

**Opportunities and constraints for
future economic development
of sustainable vegetable seed
businesses in eastern
and southern Africa**

**A scoping study commissioned by the Rockefeller
Foundation, the UK Department for International
Development Crop Protection Programme, and the Gatsby
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Executive summary and recommendations

The Rockefeller Foundation (RF), the UK Department for International Development (DFID) Crop Protection Programme (CPP) and the Gatsby Charitable Foundation (GF) give priority to promoting food security, reducing poverty, and enhancing the economic viability of smallholder farmers in eastern and southern Africa. Previous studies have indicated that there are significant opportunities to address these priorities by improving the production and quality of domestic vegetables in this region. No studies to date have specifically focused on varietal improvement accompanied by the development of improved vegetable seed systems.

In this scoping study, we aim to assess the opportunities and constraints for future economic development of sustainable vegetable seed businesses in eastern and southern Africa. It is the foundation of, and a necessary initial step to, a planned future initiative for producing high quality seed of vegetable varieties bred to meet the needs of smallholder farmers in this region, within the broader needs of the horticultural sector. The study focuses on Kenya due to the importance of the horticultural sector and the wealth of information available from other studies. It also assesses, where information is available, aspects of the vegetable sector in neighboring countries in the region. Where relevant, other initiatives to improve vegetable production within the region and in countries outside the region are also considered.

The study firstly analyses the vegetable supply chain in Kenya (Chapter 2). It then looks at the vegetable seed sector with emphasis on Kenya complemented by information from Tanzania, Zimbabwe and South Africa (Chapter 3). The next section assesses the breeding capacity available for vegetable improvement in Kenya complemented by information from Tanzania and South Africa (Chapter 4). Chapter 5 looks at the current regulatory framework with emphasis on Kenya and its implications to growth of the vegetable seed sector. Chapter 6 presents regional and other vegetable research and production initiatives of relevance to the study. Recommendations are made in Chapter 7 for targeting research and development efforts to the best opportunities for improving the production of quality local vegetables and improved supply of high quality seed to smallholder farmers in eastern and southern Africa.

Horticultural crops – both for export and local consumption – are important crops in eastern and southern Africa, recognized for their health and nutritional benefits as well as cash income. Kenya’s horticultural sector has received considerable attention from local and international researchers, government, and donors over the past decade, especially the rapid and sustained growth of its export sector. Export vegetable production is supported by improved varieties, high quality seed, good agricultural practices and a sustained effort in technical assistance and capacity building, which, until recently, has been largely funded by private-sector export companies.

Yet despite its rapid and sustained growth, exports remain a small fraction of Kenya’s overall horticultural sector. The domestic or local sub-sector dominates. For the past decade, over 90% of the volume and 70–80% of the value of fruit and vegetables produced in Kenya was consumed locally, either on-farm or through domestic markets. Vegetables are the most important component of domestic horticulture, contributing 60% to the market. In striking contrast to the export sector, domestic vegetable production is limited by major pests and diseases, excess use of inappropriate pesticides, lack of improved varieties, variable quality seed, and lack of technical assistance. In addition, poor domestic transport systems and marketing result in unnecessarily high post-harvest losses. These constraints result in levels of production that are well below their full potential; in fact, yields are only about 20–25% of those achieved in top-producing countries.

The domestic horticultural sector in Kenya is expected to continue to grow due to continued urbanization and associated increases in demand. However there are some significant

constraints to future economic development of the vegetable sector in Kenya and elsewhere in eastern and southern Africa. These include: technical, regulatory and marketing constraints. The level of investment needed in each of these areas to enhance the productivity and efficiency of the domestic horticulture sector is well beyond what once source alone could finance. Active partnerships between governments, donors and the private sector will be necessary.

The major constraints and inefficiencies in the domestic vegetable supply chain including: long supply chains with small volume transactions; inadequate market information especially for smallholders; inadequate organization among smallholders; market power mainly in the hands of traders and middlemen; poor transport systems and large distances from markets; poor standards and quality control; little or no product innovation; and high levels of inefficiency. These will need to be addressed in parallel with technical constraints if the full potential contribution of varietal improvement and improved seed systems is to be realized. Already some attempts are being made through donor-funded projects and other initiatives to improve systems of market information; improve the organization of smallholders for marketing; improve business capabilities of smallholders to negotiate with traders; and to shorten supply chains and move to higher volume transactions.

- **It will be essential for any future initiative to improve vegetable seed systems in eastern and southern Africa through technical interventions to link with projects and initiatives to improve the functioning of the vegetable supply chain to the benefit of the horticulture sector as a whole.**

Critical technical interventions can also be identified to address constraints such as: poor standards and quality control.

- **Future initiatives to improve vegetable seed systems in eastern and southern Africa should give high priority to the development of pest and disease resistant varieties adapted to local conditions and cultivated under good agricultural practices including reduced use of pesticides. This will go a long way to achieving higher quality; higher food safety standards; and product innovation that are expected to be part of an improved vegetable supply chain.**

The study has shown that improvements in production and marketing of kale, cabbage, tomato and onion would have important impacts on income levels and poverty rates. It has also shown that if marketing costs can be reduced, farm level productivity increased, and market outlets made more reliable, smallholders already selling vegetables into domestic markets may be able to specialize more in vegetable production and thus be well poised to take advantage of expanding market opportunities. There also exist opportunities for smallholders to move into niche products not currently exploited by larger farmers. And, the main supermarkets in Kenya are interested in identifying additional ways in which smallholders can continue to be part of their supply chain. This further reinforces the opportunities for improved pest and disease resistant vegetable varieties that meet quality requirements to be marketed in supermarkets.

The major constraints affecting the vegetable seed sector include: poor infra-structure especially roads; low quality and fake seed; old varieties susceptible to diseases and pests; high operational costs (especially investment in processing and storage facilities); lack of qualified distributors and retailers; lack of linkages with public sector breeding initiatives and public-private sector partnerships; and over-regulation and lack of capacity in the regulator.

