation of crop diversity: for most crops this will involve seed stored in freezers.

This in-perpetuity funding is complemented by up to US$18 million of annual funding from the CGIAR Consortium Office via the **CGIAR Research Program (CRP) for Managing and Sustaining Crop Collections (Genebank CRP)**, to finance the core costs of operating international collections in all of the 11 CGIAR genebanks. The 5-year Genebank CRP will cover the expenses of maintaining the genebanks until the Trust's endowment takes over financial responsibility for the core costs of managing and sustaining the international collections, 'in perpetuity', for the benefit of future generations.

As well as ensuring proper maintenance and development of international collections, the CRP will continue to strengthen collaboration between CGIAR and national and regional genebanks, so as to help them secure their collections for long-term conservation.

International Seed Federation (ISF) represents the interests of the professional seed industry at the global level. It engages in through interaction and dialogue with public and private institutions that have an impact on international seed trade. ISF's mission is to facilitate the international movement of seed for sowing within the framework of fair and reasonable regulations. It has developed rules to guide national and international seed trade contracts and also produces position papers on topics such as intellectual property as well as technical issues, such as seed health testing procedures.

The Scaling Seeds and Technologies Partnership: Associated with AGRA-PASS, USAID is funding a new, 3 year initiative funded by USAID working in four countries within the G8's New Alliance for Food Security -- Ethiopia, Ghana, Mozambique, and Tanzania -- where it will help governments strengthen their seed sectors and promote the commercialization, distribution and adoption of improved seeds and other key technologies. The Partnership aims to increase production of high-quality seeds by 45 percent in three years and ensure that 40 percent more farmers gain access to innovative agricultural technologies

Seed Trade Association of Kenya (STAK) is an association for seed companies registered in Kenya by Kenya Plant Health Inspectorate Service (KEPHIS), to produce, process and/or distribute seed. STAK members control 90% of the formal seed sector in Kenya. STAK strives to promote interests of seed enterprises through use of quality seed. Members sell only quality seed and adhere to ethical practices at all times. STAK is a member of AFSTA – one of more than 26 national associations. Similar national seed trade associations exist in many other African countries.

Seeds and Plant Genetic Resources, Plant Production and Protection Division (AGP), FAO: The overall goal of the AGP is to promote sustainable intensification of crop production. : Under the core theme Seeds and Plant Genetic Resources, FAO works on conservation and sustainable use of plant genetic resources with strong linkages between conservation, plant breeding and seed sector development.

The rationale for FAO's seed system work is that a sustainable seed system will ensure that high quality seeds of a wide range of varieties and crops are produced and fully available in time and affordable to farmers and other stakeholders. However, in many developing countries farmers have not yet been able to fully benefit from the advantages of using quality seed due to a combination of factors, including inefficient seed production, distribution and quality assurance systems, as well as bottlenecks caused by a lack of good seed policy on key issues such as access to credit for inputs. Pressure from the fluctuating food prices and climate change creates additional challenges.

To mitigate these constraints, FAO works to build capacity to enhance seed systems and to facilitate farmers' access to good quality seed of locally-adapted varieties. Its activities include:

- seed rules and regulatory framework
- seed quality
- seed production and delivery
- seed security and rehabilitation.

Harmonization of seed laws and legislations is presently one of the major FAO actions related to seed. The guidelines and protocols for the Quality Declared Seed system, first presented by FAO in 1996 and revised in 2006, have been widely used. This system provides an alternative approach for seed quality assurance, designed for countries with limited resources, which is less demanding than full seed quality control systems but yet promotes a satisfactory level of seed quality.

FAO also supports national or sub-national seed programmes for seed production. Activities range from the support to early generation seed multiplication by national research institution to the promotion of small-scale seed enterprises, and also community seed production in order to ensure production and access to good quality seed of adapted varieties at the community level. FAO also supports national seed services to establish an efficient seed quality assurance system.

Initiatives are also underway to strengthen seed system-related responses as part of wider response to food and agricultural emergencies. The basic rationale is that by supplying good quality seed of appropriate varieties, affected farming households can resume and increase agriculture production thereby reducing or eliminating dependence on food aid following the next harvest. Seed system analysis is being integrated into emergency needs assessment guidelines, as well as a code of conduct for seed distribution and support to local seed systems. Finally, the use of seed fairs with vouchers for a market-based approach to seed relief has been implemented in various countries with key partners in situations where seed access is the main issue. In addition AGP undertakes rehabilitation of national seed systems after civil strife through a combination of policy assistance, technical assistance and training.

Seed System: Seed System is a collaboration among diverse national and international organizations aiming to improve seed security in high stress and vulnerable areas across the world. It is focused on a website – SeedSystem.org – which is dedicated to strengthening smallholder farmers' seed systems. The site is for practitioners, researchers, managers, policy-makers and donors, working in humanitarian relief and agricultural development and aims to create a community of practice that promotes seed system security, 'putting the needs of women and men farmers fully front and center'. The site shares resources and has three main aims:

1. To improve intervention practice
2. To improve assessment
3. To improve strategic thinking around seed system response and seed system development.

Seed System also focuses on interventions for chronic stress regions - areas that are environmentally harsh and/or lacking development institutions and innovations. Tools and approaches seek to spur plant breeding, seed production and delivery, and agro-enterprise responses that serve diverse types of farmers.

The lead partners in Seed System are: International Center for Tropical Agriculture (CIAT), Pan-Africa Bean Research Alliance (PABRA), School of International Development (DEV) at the University of East Anglia in Norwich, UK, Catholic Relief Services (CRS) and United States Agency for International Development (USAID).
Users are encouraged to make use of practice briefs, system assessment tools, diagnostic manuals, background reviews and policy guides, and to comment, share, give feedback. The overall goal is to promote and facilitate the community of practice to work together to make seed system interventions more effective.

2. THE PROBLEM

In this section, a brief introduction is provided to the problem of low agricultural productivity in developing countries, low uptake of improved varieties and some deficiencies in the prevailing seed systems. A more comprehensive review of these issues is presented in Appendix 1.