There appear to be substantial opportunities to increase yields through improved, adapted varieties; high quality and affordable seed; and enhanced knowledge and production skills and

thereby foster future economic development of the vegetable seed sector in eastern and southern Africa.

- **High priority should be given to improving the linkages between the public sector breeders and private sector seed companies through building awareness and trust and, where necessary, understanding and capability so that sound partnerships can be developed to the benefit of the vegetable seed sector. The seed companies feel that the public sector lacks appreciation of the practical problems faced by them and perceive a lack of interest by public sector institutes in promoting technologies and new varieties to seed companies. Public sector representatives feel that they lack understanding, skills and confidence to develop partnerships with the seed companies e.g. how to set up MTA's and negotiate royalty agreements. Building understanding and trust between these two groups is critical to future economic development of the vegetable seed sector.**

Smallholders' needs for guaranteed quality seed, availability and affordability are not being met by the current vegetable seed system. Most affordable vegetable varieties on offer are old European varieties which are not adapted to the prevailing biotic constraints such as black rot (for cabbage) and blight (for tomato). The quality of seed is variable and poor.

- **High priority must be given to either sourcing and/or developing improved, adapted, affordable and preferred varieties of commonly grown vegetables such as cabbage, tomato and onion to the benefit of smallholders and consumers. Due to the cost of seed, it would be best to initially concentrate on OP varieties but attention is also needed to producing affordable hybrids. The plan by European seed companies to phase out commonly grown OP vegetable varieties offers an opportunity and an incentive for investment in local production of quality seed of the best current and improved OP vegetable varieties. Potential models are also being developed for local vegetable seed production through current project work on kale. This could also provide models for African indigenous vegetables.**
- **Opportunities should also be sought to build the capacity of seed distributors and retailers so that they can provide farmers with high quality product and necessary advice. Options to improve the seed regulatory system are identified below.**

Lack of public sector breeding capacity and under-utilized private sector breeding capacity; lack of linkages between the public and private sector; lack of appropriate germplasm with required traits; lack of funding support; and lack of a comprehensive, coordinated programme severely constraints the development of improved vegetable varieties in the region. These constraints will need to be addressed if improved and affordable vegetable varieties adapted to local conditions are to be successfully produced. Above all, the major constraint is the lack of vegetable breeding capacity in the public sector in East and southern Africa. It is currently severely restricting the development of improved, adapted vegetable varieties in this region.

- **Highest priority should be given to re-building vegetable breeding capability in eastern and southern Africa.**

There are various options: currently under-utilized breeding skills in the private sector could be sourced; two universities in Kenya have experienced onion and tomato breeders who could train additional breeders; NARS breeders currently working on other crops could be reallocated; there is potential to be tapped in AVRDC where most breeding capacity is currently concentrated in Taiwan; and the ACCI in South Africa offers PhD's in plant breeding through a Rockefeller supported programme.

- **Existing breeding skills in the region should be initially tapped for capacity building in improving specific vegetable crops. This could be strengthened over time. It is likely that such support for the public sector research would attract private sector investment. Priority should be given to developing a coherent, supported programme.**

Advice and help is also needed on where and how to efficiently source germplasm with desired traits, especially what farmers and consumers want.

- **Highest priority should be given to those target crops where key constraints (e.g. black rot of cabbage; blight and viruses of tomato; improved storage life for onion etc.) have already been identified and in some cases, sources of traits identified and breeding programmes in progress e.g. in Tanzania.**

Potential models for vegetable breeding programmes have been proposed.

- **It is recommended that the most sustainable system – already successfully pioneered by East-West Seeds in SE Asia - would be a phased approach involving: the introduction of potentially useful existing OP varieties with needed traits from breeding programmes around the world for evaluation under local conditions (phase 1); the initiation of breeding programmes in parallel to produce improved, locally adapted (especially with needed disease and pest resistances) OP varieties to meet market requirements and to boost farmer' income (phase 2); followed by the introduction of hybrids (phase 3). In this phased way, improved varieties from elsewhere could be available to farmers within 2–3 years and improved, locally adapted varieties within 3–5/4–7 years.**

This approach could be complemented by the development of public-private partnerships through linking the breeding expertise of the public sector with the resources and infrastructure of the private seed companies for seed production. In Kenya, Hygrotech has expressed interest in developing such partnerships and has a vision which includes smallholders. Public sector institutes should be encouraged and supported to build understanding and confidence to pursue such partnerships.

The major constraints affecting the regulation of the seed sector in Kenya (more so than in Tanzania) include: restrictive, complex and difficult administrative and regulatory systems for the importation of seed, registration of new varieties, and multiplication and marketing of seed; lack of harmonization of seed regulations with those of other inputs (in contrast to Tanzania); specific barriers to harmonization of regulations affecting vegetable seed due to lack of information; lack of capacity in KEPHIS to satisfactorily meet its multiple roles; and lack of understanding between key stakeholders in the seed sector.

Over-regulation of the seed sector is a serious disincentive for innovation, entry and growth of the sector. The current regulatory system needs critical attention in parallel with technical constraints if the full potential contribution from varietal improvement and improved seed systems is to be realized. Already some attempts are being made through donor-funded projects and other initiatives to address these constraints.

- **It will be essential for any future initiative to improve vegetable seed systems in eastern and southern Africa to link with projects and initiatives to improve the seed regulatory system to the benefit of the horticulture sector as a whole.**

- **Opportunities should also be sought to facilitate the building of improved relations between key stakeholders in the sector especially the regulatory bodies and the seed companies.**

There is strong support from KEPHIS for building local vegetable breeding and seed production skills in terms of its contribution to local production of quality breeder seed. Because the development of a system based on partnerships between public sector breeders, seed companies and contract farmers to produce quality seed for sale to smallholders in Kenya would probably eliminate many of the critical bottlenecks and inefficiencies in the current system, this is further justification for support for improving the vegetable seed sector. This one intervention would solve both technical and regulatory issues simultaneously.

- **Effort should be given to developing national varietal list for vegetables in Kenya, Tanzania and other countries that need such a list.**

The development of such lists is an important step in the process of liberalizing seed movement between the Kenya, Tanzania and Uganda as part of the regional harmonization processes.

Progress made in liberalizing the seed sector within the broader context of liberalized markets in Tanzania has resulted in a more flexible and workable system and seed sector which seed companies appreciate.

- **In light of the progress made in Tanzania, it is recommended that future efforts to reform of the Kenyan seed sector should take note of the useful lessons learnt in Tanzania.**

KEPHIS is mandated to fulfill a daunting number of tasks which may be contributing to its lack of capacity and expertise in some areas e.g. seed technology.

- **The options to address this would be to build capacity and expertise in KEPHIS to meet the needs of the major stakeholders in the system, especially the seed companies or to reallocate particular tasks to other institutes e.g. Moi University for seed technology.**

The plan to establish an East African Seed Committee with representatives of the regulators, seed traders associations and plant breeders associations for those countries that already support harmonization is seen by the study team as a positive development in resolving some of the constraints to simplify restrictive seed regulations and facilitate the harmonization process.

Assessment of regional initiatives showed that there are currently **no** comprehensive institute- or project-based programmes to breed improved vegetable varieties and improve local seed systems. However, there are a number of important initiatives to improve the vegetable sector that should be linked to a future initiative to improve vegetable seed systems in eastern and southern Africa to the benefit of the horticulture sector as a whole.

Of particular note is ICIPE's horticultural research and training programme aims to develop improved IPM practices in smallholder horticultural systems across export and local sectors.

- **Future research on improving vegetable breeding and seed systems in the region should be closely linked to ICIPE's efforts to develop improved strategies and technologies for management of vegetable pests.**

HCDA has the experience and the position to provide support across the vegetable sector in Kenya, both export and domestic.

- **A comprehensive programme of support for the domestic vegetable sector coordinated by HCDA and based on quality seed and other needed inputs; technical training and advice; and an improved marketing system would greatly increase the productivity and efficiency in the domestic vegetable sector in Kenya.**

Technoserve is strongly committed to improving the domestic horticulture sector through improved marketing systems to secure the future for smallholders.

- **Future research on improving vegetable breeding and seed systems in the region should be closely linked to Technoserve's interest and potential support for upgrading physical markets in urban areas; improving marketing systems; and building links between retailers and farmers, based on elements of the export model.**

In this region, there are also notable project-based initiatives which include: the DFID CPP's cluster of vegetable pest management projects; FINTRAC-HDC USAID-funded project to increase incomes of horticultural smallholders; and the Maendeleo Agricultural Technology Fund project on sustainable production, seed supply and marketing of African Indigenous Vegetables in East Africa.

- **Future research on improving vegetable breeding and seed systems in the region should build on the knowledge bases developed by these projects.**

Lesson learning and relevant outputs from the three projects: CARE-REAP; DFID BSMDP; and GTZ PSDA on tackling market inefficiencies in vegetable supply chains and building smallholder capacity are relevant to future research on improving vegetable breeding and seed systems in Kenya.

- **Future research initiatives on improving vegetable breeding and seed systems in the region should seek linkages to projects addressing marketing constraints for improvement in the sector as a whole.**

A review of a limited number of selected vegetable seed initiatives in Asia identified potential models for future economic development of sustainable seed businesses in eastern and southern Africa.

- **Phased development of improved OP vegetable varieties followed by hybrids successfully used by East-West Seeds in SE Asia;**
- **Public-private sector partnerships developed by AVRDC with seed companies in Asia for promotion of vegetable varieties;**
- **Development of OP tomato varieties with the public sector in India to stimulate the interest of private seed companies.**

In addition to the recommendations given above to address the major technical, regulatory and marketing constraints currently faced by the domestic vegetable sector in eastern and southern Africa, several general recommendations can be made to improve the functioning and future viability of the sector as a whole.

Due to the complexity of the vegetable sector in East Africa; the large and growing number of stakeholders and donors involved; and the increasing number of individual, and currently,

uncoordinated projects, there is increasing potential for duplication of effort and waste of resources. A horticulture network was originally proposed by the GTZ IPM Horticulture Project based in ICIPE in 1997. Recently, AVRDC-RCA proposed a vegetable network: “Improving vegetable productivity and consumption in ASARECA member countries”.

- **A vegetable network, under the auspices of ASARECA would help to establish much needed coordination in this sector. However, at this stage, priority should be given to further consultation on the structure, coverage, function and membership of the network in consultation with all major stakeholders.**

Such a network will need to be aware of the needs of the whole vegetable sector: varietal improvement; improved seed systems; simplified seed regulations; improved marketing systems and processing needs in order to direct investment at the best opportunities to address the most critical and priority constraints.

- **It is therefore recommended that funding should be sought to hold for a workshop involving representatives from public research organizations, private companies, marketing groups, supermarkets, processors, regulatory bodies etc. to discuss the structure, coverage and function of a network for the benefit of the sector as a whole.**

Such a workshop would initiate the important process of building awareness of the capabilities of each potential member.

The export vegetable sector in Kenya has achieved remarkable growth and success and involves tens of thousands of smallholders. It is based four pillars: improved vegetable varieties; high quality seed; efficient marketing systems; and reliable technical assistance and capacity building.

Production of vegetables for the domestic market is almost entirely by smallholder farmers. These farmers usually have the minimum infra-structural requirements and are often not too distant from urban markets. However, their greatest needs are for the four basic pillars of the export sector: improved varieties; quality seed; efficient marketing systems; and reliable technical assistance and capacity building.