2.1. Low crop productivity

Crop productivity in Africa is low. Average maize yields in Africa are just 1.7 tons/hectare compared to a global average of 4.9 tons/hectare. Between 1986 and 2006, Africa's average maize yield declined from 39.6% to 35.7% of the global average yield. The situation is similar for other staple crops: per capita agricultural output in Africa is 56% of the global average[4].

A variety of factors contribute to low yields, including low rates of fertilizer application (average of 8 kg/hectare in Africa[5] versus 101 kg/hectare in South Asia and 300 kg/hectare in the European Community[6]); high incidence of degraded soils; high dependence on rainfed agriculture with very little land irrigated (6% of Africa's cropland is irrigated compared to 37% in Asia); the impact of climate change in terms of increased frequency of extreme weather events (floods and droughts) and often a shift towards generally less favourable growing conditions; losses due to crop pests, diseases and weeds (in developing countries, up to 40% of food is lost before it can be consumed[7]); and low levels of investment in the sector by both the public and private sectors. Crop productivity in poor countries in South Asia is generally better than in Africa but is still sub-optimal.

[4] http://www.fara-africa.org/media/uploads/library/docs/policy_briefs/patterns_of_change_in_maize_production_in_africa.pdf
[5] https://openknowledge.worldbank.org/bitstream/handle/10986/6650/390370AFR0Fert101OFFICIAL0USE0ONLY1.pdf?sequence=1
[6] http://www.fao.org/docrep/w5146e/w5146e09.htm
[7] http://www.fao.org/save-food/key-findings/en/

2.2. Low uptake of improved varieties

New crop varieties, developed in international and national crop breeding programmes, address local agro-ecological conditions and pest problems and have a higher yield potential. But less than 20% of the land in Africa is planted with improved varieties. This low uptake is partly due to the inability of poor small-scale farmers to pay for improved seeds owing to shortage of cash and limited access to credit, and also because they know that in order to get the benefits of the new varieties they must also invest in other improved agricultural practices and increased inputs. Access to seed by poor women is likely to be even more constrained than access by men due to even worse access to cash, as well as limitations imposed by cultural norms, for instance on the freedom to travel to purchase seed.

Often seed of improved varieties is simply not there to buy, especially in more remote and marginal areas. In many cases, there are no effective seed systems to enable the seed to be produced in quantity and made available to small-scale farmers in the areas to which they are most suited. This is particularly true for non-hybrid seed varieties that are of limited interest to multi-national seed companies, such as OPV crops bred to address developing country challenges and under-utilised crops such as indigenous vegetables that could make a major contribution to human nutrition and dietary diversity. Public research programmes developing such materials therefore need to find other ways to disseminate their varieties, commonly through informal or participatory means.

2.3 Lack of enabling policy environments

National seed policies often fail to provide the enabling environment that is crucial to the development of diverse seed enterprises, including models other than large-scale seed companies. Currently the trend in Africa is towards more formal seed systems and away from informal systems. Many NGOs believe this shift will favour large-scale seed companies and plant breeders at the expense of small-scale farmers.

The policy environment must be supportive of the nature and scale of seed enterprise planned. These could range from recognition of farmers' privilege (the right to save, exchange and sell seed even of commercial varieties) for small-scale, farmer-based seed enterprises through support for privatization and commercialization of agricultural services and also the recognition of the plant breeders' rights. The objective of the policy environment should be to promote the development of diverse sources of supply of seed through encouraging a variety of different types of enterprise to participate in delivering the seed farmers need.

However, very few countries have policies that support farmer seed systems, which hampers the operation of these systems. For example excessively strict certification and varietal registration schemes can hamper the development of an integrated seed sector. QDS is one approach to reduce costs to government and farmers/ businesses. However, other approaches are also possible; for example, to increase the supply of well-adapted varieties from either the formal or the informal systems in countries like India and Nepal seeds can be marketed as 'truthfully labelled'. Community biodiversity management is another option that looks at the marketing of farmer-developed varieties by accepting that landraces will not necessarily pass the DUS (distinctness, uniformity and stability) requirements.

Ideally, as Robert Tripp of the Overseas Development Institute has observed, "*regulation should be seen as a set of policies that encourage the evolution of a diverse collection of seed enterprises rather than as an institution whose purpose is to limit access to seed market participation.*"[8]

3. STRATEGIC APPROACH

In this section the scope of the strategy is outlined, as well as CABI's key features and its strengths in the area of seed systems. CABI has gained considerable experience in the seed sector over the past decade or more. This work has led CABI to develop a set of principles which guide the strategy.

3.1. Scope

The focus of this strategy is landraces and improved varieties of cereals, legumes and vegetables that farmers want to grow for consumption by their own households, or for which there is a viable and growing market, either directly from consumers or from agribusinesses. These crops will mostly be open pollinated varieties (OPVs), although when and where appropriate hybrids will also be targeted. In addition to this strategic focus, appropriate opportunities will also be seized to address seed issues for other crops. Currently there is an opportunity for CABI to address the problems affecting the supply of quality coffee seed in Ethiopia. Coffee is a crop for which CABI has particular expertise and so this is a good example where the scope is being extended to address a real problem for which CABI has a comparative advantage.

Geographically, the focus will initially be on East and Southern Africa, where CABI has most experience with seed systems to date, but opportunities will also be sought to roll-out/adapt successful models and interventions in the rest of Africa and South Asia.

3.2. CABI's strengths in relation to seed systems

CABI is a not-for-profit international organisation owned by 48 member countries. Its mission is to improve people's lives by solving problems in agriculture and the environment. Together with its members CABI addresses issues of global concern including food and nutritional security, environment, trade, access to knowledge and climate change.

As an independent, objective and science-based organisation, CABI is well placed to act as a bridge between research and development. Science and technology provide the raw material of development, but their application for societal benefit remains a challenge in many countries. Funders, implementers and intended beneficiaries of agricultural research and development are increasingly searching for more effective ways of getting research into use, knowledge into action and evidence into policy. The creation, sharing, adaptation and use of knowledge involves many different actors in the public, private and civil society sectors, so organisations that can foster and broker linkages between them are now recognised as having a key role to play. Gaps that need to be bridged include those related to differences in knowledge, resources, objectives and power. Effective communication and sharing of information are critical in developing the necessary linkages. In brief, this means bringing together the right people at the right time and facilitating processes to find creative and mutually acceptable solutions to problems and opportunities: this way of working is often referred to as an innovation systems approach and this way of bring people together as

[8] http://www.syngentafoundation.org/db/1/447.pdf

innovation platforms. Such approaches can work well to bring together actors from across seed supply chains to develop more effective and sustainable seed systems.

Many of the principles described in Section 3.3 are features of successful bridging organisations and CABI is seeking to use its status and establishment in this context.

3.3. Key areas of activity

CABI has more than 10 years' experience of working on seed systems in developing countries. An analysis of this work resulted in the identification of a set of 15 key areas of activities which CABI and partners have undertaken. These activities span both seed and crop value chains.

The 15 types of activity are:

- Linking relevant actors and facilitating their interactions by acting as 'honest broker', i.e. convening and facilitating innovation platforms
- Problem diagnosis and identification of opportunities
- Participatory selection of local landraces/varieties
- Development of varietal descriptors
- Farmer mobilisation and group formation (producer and marketing groups)
- Farmer training/capacity building
- Training non-farmer actors: e.g. extensionists, seed company field officers
- Promoting utilization of the crops by the community
- Production of training/extension materials
- Seed bulking
- Characterisation and testing of farmer-led seed production models
- Regulatory analysis
- Intellectual property rights and benefit sharing
- Demand-driven scientific research
- Evidence-based advocacy

A comprehensive review of CABI-led seed work is presented separately including an overview of seed-focused projects completed or still underway, and a summary of lessons learnt.

3.4. Principles

Following analysis of work undertaken by CABI in the seed sector over the past decade, a set of principles have been developed which will guide the implementation of the strategy.

***Flexibility*:** Development and innovation are unpredictable and flexibility is required from implementers, partners and investors to enable emerging problems and opportunities to be addressed as and when they arise.

Developing capacity[9]: Enhancing skills of farmers and other private and public sector actors is just one component of the work. Developing long term system capacity to respond to new challenges has far greater impact than providing training and assistance to address only the immediate problem

[9]United Nations Development Programme (UNDP) defines capacity as 'the ability of individuals, organisations and societies to perform functions, solve problems, and set and achieve objectives in a sustainable manner' (UNDP, 2010). This definition is used in this strategy.

at hand. This involves working with organisations to find new ways of working together, so they can become more effective and better able to play their roles.

Addressing both supply and demand: Supply and demand of quality seed and of the produce grown from them, as well as technologies involved in seed production and processing, all need to be addressed to ensure sustainable and economically viable production.

Promoting new ways of working: Organisations can often be more effective if they work in new ways: a good example is seed regulatory agencies going beyond their role of enforcing seed standards (see Appendix 1) to also help seed producers produce better seed.

***Letting go at the right time*:** Organisations often find it hard to acknowledge that they have fulfilled their role and that the time has come to hand over to another organisation whose mandate and comparative advantage is better placed to achieve the next step. Leading by example, CABI will also help other organisations to let go at the right time.

Understanding what motivates and constrains others: Organisations and individuals have different motivations and goals. Understanding what these are makes it easier to design interventions, projects or programmes that help to deliver the overall goal as well as those of the organisations and individuals involved.

Allowing enough time: Working in partnerships that involve multiple actors from the public and private sectors is difficult. Sufficient time needs to be allowed to enable partners to get to know each other and to develop mutual trust and respect. Sufficient time needs to be built into projects to ensure a reasonable probability of success, including addressing the 'last mile': experience shows that if projects end before all the bottlenecks have been addressed, there is a tendency for initiatives to stall and fail to achieve real, lasting impact.

***Bringing the right people together at the right time (innovation systems approach)*:** Seed systems are complex and, at different stages in the seed value chain, involve many different actors. The key to making progress is often bringing together the right people and organisations at the right time to find a solution to a problem. To do this effectively requires individuals with excellent facilitation skills who belong to organisations which do not have a direct stake in the outcome, so they can create the safe space in which a solution can emerge. Establishment of new working relationships enables stakeholders to work together in novel ways to address problems jointly. CABI believes it is well placed to facilitate this process.

***Alignment with CABI's overall gender strategy*:** CABI has recently developed a gender strategy[10]. This includes a set of recommendations that must be considered at all stages of the project cycle, and the seed strategy will take these into account as it proceeds to more detailed planning and implementation. The recommendations are:

- Identify gender roles and issues relevant to the project
- Consider this information throughout the project cycle
- Ensure that project documents and targets are gender disaggregated

10 Finegold and Williams (2012) CABI project and programme gender strategy. CABI, UK http://www.cabi.org/Uploads/CABI/about-us/4.8.5-other-business-policies-and-strategies/CABI-gender-strategy.pdf

- Collect gender disaggregated data
- Facilitate meaningful participation of relevant stakeholders, including marginalised groups (e.g. women, youth)
- Ensure that project budgets contain adequate resources to cover all measures taken to ensure that a project is gender responsive

This strategy goes beyond merely considering gender to addressing gender: to facilitate this, specific gender indicators are included in the majority of the strategic objectives.

Leading but also supporting: In some cases it will be appropriate for CABI to lead an activity, project or programme, but in many others cases other organisations will be best placed to take the lead with CABI playing a supporting role: both roles are equally valuable. Policy is an important area where does not enjoy a comparative advantage. CABI's role would usually be to support others, such as FAO or ISSD, rather than lead in policy debates, bring field experiences, knowledge and lessons learnt as evidence to support advocacy activities.

4. VISION, PURPOSE AND STRATEGIC OBJECTIVES

In this section, CABI's vision for a better future, the purpose of this strategy and its objectives are outlined. This section forms the heart of the strategy. It comprises four complementary and overlapping objectives which together describe the key areas CABI seeks to address through the strategy. For each objective, the issue, CABI's response and output and outcome targets are presented.