In many cases, the same smallholder farmers are growing vegetables for both the export and domestic sectors. These smallholders are **the common denominator** for transfer of knowledge and technologies from the export to the domestic sector. Significant opportunities therefore exist for smallholders to benefit from the learning experiences of the export sector.

- **It is strongly recommended that support from governments, donors and the private sector be tapped to transfer relevant learning experiences and the technical expertise and skills from the Kenyan export sector to improve the domestic vegetable sector based on the four basic pillars, which is also an appropriate model for the domestic vegetable sector.**

Through the development of robust partnerships between appropriate stakeholders, improved, adapted vegetable varieties could be bred and appropriate, affordable and sustainable seed delivery systems could be developed in eastern and southern Africa. Much needed vegetable breeding capacity in the region would be significantly strengthened; environment and human health would be improved through reduced use of pesticides; livelihoods would be enhanced through income generation and employment opportunities; and widespread delivery of adapted and affordable seeds would be promoted in a financially sound manner. In addition,

viable public-private sector partnerships would be created and fostered for future sustainable national and regional economic growth.

This study has identified some exciting opportunities for addressing the major constraints to future economic development of sustainable vegetable seed businesses in eastern and southern Africa. We conclude that research input in, and development support for, an improved domestic vegetable sector is overwhelmingly justified by its potential to reduce poverty and improve the livelihoods of the poor, not the least through increasing the availability and lowering the cost of a range of nutritious vegetables. Already the necessary technologies and skills are available both in the region and in developed countries to address the major constraints in the region.

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Acronyms

AATF	African Agricultural Technology Fund
ACCI	African Centre for Crop Improvement
ADHEK	Association of Developing Horticultural Exporters of Kenya
AFRICERT	African Certification (for EUREPGAP)
AIVs	African Indigenous Vegetables
ARIS	Agricultural Research Investment Scheme [KARI]
ART	Agricultural Research Technology
ASARECA	The Association for Strengthening Agricultural Research in eastern and Central Africa
AVRDC-RCA	Asian Vegetable Research and Development Center Regional Center for Africa
BCAs	Biological Control Agents
BSMDP	Business Services Markets Development Project
CABI-ARC	CABI-African Research Centre
CARE-REAP	CARE Rural Enterprise Agri-Business Promotion
CBOs	Community Based Organizations
CBSP	Community Based Seed Production
CGIAR	Consultative Group for International Agricultural Research
CIDA	Canadian International Development Agency
CPP	Crop Protection Programme
CSL	Central Sciences Laboratory
DFID	UK Department for International Development
DGIS	Directorate-General for Development Cooperation
DUS	Distinct Uniform Stable
ECAPAPA	eastern and Central Africa Programme for Agricultural Policy Analysis
EU	European Union
EU-PIP	EU Pesticides Initiative Programme
EUREPGAP	Euro-Retailer Produce Working Group - Good Agricultural Practices
E-WI	East-West Seed International
E-WZ	East-West Seed Zimbabwe
E-Z	Enza-Zaden Africa
FAO	Food and Agriculture Organisation
FFS	Farmer Field Schools
FFV	Fresh Fruit and Vegetables
FIPS	Farm Input Promotional Service
GDP	Gross Domestic Product
GF	Gatsby Charitable Foundation
GoZ	Government of Zimbabwe
GSI	Good Seed Initiative
GTZ	German Agency for Technical Cooperation
HCDA	Horticultural Crop Development Authority
HDC	Horticultural Development Centre
HRI	Horticultural Research International
HRC-Z	Horticultural Research Centre - Zimbabwe
HSPAK	Horticultural Service Providers Association of Kenya
IARCs	International Agricultural Research Centres
ICIPE	International Centre for Insect Physiology and Ecology
IFAD	International Fund for Agricultural Development
ISF	Input Supply Fund
IPGRI	International Plant Genetic Resources Institute
IPM	Integrated Pest Management

IPR	Intellectual Property Rights
ISTA	International Seed Testing Association
JICA	Japan International Cooperation Agency
JK	Jomo Kenyatta University of Agriculture and Technology
KAPP	Kenya Agricultural Productivity Project
KARI	Kenya Agricultural Research Institute
KEPHIS	Kenya Plant Health Inspectorate Service
KFA	Kenya Farmers Association
KEFRI	Kenya Forestry Research Institute
KFU	Kenya Farmers Union
KIOF	Kenya Institute of Organic Farming
KSC	Kenya Seed Company
KZN	University of KwaZulu Natal
MATF	Maendeleo Agricultural Technology Fund
MoALD	Ministry of Agriculture and Livestock Development
MRLs	Maximum Residual Levels
MSU	Michigan State University
NARES	National Agricultural Research and Extension Systems
NGOs	Non-Government Organizations
NRI	Natural Resources Institute
OECD	Organization for Economic Cooperation and Development
OP	Open Pollinated (varieties)
PBAK	Plant Breeders Association of Kenya
PMO	Product Marketing Organization
PSDA	Promotion of Private Sector Development in Agriculture
PSSP	Private Sector Service Provider
PUs	Production Units
PVP	Plant Varietal Rights
PVR	Plant Varietal Protection
QDS	Quality Declared Seed
RF	Rockefeller Foundation
SADC	southern African Development Community
SRC	Seed Regulation Committee
STAK	Seed Traders Association of Kenya
TAMPA	Tegemeo Agricultural Monitoring and Policy Analysis
ToLCV	Tomato Leaf Curl Virus
TOT	Training Of Trainers
THRC	Thika Horticultural Research Centre
THRI	Tengeru Horticultural Research Institute
TOSCA	Tanzania Official Seed Certification Agency
UK	United Kingdom
UNDP	United Nations Development Programme
UPOV	International Union for the Protection of New Varieties of Plants
USAID	United States Agency for International Development
VOPI	Vegetable and Ornamental Plants Institute [Roodeplaat]