4.1. Vision and Purpose

CABI's *overall vision* is for the world's poorest people to *grow more, lose less* and improve their livelihoods.

The *purpose* of this seed strategy, which is expected to make a significant contribution to that vision, is to improve the seed systems on which poor and small-scale farmers rely in sub-Saharan Africa and South Asia.

This will be achieved through working together with stakeholders to strengthen seed value chains so they are more effective and more able to respond to new challenges. A key focus of the work will be to build the skills of smallholder farmers to produce high quality saved seed to plant or share through informal seed systems, as well as participating in the formal sector.

4.2 Strategic objectives

The four *objectives* of this strategy are given below, together with a description of the issue or concern for each, and how CABI proposes to respond to it.

Objective 1 relates to better farmer-saved seed

Objective 2: New improved varieties from landraces

Objective 3: More effective pro-poor formal seed systems

Objective 4: Sustained and growing demand for quality seed

Objective 5: Addressing crop health issues that impact on seed systems

Objective 1: Better farmer-saved seed

To improve the quality of farmer-saved seed, for either own use or for use by others in the local community, through non-commercial and unregulated (informal) systems.

The issue

It is estimated that 80% of seed sown in Africa is seed saved by farmers from the previous season. This includes both landraces and improved varieties. In addition to using their own saved seed, farmers have for millennia exchanged, bartered and gifted seed within their families and communities. Today, some also sell seed locally, although this is usually done outside the provisions of national seed laws.

The majority of seed used by smallholders in sub-Saharan Africa and South Asia is expected to continue to be farmer-saved for the foreseeable future. They will therefore continue to rely largely on the informal seed sector, with little or no involvement of regulatory agencies, extension services or the private sector.

The main issue here is that the quality of farmer-saved seed is often poor. This is due to bad practices at all stages of production, seed selection, harvesting, seed cleaning and storing, resulting in poor germination rates and low yields in the subsequent crop.

Many of the steps involved in producing and processing seed are traditionally regarded as women's responsibilities.

For improved varieties, some farmers attempt to save seed grown from hybrid seed, but crops grown from this type of saved seed are unlikely to perform as well as the original crop.

CABI response

The main need is for capacity building for farmers, especially women, to enable them to adopt best practices for growing, selecting, cleaning and storing seed so that they can produce and store better quality seed. Selecting seed in the field rather than in the granary is likely to be a key message.

The actions needed go beyond conventional farmer training, although that will remain important: they will also include the use of mass media (radio, television, public film shows, newspapers, roadside billboards), participation in local agricultural shows, farmer field days, and production of various extension materials to promote and raise awareness at scale about the improved practices. Effective engagement with intermediaries, such as journalists and communication specialists, will be vital.

Training can usually be best provided by working with groups of farmers, including women's groups. Approaches based on demonstrations involving lead farmers and experiential learning techniques, such those used in farmers field schools, are likely to be particularly effective.

Training needs to be provided in ways that respect and accommodate cultural norms; for example, women are often unable to travel long distances to attend training sessions and so the training needs to be brought to them. Training also needs to fit into agricultural calendars, for example by avoiding scheduling sessions during periods of peak farming activity, such as when fields are being preparing ahead of the rains, or at harvest time.

Opportunities to exploit increased access to mobile phones will also be explored.

By improving practices for farmer-saved seed, farmers will also be better prepared to take advantage of opportunities to engage in seed production as an income generating activity within the formal seed sector – this aspect is covered under Objective 3.

Output and outcome indicators

Output: Number of farmers who received training on better practices for own-saved seed, 50% of whom are women. Number of farmers receiving and acting on broadcasted/published messages.

Outcome: Proportion of small-scale farmers who received training or publicity *and* who adopted one or more improved technique likely to result in better farmer-saved seed (based on a sample size that can give statistically significant results).

Risks and mitigation measures

This objective has limited risks. There is a risk that commercial companies will see training in improving the quality of saved seed will threaten their businesses and oppose activities and good advocacy will be needed to balance private sector interests.

Objective 2: New improved varieties from landraces

To increase access, especially by the poor, to the benefits offered by promising landraces, such as disease or drought tolerance, by taking them through the stages of testing and development of varietal descriptors to formal varietal release (from informal to formal systems), thus paving the way for commercialisation.

The issue

Most improved varieties, especially of OPVs, come from national and international crop breeding programmes. However, farmers have for millennia consciously or unconsciously been selecting those crops which best meet their needs and preferences, while natural selection has acted to favour those best suited to the prevailing agro-ecological conditions. In this way distinct sub-populations of crops with useful traits and characteristics, known as landraces, have been developed.

Over time, farmers have gained access to these landraces through exchange, barter and gifting of seed. More recently some farmers have also sold the seed they have saved from their landraces, but this is usually outside the provision of the prevailing seed regulations: although seed regulators tend to turn a blind eye to this trade, in many countries it is illegal.

It is likely that the traits and qualities of many of these landraces would be useful beyond the local area where they developed. This is likely to be increasingly the case as the impacts of climate change mean that farmers may need to shift from the landraces they have traditionally cultivated to those that have been developed in different agro-ecological zones. Depending only on the informal system, however, it is difficult for farmers located beyond the immediate local area to benefit.

CABI response

To enable the potentially beneficial traits and characteristics associated with landraces to be enjoyed more widely, seed needs to be more freely traded. Since seed from landraces cannot legally be traded, the landraces first need to be subsumed into the formal seed system. For this they need to go through the process to upgrade them into formally recognised improved varieties.

This requires bringing together farmers, researchers, regulators and seed companies, and facilitating and encouraging them to work in creative new ways. The first step is collection of seed of the different lines of the landrace (equivalent to breeder seed) from farmers' field and testing the lines (including participatory testing by farmers and consumers). If the results are encouraging, prioritisation of the most promising lines, development of varietal descriptors, naming and formal varietal release can then take place. Having transformed the promising landraces into formally recognised named varieties, these can then be bulked up to foundation seed and commercialised, which is covered under Objective 3.