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1. Introduction

1.1 Study objectives

The Rockefeller Foundation (RF), the UK Department for International Development (DFID) and the Gatsby Charitable Foundation (GF) give priority to promoting food security, reducing poverty, and enhancing the economic viability of smallholder farmers in eastern and southern Africa. To contribute to these objectives, previous studies have indicated that there are significant opportunities to improve the production and quality of domestic vegetables in this region. Opportunities include: the development of improved cultural practices; IPM and biological control to reduce pesticide use; and improved marketing systems. **No studies to date have specifically focused on varietal improvement accompanied by the development of improved vegetable seed systems.**

Mohamed and Tripp (2002) showed that there appear to be significant opportunities for improving local food production through the development of adapted pest and disease resistant varieties and improved supply of high quality seed to smallholder farmers in eastern and southern Africa. Although they gave emphasis to maize, there appear to be a number of common factors that justify investment in private sector seed production of other locally important crops in this region, including the economic advantages of seed of improved varieties to small farmers. More importantly and more so than for maize, as local vegetables are an important source of cash income, small farmers are likely to be highly interested in improved varieties with resistances to diseases and pests, as pesticides are a major expense. Also the local seed systems for domestic vegetables, with the exception of kale, are largely under-developed and have greater deficiencies and inefficiencies than those for maize and other staple food crops. Much of the seed, especially for tomato and cabbage, is imported. Varieties are not locally-adapted and seed is expensive and of variable quality.

In this scoping study, we aim to assess the opportunities and constraints for future economic development of sustainable vegetable seed businesses in eastern and southern Africa. We hope to show that through the development of robust partnerships between appropriate stakeholders (international, regional, national public and private sector), improved, adapted varieties could be bred and appropriate, affordable and sustainable seed delivery systems could be developed. If this process can be achieved, much needed vegetable breeding capacity in the region would be significantly strengthened; environment and human health would be improved through reduced use of pesticides; livelihoods would be enhanced through income generation and employment opportunities; and widespread delivery of adapted and affordable seeds would be promoted in a financially sound manner. In addition, viable public-private sector partnerships would be created and fostered for future sustainable national and regional economic growth.

This study is the foundation of, and a necessary initial step to, a planned future initiative for producing high quality seed of vegetable varieties bred to meet the needs of smallholder farmers in this region, within the broader needs of the horticultural sector. The study focuses on Kenya due to the importance of the horticultural sector and the wealth of information available from other studies. It also assesses, where information is available, aspects of the vegetable sector in neighboring countries such as Tanzania in Eastern Africa and Zimbabwe and South Africa in southern Africa. South Africa, for example, currently supplies a sizable proportion of vegetable seed to the region and has plant breeding skills which could be utilized for building capacity throughout this region. Where relevant, other initiatives to improve vegetable production within the region and in countries outside the region are also considered.

The study was carried out over an 8 month period and included eight activities which are detailed in Appendix 1. Although it focuses on the domestic vegetable sector, where relevant, comparisons are made with the export sector to help define the importance of the domestic sector in the overall context of the horticultural sector in Kenya and to emphasize its neglect to date in terms of research input and donor support.

The study firstly analyses the vegetable supply chain in Kenya, in particular, production and marketing (Chapter 2). It then looks at the vegetable seed sector with emphasis on Kenya complemented by information from Tanzania, Zimbabwe and South Africa (Chapter 3). The next section of the study assesses the breeding capacity available for vegetable improvement in Kenya complemented by information from Tanzania and South Africa (Chapter 4). Chapter 5 looks at the current regulatory framework with emphasis on Kenya and its implications to growth of the vegetable seed sector. Chapter 6 presents some regional and other vegetable research and production initiatives of relevance to the study in terms of future linkages or models. Recommendations are made in Chapter 7 for targeting research and development efforts to the best opportunities for improving the production of quality local vegetables and improved supply of high quality seed to smallholder farmers in eastern and southern Africa.

1.2 The horticultural sector in Kenya

The Policy Paper on the Horticultural Industry in Kenya describes the outcomes of accelerating the growth of horticultural production: as improving food security, earning foreign exchange, generating employment and income, alleviating poverty and enhancing development in arid and semi-arid areas. It also sets out a range of strategies to accelerate the growth of the industry: improvement of infrastructure such as roads, telecommunication, irrigation and electricity supply; financing; supply of inputs; extension services; and research. With regard to vegetable production, the GoK aims to increase production of quality vegetables, diversify varieties, improve post-harvest technology, register nurseries for plant propagation, and set quality standards for the domestic market. The policy environment in Kenya is therefore conducive to initiatives supporting further development of the horticultural sector.

Horticultural crops – both for export and local consumption – are important crops in eastern and southern Africa, recognized for their health and nutritional benefits (especially for those infected with HIV-Aids) as well as cash income. Kenya's horticultural sector has received considerable attention from local and international researchers, government, and donors over the past decade, especially the rapid and sustained growth of its export sector (Jaffee, 1995; Kimenye, 1995; Stevens and Kennan, 1999; Dolan and Humphrey, 2001; Harris et al., 2001; McCulloch and Ota, 2003; Osmosa, 2002; Ota and Lenné, 2003; Minot and Ngigi, 2004; Mutuku Muendo et al., 2004). From an insignificant base, export horticulture has grown steadily in post-independent Kenya, increasing 12-fold in tonnage and 40-fold in value. It is the fastest growing agricultural sub-sector and one of the top five foreign exchange earners in Kenya, contributing almost 13% of GDP in 2003. It is a major engine of economic growth.

Export vegetables are also an important source of income for approximately 30,000 smallholder farmers and their families, scattered throughout rural Kenya, following strict production regimes including, increasingly, compliance with EUREPGAP. This sector also employs hundreds of thousands of semi-skilled and unskilled Kenyans who would otherwise struggle to find alternative employment. A considerable number of Kenyans therefore rely on export horticulture for their livelihoods. Its further growth will continue to contribute to reducing poverty, food insecurity and nutrition and increasing rural incomes. **Export vegetable production is supported by improved varieties, high quality seed, good agricultural practices and a sustained effort in technical assistance and capacity building,** which, until recently, has been largely funded by private-sector export companies.

Yet despite its rapid and sustained growth, exports remain a small fraction of Kenya's overall horticultural sector (Ota and Lenné, 2003; Mutuku Muendo et al., 2004). The domestic or local sub-sector dominates. For the past decade, over 90% of the volume and 70–80% of the value of fruit and vegetables produced in Kenya was consumed locally, either on-farm or through domestic markets. Vegetables are the most important component of domestic horticulture, contributing 60% to the market. In addition, the absolute overall growth in the horticultural sector in Kenya has come

overwhelmingly from the domestic sub-sector: between 1992 and 2001, the domestic market accounted for 91% of the total growth in vegetable production (Mutuku Muendo et al., 2004). Even allowing for the higher value of export commodities, the dominance of the domestic sub-sector is clear.

Most production in the domestic sub-sector is by smallholder farmers, producing tomato, kale, cabbage, onion and indigenous leafy vegetables for cash income as well as for food. More than 90% of smallholder farmers in all but the arid regions of Kenya produce horticultural products while fewer than 2% do so directly for export. In striking contrast to the export sector, **domestic vegetable production is limited by major pests and diseases, excess use of inappropriate pesticides, lack of improved varieties, variable quality seed, and lack of technical assistance.** One of the main reasons why pests and diseases are major constraints to increased vegetable production in Kenya is that the most commonly grown vegetable varieties have been introduced and have not been bred for resistance to local biotic and abiotic constraints. These constraints result in levels of production that are well below their full potential; in fact, yields are only about 20–25% of those achieved in top-producing countries. In addition, **poor domestic transport systems and marketing result in unnecessarily high post-harvest losses.**

2. The vegetable supply chain

2.1 Vegetable production in Kenya

Kenya has a land area of 583,000 km², of which about 17% is arable. The total area under horticultural crops is estimated at 246,000 ha of which 99,000 ha is vegetable production (HCDA, 2002). In 2001, Kenya produced over 1.5 million tonnes of vegetables of which 90% was consumed domestically and 10% exported. Vegetable cultivation is a very important activity among Kenyan farmers. It occurs across different agro-climatic conditions from semi arid to high altitude. The traditional vegetable growing areas are mainly found in the mid to high altitude zones of Central, Rift Valley and Eastern provinces. By area, Central province accounts for 43% of the total vegetable production area, followed by Rift Valley (23.9%). Most production (70–80% of marketable product) is carried out by smallholder farmers each with approximately 1–2.5 ha of land.

Table 2.1 The main vegetable crops grown in Kenya by area, volume and value

Crop	Area(ha)	Volume(tonnes)	Value(000sKSh)
Kale	23,121	317,281	103,061
Tomato	17,430	284,859	225,697
Cabbage	18,905	260,774	58,568
Indigenousvegetables	11,610	69,190	59,352
Onion	5,864	60,536	59,245
Carrot	3,965	53,799	17,702
Frenchbean	6,482	28,818	43,555
Gardenpeas	6,522	26,013	19,394
Spinach	862	8,296	2,516
Okra	671	3,402	4,734
Capsicum	451	2,615	4,941

Source: HCDA (2002)

Table 2.2 Area and production shares of major vegetable crops in Kenya, 1992 and 2001 (adapted from Mutuku Muendo et al. [2004])

Vegetables	Area shares %		Production shares %	
	1992	2001	1992	2001
Cabbage	25	17	32	22
Kale	21	25	25	31
Tomato	17	18	22	24
Onion	6	6	5	5
Carrot	6	4	6	5
French bean	8	6	2	2
Garden peas	8	7	2	2
Indigenous vegetables	5	10	3	5
Other vegetables	4	7	3	4

Data Source: MoALRD

Production trends in major vegetable crops in Kenya during the past ten years are given in Table 2.2. These trends for most vegetables showed slight increases with kale, tomato and indigenous vegetables showing steady increases in production during the period. Increases in kale production were the most impressive. However, cabbage production and area sown dropped sharply in 1993 and has remained the same since then. This may be due to increasing difficulties faced by smallholder farmers in

managing major pests and diseases of non-adapted varieties and merits further study. Among export vegetables, although yields of both French bean and garden pea increased, the area shares decreased. This suggests that more productive varieties are being grown and/or improved agronomic practices are being used.

The yield of most domestic vegetables remained about the same from 1992 to 2001, with the exception of traditional vegetables which increased (Mutuku Muendo et al., 2004). When compared to the top five producers of cabbage, tomato and onion globally, the yield of these vegetables in Kenya is the lowest in all crops, being 20–25% of the yields achieved by the top countries. This is attributed to a combination of poorly adapted, old varieties; poor quality seed; inadequate and/or inappropriate inputs; and lack of knowledge and production skills. Therefore it appears that there are substantial opportunities to increase yields through improved, adapted varieties; high quality and affordable seed; and enhanced knowledge and production skills.

2.2 Characteristics of smallholder vegetable production in Kenya

The following section summarizes the key characteristics of smallholder vegetable production in different areas of Kenya from two studies: peri-urban Nairobi (Thika, Kiambu, Machakos and Kajiado Districts) (Uruko and Ndungu, 2001) and Kirinyaga, Machakos, t Elgon and Nakuru Districts (Wanyonyi, 2004). The latter survey was supported by the scoping study.