Important issues will be to develop and test models for holding intellectual property rights on behalf of farmers (or the nation); licensing seed companies to enable them to access and use the new varieties; and sharing benefits in equitable ways.

Output and outcome indicators

Output: Number of new varieties derived from landraces that have been formally released with project support

Models developed and tested that deal satisfactorily with intellectual property rights and benefit sharing.

Outcome: Number of varieties for which commercialisation partners are identified and engaged and plans for bulking up, distribution and sales are available

Risks and mitigation measures

There is a risk that, in transforming landraces into formally recognised varieties, the farming communities which developed the landraces could, in a worst case scenario, be prevented from continuing their traditional ways of saving seed and sharing seed it with others and may lose faith in such programmes/research organizations. To prevent such problems arising, it is important that robust models are developed, tested and shared that are specifically designed to ensure that benefits are fairly shared, especially that plant breeders rights' are not transferred to others to the detriment of the farming communities which developed the landraces.

Objective 3: More effective pro-poor formal seed systems

To strengthen commercial and regulated seed systems in ways that are economically and environmentally sustainable and which better meet the needs of the poor (formal systems).

The issue

Much of the quality seed that is useful to poor and small-scale farmers is not attractive to large-scale, multinational seed companies. The geographical areas which best suit a specific variety are likely to be relatively small and markets are consequently small, erratic and hard to predict. The crops will mostly be OPVs (so farmers will save rather than to purchase seed every year). Provision of seed and other services is challenging in the remote and marginal areas where the poor live. For all these reasons, the multinational players mostly prefer to target more dependable, larger and more profitable markets, which are usually for hybrid seeds.

Small and medium-sized local seed companies are more likely to be interested in these more niche markets. However, they usually lack the infrastructure to produce their own certified or standard seed for sale, and lack experience and know-how for working effectively with small-scale out-

growers. In addition, small-scale farmers rarely have experience of formal contracts and often fail to understand either the benefits they could enjoy or the obligations they are entering into: past experience of middle-men and unscrupulous traders have often made them wary of entering formal agreements in the belief that the arrangement is likely to be biased in favour of the other party.

Linkages between national and international research organisations, which undertake plant breeding, and seed companies is often poor. The result is that improved varieties remain on the shelf in the research facilities.

CABI response

There is an opportunity to increase the capacity of both small-scale farmers and small and medium-sized seed companies to work together in ways that are mutually beneficial. Experience gained in CABI-led work over the past decade has shown that it is advantageous to bring together farmers, plant breeders, seed companies and seed regulators to explore new ways of working. Working together to identify and address immediate bottlenecks becomes the first step towards strengthening the seed system so that new challenges emerging in the future can be addressed more effectively. Linkages need to be improved between research organisations, seed companies, regulators and farmers to forge mutually beneficial partnerships to commercialise the most promising varieties developed.

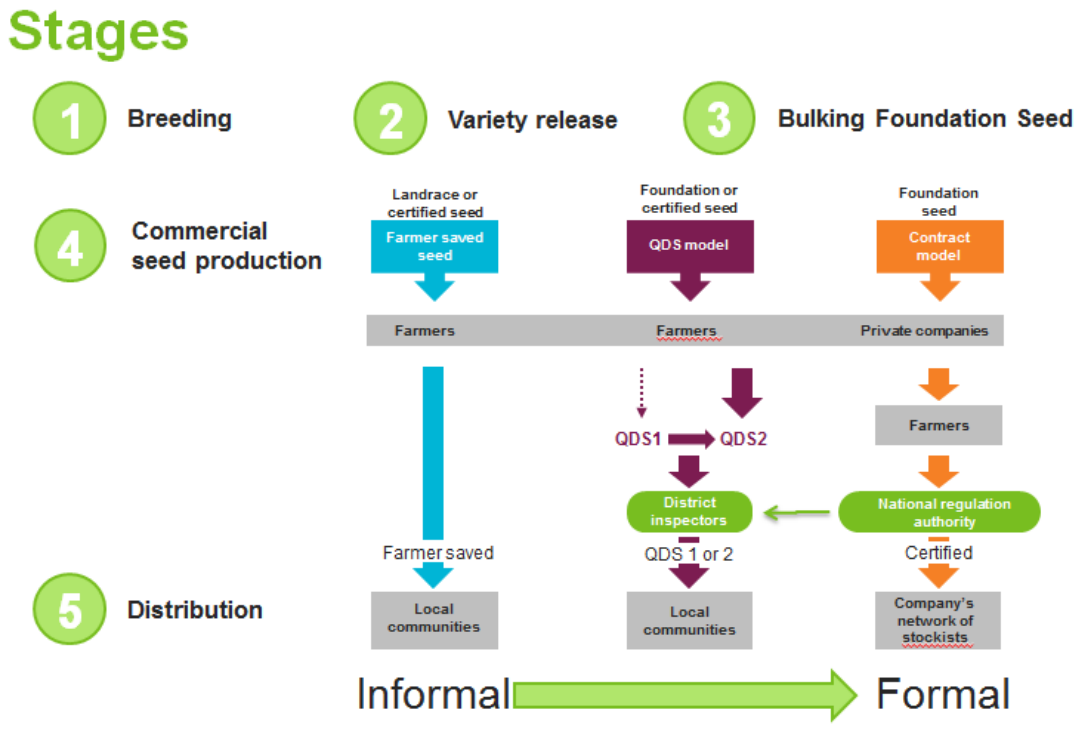

Figure 1: The role of farmers and other stakeholders in different seed system models[11]

[11] *QDS1 seed is seed bulked from foundation seed, while QDS2 is bulked from certified seed*

Developing, testing, documenting and scaling up different models for production, processing, distributing and marketing of quality seeds will be an important activity. Different models will be appropriate in different circumstances and might co-exist in complementary ways, but it is likely that participation of smallholder farmers, especially women, will be central to them all. Special consideration will be given to identifying and alleviating constraints that limit active participation by women in seed systems. Attention also needs to be given to increasing the capacity of farmers to understand contracts and to be more confident in negotiating a fair deal which recognises the rights and responsibilities of all parties.