Peri-urban vegetable production around Nairobi

Uruko and Ndungu (2001) surveyed 200 farmers specifically growing vegetables for the domestic market in the Thika, Kiambu, Machakos and Kajiado Districts of peri-urban Nairobi. Vegetable production in these areas has expanded over the past 20 years in response to the increasing food demand from a rapidly growing urban population. Peri-urban vegetable farms averaged 1.3 ha. Vegetable crops covered about 0.4 ha per farm, with tomato, cabbage and kale dominating. The average age of farm operators was 38 years, and for farm owners 49 years. These farmers have high literacy levels, with 78% having completed at least primary education and 27% with secondary education or higher. They are predominantly male. The majority of peri-urban farmers used some irrigation, improved soil fertility with inorganic fertilizers, and used chemical pesticides to control pests. Cal J tomato (87%), Collard kale (75%) and Gloria F1 cabbage (79%) were the preferred varieties. All of these varieties are at least 20 years old and were not bred in Kenya (see Chapter 3).

The majority of vegetable farmers obtained seed from retail outlets or stockists who stock a variety of agricultural inputs including seed, fertilizers and pesticides. All cabbage seed (98 farms) was purchased from a stockist, as was the majority of tomato and kale seed (96% and 70% of farms, respectively). Three farmers (2%) purchased tomato seed and 28 farmers (18%) purchased kale seed from other farmers. One farmer used his own tomato seed and only kale seed was purchased from hawkers (4%).

Most farmers (67%) considered pests and diseases to be the major constraints to vegetable production in peri-urban Nairobi. Most commonly grown varieties are susceptible to the prevailing pests and diseases and 99% of the peri-urban farmers surveyed applied pesticides to control vegetable pests. There is limited knowledge of safe use of pesticides and food safety issues, and widespread excessive application. Of 200 farms surveyed, only 5 used botanical pesticides to control pests although a range of cultural practices were integrated with pesticides. A key motivational factor for using chemicals to control pests is the higher returns from vegetables with blemish-free appearance. Commonly-used chemicals provide variable levels of control depending on quality and effectiveness of use. Resistance to common pesticides is widespread and some commonly applied chemicals e.g. Dithane M45 are ineffective against major diseases such as black rot.

Other production constraints were inadequate capital to purchase inputs and inadequate and/or irregular access to irrigation. Marketing constraints included low product prices, no market at peak production time, and high transport costs.

The returns to vegetable farming (gross margins) ranged from £264–2700 per ha per cropping season depending on the crop. Tomato farming yielded the highest gross margins per ha. Notably, the cost of irrigation constituted a large proportion of total variable costs. A 50% reduction in irrigation costs nearly doubled the gross margins. The cost of seed was relatively low at £6/ha for cabbage and kale and £10/ha for tomato. The cost of crop protection varied from 20–65% of the variable costs. However, where the cost of crop protection was high the gross margins were also high.

Vegetable production in Kirinyaga, Machakos, t Elgon and Nakuru Districts

A survey was made of 18 smallholder vegetable farmers in the Kirinyaga (Mwea), Machakos (Athi River), t Elgon (Cheptais) and Nakuru (Molo) Districts (Wanyonyi, 2004). The average age of farmers was 36 years and 94% were male. A majority of farmers (50%) had secondary education. The average household size was 4 people. The average farm size was 2.3 ha with vegetables occupying an average of 0.45 ha. The source of labour was both hired and family labour. All farmers used inorganic fertilizers, some farmers also used manure, and all farmers applied pesticides. All farmers in Mwea used irrigation compared to 85% in Athi River, 50% in Cheptais and 35% in Molo. The most commonly grown domestic vegetables were tomato, kale, onion and cabbage. Most farmers in Mwea also grew French beans for export. All farmers grew Copenhagen Market cabbage. The majority of tomato farmers (59%) planted Cal J, 100% of onion farmers grew Red Creole, while Collard was grown by 89% of kale farmers. The variety Cal J is more than 30 years old while Copenhagen Market is nearly 100 years old.

The majority of vegetable farmers (79%) purchased seed from stockists. Own farm saved seed was used by 14% of the vegetable farmers whereas 14% obtained seed from other farmers. The average quantities of seed used by vegetable farmers per hectare per season ranged from 50g for cabbage (KSh 80–100 based on variety grown) to 250g for tomato (KSh 1500–1800) and onion (KSh 700–1000). Crop yield per cropping season varied with location. Mwea recorded the highest tomato yield of 24 t per ha per season; Cheptais had the highest onion and cabbage yields of 6.5 t and 8 t per ha per season respectively; while the highest kale yields were recorded in Mwea of 8 t per season.

The main constraints to production were identified as pests and diseases, expensive farm inputs (fertilizer, pesticides and labour), and lack of irrigation water. The main marketing constraints were low product prices especially during the peak season, high transport costs, loss of produce due to rotting (perishability), and lack of organized marketing systems.

2.3 Marketing vegetables in Kenya

Most farmers in Kenya produce some vegetables for their own consumption. Vegetables are also marketed through fresh and processed local or export markets. In peri-urban environments such as around Nairobi, most smallholders sell a proportion of their produce to middlemen or directly in markets. This provides an important source of cash income. Mutuku Muendo et al. (2004) used available data (mostly from MoALRD) to estimate the proportion of total vegetable production a) consumed on farm, b) marketed locally, and c) exported in fresh or processed form.

During 1997–2001, fresh vegetable exports from Kenya averaged 9.3% of production, by value. With the addition of processed vegetable exports, the total export share between 1997 and 2001 increased to about 12%. Data from the Tegemeo/MSU Tampa smallholder income survey showed that 64% of vegetable production in 2000 was marketed and 36% was retained on farm. By combining these data sets, it was estimated that the value of vegetable production sold and then consumed domestically during 1997–2001 was at least 4–5 times as large as the value exported in fresh and processed form (52% compared to 12%).

Value added per unit of farm-gate production is higher in the export sector due primarily to higher quality and food safety standards. A comparison of MoALRD farm-gate prices with HCDA export prices for French bean and Asian vegetables showed that export prices exceeded farm-gate prices by 290% (Mutuku Muendo et al., 2004). In contrast, mark-ups in domestic markets are typically about 100% from farm-gate to wholesaler and 150% total markup from farm-gate to retail in local markets. Applying these figures to the share of production flowing through domestic and export channels, showed that overall total value added in domestic vegetable markets is nearly three times that in vegetable export markets. Thus, although vegetable exports are an important component of the vegetable supply chain, absorbing about 20% of all traded produce by value, and accounting for about 25% of all value added after the farm gate, domestic markets remain the primary outlet for vegetable production and generate more absolute value added than do export markets (Mutuku Muendo et al., 2004).