Figure 1 illustrates the different involvement of farmers as systems become more formalised, where stages 1-5 in the seed value chain are considered as 1) breeding, 2) varietal release, 3) bulking foundation seed, 4) multiplication or commercial seed production, and 5) distribution.

The eventual aim is to make improved varieties available to farmers who could benefit from them, including the poor, in ways that are economically sustainable, in accordance with prevailing seed regulations, and so that the benefits accruing are shared in an equitable manner.

The results of such approaches could include:

- Small-scale farmers enjoying increased incomes from producing and selling quality seed.
- Small and medium-sized local seed companies developing their capacity and growing into larger, more effective, more profitable and sustainable businesses.
- Better relations between outgrowers, seed companies and regulators, with their interests becoming more closely aligned.
- Increased supply of quality seed, including niche crops and varieties that poor and small-scale farmers most need.

Output and outcome indicators

Outputs: Number of farmers newly engaged in commercial seed production, at least 60% of whom are women.

Weight of seed sold of improved varieties that are relevant to the poor sold

Outcomes: Incomes of farmers engaged in commercial seed production increased compared to control farmers

Risks and mitigation measures

It is important that small-scale farmers entering into seed production as a money making venture are fully aware of the potential risks, including their contractual obligations, as well as the potential benefits. Capacity building of farmers to increase their understanding of contracts will prevent misunderstanding arising and help avoid disputes.

Incorporation of climate proofing measures, such as water harvesting and timely sowing, into seed production initiatives will also be critical to avoid frequent loss of seed harvest due to deteriorating weather patterns. However, in most cases these farmers will not be the most poor and are likely to have access to irrigation or be in areas that are less prone to climatic extremes.

Women may have restricted access to contract arrangements where men dominate activities generating income. Mitigation activities may include negotiation with companies to encourage women to be contracted directly.

Objective 4: Sustained and growing demand for quality seed

To create more dependable and growing demand for quality seed of improved varieties through strengthening agricultural value chains.

The issue

One of the reasons why seed companies are reluctant to invest in seeds of OPVs is that it is difficult to predict demand. Also demand tends to be very variable, often driven largely by donor or government-funded initiatives, and also by the weather

Amongst the lessons learnt from CABI's work in the seed sector over the past decade or so is that both supply and demand for seed need to be addressed: even in situations where, at the outset, there is apparent unmet demand for quality seed, it is all too easy to swing into a situation of oversupply.

Also, initiatives to stimulate demand for agricultural produce resulting from the use of quality seed of improved varieties have proven to be useful approaches to promoting long-term demand for seed.

CABI response

To address both supply and demand, in tandem with efforts to improve the supply of seeds of improved varieties, steps will also be taken to increase demand from farmers. Also, as more farmers grow crops based on the improved varieties, steps will need to be taken to ensure dependable and growing markets for the produce.

This will partly be addressed through mass media campaigns to raise the awareness of the importance of good quality seed and of the value of the produce. The response will include working with informal traders and supermarkets as well as agribusinesses such as millers, bakers, brewers, confectioners, canners and animal feed manufacturers, amongst others. Bringing together the right people at the right time to identify opportunities or address bottlenecks will be key.

In addition, steps will be taken to increase demand for new seed technologies that look promising.

Output and outcome indicators

Outputs: Number of mass media campaigns designed to increase awareness of importance of quality seed of improved varieties distinguishing those targeting women and youth.

Number of initiatives implemented with supermarket or agribusinesses designed to increase demand for specific agricultural products grown from seed of improved varieties.

Outcomes: Number of times during lifetime of strategy when farmers producing seed with project support fail to sell their seed due to oversupply issues.

Risks

This objective explicitly aims to address a very real risk – that of avoiding gluts of seed or produce for which there is no market.

Objective 5: Addressing crop health issues that impact on seed systems.

To exploit CABI's comparative advantage in the area of plant health to support others to address crop health issue that impact on seed systems

The issue

CABI is widely acknowledged to be a global leader in the area of plant health and a central thrust of its work is focused on combating agricultural pests and diseases. Much of the work CABI has done on seed systems over the past decade or so had as the entry point a plant health problem. In diagnosing the problem and selecting from amongst potential solutions, the opportunity to exploit existing disease-tolerant landraces resulted in several instances in the need to address problems along the entire seed value chain.

CABI's response

Recognising this situation is likely to reoccur in the future, this strategic objective aims to channel CABI's acknowledged expertise in plant health to address crop health issues that impact on seed systems. In doing so CABI's role will include support to other organisations working on seed systems for which CABI's plant health expertise will be complementary; as well as targeted activities to address specific seedborne diseases. In this context, 'seed systems' could include vegetatively propagated crops as well as true seed.

Output and outcome indicators

Outputs: Practices to manage seed borne diseases developed. Number of producers trained in new practices

Outcomes: Proportion of farmers or seed system actors adopting new practices. Reduction in spread of seed borne diseases

Risks and mitigation measures

This objective has limited risks.

RISKS

Potential risks associated with the strategy and possible mitigating measures to address them are summarised in the table below

Risk	Mitigation
Developing countries shift towards more rigorous seed regulatory systems, reducing or eliminating opportunities for farmer-led seed systems and making seed more expensive	Develop evidence of effective farmer-led seed enterprises Evidence-based advocacy Facilitate small-scale farmers to have their voice heard Participate in policy debates
Farmers not interested in adopting improved varieties or engaging in seed production as an income generating activity	Increase awareness of benefits and opportunities, as well as risks and disadvantages Using participatory approaches such as lead farmer demonstrations, farmer field schools, farmer-to-farmer video
Lack of foundation seed	Facilitating development of partnerships between public and private sector actors Advocacy: highlighting importance of availability of quality foundation seed
Oversupply of seed	Addressing both supply and demand issues, including for produce grown using quality seeds
Partners might not want to engage with CABI	Develop series of communication products to share CABI's experience in seed sector
Seed production may not be profitable, or the most profitable option, for poorest smallholders	Building capacity amongst smallholders to be able to calculate simple cost-benefits of different options Target farmers for seed production who have some capacity to take risk – or where risk of crop failure is low
Seed systems not a priority for governments, NGOs and donors	Evidence-based advocacy Sharing success stories and highlighting impacts on the poor
Climate change threatens overall success of the strategy	Climate-smart measures, such as appropriate water harvesting technologies, incorporated into design of activities

APPENDIX 1: PROBLEMS AND CHALLENGES WITH SEED SYSTEMS IN DEVELOPING COUNTRIES

A1.1 Deficiencies in formal seed systems

Before the seed of an improved variety can be made available to farmers a series of steps need to be taken. The main ones include:

Breeding: Throughout the history of farming, better types of crops have been produced by either conscious or unconscious selection for desirable characteristics, such as productivity, quality and resistance to pests, diseases and other stresses. In the past this process has occurred largely in farmers' fields but more recently it has been undertaken largely by specialist plant breeders in the public or private sectors who use increasingly sophisticated techniques, including those that exploit recent advances in biotechnology. A major problem is that national systems have a chronic shortage of plant breeders[12]; those they do have tend to be coming towards the end of their careers, suggesting that in the future the shortage will be even more acute.

Seed companies need to have good links to plant breeders in national and international research organisations so they can identify and access varieties that meet the needs of their customers. Currently linkages between research organisations and seed companies are often poor. Also, the 'rules of the game' that define how and on what basis germplasm can be passed from the breeders to the companies are often poorly defined; this can cause long delays in negotiating agreements, and this delays getting new and improved varieties to market, or even leaves them stranded on the shelf indefinitely.

Variety release*:* Having bred an improved variety, or a group of improved lines, a series of steps need to be completed before they can be made available to farmers. These include: selection of the most promising lines, ideally including through the use of participatory trials involving farmers and consumers; development of varietal descriptors; and testing under a range of agro-ecological conditions leading to formal varietal release.

Foundation seed production*:* Plant breeders usually only produce small quantities of breeder seed, often just a few grams. The first stage in making seed of improved varieties available in large quantities is to bulk up breeder seed to foundation seed. Production of foundation seed can be a bottleneck in the bulking up process: whilst it is clear that the breeders, usually in national or international research organisations, produce breeder seed and the seed companies are responsible for producing certified seed (or standard seed in some circumstances), responsibility for producing foundation seed can fall between these two types of organisation. Lack of foundation seed is therefore often a major constraint to increasing access to improved varieties.

Certified seed production*:* Foundation seed can be supplied to others, including smallholder outgrowers, for further bulking to seed that can be sold commercially: in different regulatory environments this can be QDS, standard or certified seed (see Section 1.4).

[12]Morris, M., G. Edmeades, and E. Pehu. 2006. The global need for plant breeding capacity: What roles for the public and private sectors? HortScience 41:30–39

Large multinational seed companies tend to focus on more profitable seed of hybrid varieties and mainly rely on in-house production or large-scale outgrowers to produce the certified seed which they sell to farmers.

Small- and medium-sized local seed companies often have limited land and, if they are to move beyond simply selling on seed produced by the multinationals, they need outgrowers, including smallholders, to bulk up their foundation seed to certified seed. Often, however, they lack the capacity needed to work with large numbers of smallholders, such as being able to recruit, mobilise, train, contract, supervise and generally support teams of outgrowers.

Some of the challenges facing smallholder farmers in seed production, whether as part of informal or formal systems, are addressed in the next section (A1.2).

Distribution: Seed companies have generally invested little in the distribution of seed in rural areas. The result is that it is often impossible to buy seed of improved varieties other than in urban centres. Even if farmers can travel from their rural homes to buy seed, often pack sizes are too large for their needs and the prices too high for their pockets. There have, however, been a number of successful initiatives in which smaller seed packs have been introduced, which have proven to be popular with small-scale farmers[13].

Engaging smallholder farmers to produce seed as an income-generating activity does not necessarily improve access to that seed in the local area. If the farmers are outgrowers for a seed company, which buys the seed produced and transports it to a central processing, storage, packing and distribution centre, local farmers will depend on the strength of the seed company's distribution system. As these are often weak, there is a good chance that local agro-dealers will not stock the seed originally grown by local outgrowers.

A1.2 Other issues impacting on formal seed systems

Demand: One of the reasons that seed companies advance to explain their lack of interest in many OPV crops is the difficulty in predicting demand for seed. Much of the demand for this seed currently comes from NGOs and government schemes which provide seeds as part of packages provided to households affected by natural or manmade disasters[13].

Clearly the demand here depends on both the incidence of such disasters and the components of relief operations mounted by civil and state actors. Having obtained their initial seed of improved OPV crops, farmers are able to save their own seed for use in subsequent seasons, which can impact on future demand for seed. Although in the West, farmers are obliged to keep records of the seed they save, submit these to the relevant authorities and pay royalties accordingly, such systems are probably unworkable and, for now at least, inappropriate in developing country, smallholder systems.

An additional complication to predicting demand, which is also a risk to the long-term viability of commercial distribution systems, is the practice of some NGOs and state actors to distribute seed free of charge.

[13] Setimela, P.S., Mongo, E. &Banziger, M. (eds) 2004. Succesful community-based seed production strategies. Mexico, D.F.: CIMMYT

Regulation: Regulations governing seed production vary between different countries. Kenya has relatively rigorous regulations which outlaw the informal seed trade. Farmers are not permitted to sell their own saved seed; this can only be done by organisations that meet the required standards and have the necessary facilities and resources for processing, packing and labelling. In Kenya, farmers can only lawfully engage in seed production as an income-generating activity by becoming outgrowers for seed companies: these supply foundation seed (and, ideally, advice and inputs),then farmers bulk this up to certified (or standard) seed, which they sell back to the seed company which processes, packs, distributes and markets the seed.

Seed certification in Kenya is governed by the Seeds and Plant Varieties Act (Chapter 326 of the Laws of Kenya) and is guided by International Seed Testing Association (ISTA) rules of seed testing and the Organization of Economic Cooperation and Development (OECD) seed certification schemes. The certification process includes field registration, seed crop inspection during active growth, seed processing, seed laboratory testing, labelling and sealing, and post certification survey.

Seed certification agencies are required to register and inspect seed crops on small-scale farms, including in remote and marginal areas. Shortage of such inspectors and lack of capacity to travel means that farmers risk not having their crops inspected at key stages, which may mean that they cannot be certified.

In Tanzania and Uganda, smallholders are allowed to produce and sell seed under the QDS system. This is a light-touch certification approach under which seed producers are responsible for quality control, while government agents check only a very limited portion of seed lots and seed multiplication fields. Under the QDS system, farmers can sell their saved seed within the local area. Here an issue is the delay between inspectors collecting seed samples on farms, and the test results for germination and purity being received back; until this happens the farmers cannot sell seed produced under the QDS system (see Box 1, Quality declared seed, Section 2).

Harmonisation of regulations: Within the East African Community, only Kenya subscribes to strict OECD seed standards. This makes cross-border seed trade difficult as the neighbouring countries are not compliant to the same international seed certification standards.

A1.3 Challenges for smallholder farmers to produce seed in formal and informal seed systems

Whether saving seed for their own use, producing seed for distributing through informal systems, or acting as outgrowers, seed production raises a number of issues for smallholder farmers that need to be addressed.

Access to inputs, facilities and resources: Firstly, smallholders need to be able to identify and make available a plot that meets the regulatory requirements for the crop and class of seed they aim to produce. For some cross-pollinated crops, such as maize, this can mean that the seed plot must be isolated from other plots of the same crop, or wild relatives of the crop, by distances of up to several hundred metres (Table A1). Certified seeds traded must meet requirements such as these. On individual small plots this will often be impossible, meaning that some seed crops simply cannot be grown by smallholders unless they can reach agreement with all their neighbours that only one

variety will be grown and this variety will be managed to meet the requirements of the seed regulatory agency. Small, isolated seed plots of sorghum or millet, for example, can also be particularly vulnerable to pests such as birds, which can decimate the crop.

Table A1: Minimum isolation distance for certified seed (in metres):

Crop	Distance	Crop	Distance
Sunflower	1500	Wheat	10
Sorghum	500	Groundnut	5
Cotton	400	Soya bean	5
Tobacco	400	Rice	5
Pearl millet	200	Beans	5
Pigeon pea	200	Cowpeas	5
OPV maize	200		

Technical agreements on harmonization of seed regulations in the SADC region[14]

Having identified a suitable plot, smallholders need timely access to quality seed in the required quantity to enable them to plant their seed plots. In many cases this will be foundation seed from which they will produce certified seed, although in different countries other arrangements also prevail.

To ensure that the seed crop achieves the desired yield and meets quality standards, for example freedom from pests and diseases, smallholder farmers need timely access to the right types of fertilizer and pesticides, supplied in pack sizes appropriate to the scale of their operations.

Shortage of seed cleaning facilities represents a real bottleneck to farmers having their seed cleaned prior to sale, either directly to other farmers (if permitted) or to seed companies. In Ghana, for example, seed cleaning facilities are only sited at the seed regulatory authority's state-level headquarters. There appears to be a real opportunity for privately operated seed cleaning enterprises in developing countries, including small-scale mobile units. At a larger scale, mobile seed cleaning businesses are an established and essential feature of farmer-saved seed systems for OPVs in developed countries, such as the UK and The Netherlands. They have also been given responsibility in some countries for the collection of fees payable to plant breeders from farmers who save their own seed. In the UK, fees paid for farmer-saved seed amount to more than £8 million a year[15]; this is used to fund future plant breeding work.

Awareness of Good Agricultural Practices: Management of a crop for seed is knowledge intensive. Smallholders, especially in the more remote and marginal areas, tend to be poorly served by state- or local authority-funded extension workers, and extension workers aligned to NGOs or for-profit companies are also thinly spread. Local suppliers of agricultural inputs, such as small-scale agro-dealers, tend to be staffed by untrained sales assistants.

The result is that, even if smallholders can access fertilizers and pesticides, they lack access to expert advice that would enable them to get the best out of their investments. Soil testing is generally unavailable, so they are unable to target specific nutrient deficiencies in their soils, and in the

[14]http://www.icrisat.org/Publications/EBooksOnlinePublications/Publications-2008/Seed_harmonization_English_J304_2008.pdf

[15]http://publications.hgca.com/publications/documents/Farm-Saved_Seed_FAQs_1-13.pdf

absence of expert diagnoses for pests and diseases affecting their crops they are unable to select and apply the most appropriate remedy for any given problem. The result is that farmers often fail to realise the yield-increasing potential of their expensive inputs. Lack of awareness of the need for safe handling and storing procedures for agro-chemicals, exacerbated by a lack of appropriate safety equipment such as protective clothing and secure storage facilities, can expose smallholders to threats to their health.

Profitability of seed enterprises and competing opportunities and demands: Production of quality seed that meets standards set by regulatory authorities and seed companies can be an expensive undertaking requiring purchase of inputs, adherence to cultivation guidelines, such as lower density planting compared to grain crops, and significant labour requirements for operations such as roguing off-types and more careful weeding, in addition to operations common to seed and grain crop production.

Prices paid for the eventual seed crop are often fixed by the buyer, be they farmers' associations, NGOs, governments or seed companies. Smallholder farmers rarely keep good records and many are unaware of the true costs of production, or whether their seed enterprise is profitable. Yet more challenging is determining whether alternative options, such as growing grain crops rather than seed, growing different crops, selling their labour to larger-scale farms, or taking up non-farm employment, or other business opportunities could be more profitable. These considerations are further complicated by the need to consider the relative risk of the different options, which may affect their profitability in the long term.