In Kenya, production and sales of major vegetable crops tend to be concentrated (Mutuku Muendo et al., 2004). For the top 10 vegetable and fruit crops, 15% of rural households account for about 80% of all sales. Nevertheless, useful distinctions can be made between crops. Kale is one of the least concentrated geographically and at household level. It is produced throughout Kenya and is actively marketed. In most areas at least one-third of all rural households sell kale. **Improvements in production and marketing of kale would have the broadest impacts on income levels and poverty rates.** Cabbage, tomato and onion are intermediate in terms of concentration of sales. Each is produced in most horticultural production zones in Kenya, and 5% of the rural population accounts for 81–88% of sales. **Improvements in production and marketing of cabbage, tomato and onion would also have important impacts on income levels and poverty rates throughout Kenya.**

Mutuku Muendo et al. (2004) found that the households of smallholder farmers selling vegetables remain relatively diversified in their income strategies, typical of African smallholders. A potential implication is that, if marketing costs can be reduced, farm level productivity increased, and market outlets made more reliable, this group of households may be able to specialize substantially more in vegetable production and thus be well poised to take advantage of expanding market opportunities.

2.4 Domestic marketing channels

Domestic horticultural produce is marketed through a range of outlets including village markets, urban markets, small to medium size retail outlets (e.g. greengrocers, self-service grocers, kiosks, other shops etc.) and supermarkets. Independent smallholders produce the bulk of the vegetables for domestic markets. **Hence, increasing the volume and value of traded fresh horticultural produce among rural agricultural households as well as between them and the rest of the domestic and regional economy should increase rural incomes and reduce poverty.**

Government assistance to the domestic horticultural sector has been mainly through the construction of markets, which primarily serve urban areas (Mutuku Muendo et al., 2004). Concerns about traffic congestion and lack of hygiene in public markets have become increasingly pressing in recent years, while poor road infrastructure has imposed high costs on the marketing of all agricultural products. Thus, the size of the urban population, the degree of self sufficiency of rural households, the purchasing power of urban and rural households, and the costs of collecting, transporting, and selling horticultural products are key determinants of the size of the horticultural market for Kenyan smallholders.

The main traders in the domestic markets are wholesalers (Mutuku Muendo et al., 2004). Wholesalers are divided into collecting and distributing wholesalers. The former specialize in collecting produce from farmers scattered throughout production areas. They travel long distances to purchase commodities. Collecting wholesalers frequently employ purchasing agents who work in the production areas. Purchasing agents reduce costs by identifying produce for sale, negotiating a price, accumulating, assembling and transporting the produce to the nearest road for ease of collection. Hence, they streamline the procurement process (Dijkstra, 1996, 1999). Once enough produce is

obtained, collecting wholesalers then transport the commodities to the main cities/towns. Collecting wholesalers sell primarily to distributing wholesalers in urban wholesale markets.

Collecting wholesalers thus allow distributing wholesalers to focus entirely on their urban clientele (Mutuku Muendo et al., 2004). This is important in large urban centers such as Nairobi where wholesale and retail markets operate six days a week. The urban clientele served by distributing wholesalers is highly diverse. It includes traders in traditional open-air retail markets; green grocers serving middle-class clientele in roadside kiosks; “up-market” green grocers mostly in established retail centers; supermarkets; and hotels. The urban wholesale markets play the main role in the domestic horticultural marketing system as the dominant source of supply for open-air retail markets and kiosks.

Supermarkets have expanded their participation in horticultural markets a great deal in recent years. The two largest supermarket chains, however, appear to have by-passed these markets, relying instead on brokers and increasingly on direct procurement with an assortment of contracted commercial farmers and some organized small- and medium-sized farmers through “preferred supplier schemes” (Neven and Reardon, 2004 – see section on supermarkets).

In general, Kenya’s traditional domestic horticultural marketing system is characterized by fragmentation both at producer and retailer ends of the supply chain; market power mainly in the hands of wholesalers; long supply chains; little quality control and grading; few standards; little or no product innovation; and small volume transactions (Neven and Reardon, 2004). It is a highly inefficient system. In striking contrast, the export marketing system is dynamic, continuously innovative with new products and institutional and organizational improvements, and, being highly efficient, able to continue to compete in the EU market.

Smallholder farmers producing vegetables for domestic markets – through whichever outlet – face significant constraints to realizing full value from their produce (Mutuku Muendo et al., 2004). These constraints include: inadequate market information; lack of efficient marketing organizations; distance from markets and inadequate transport systems; and in the case of supplying the supermarkets, inability to meet quality and consistent supply requirements. Although market information for major vegetable commodities is now available in the Nation newspaper and the cell phone company Vodaphone has recently begun supplying market information through cell phones, it still appears that most farmers are either not aware or not able to access the information.

Critical interventions can be identified to address these constraints such as: improved pest and disease resistant varieties adapted to local conditions that will meet the quality requirements expected by supermarkets. **However, other major inefficiencies in vegetable marketing systems will also need to be addressed if the full potential contribution of varietal improvement and improved seed systems is to be realized for the benefit of smallholders. For example, improved access to market information by smallholder farmers will help to maintain a balance of benefits throughout the developing supply chain and prevent the situation which has developed in some other markets (e.g. UK) where the benefits are heavily weighted to the retail end of the supply chain.**

Survey of traders in Kitale, Eldoret and Nairobi vegetable markets

Wanyonyi (2004) surveyed 14 vegetable traders selling tomato, onion, cabbage and kale at major markets in Kenya. These included wholesalers: in Kitale (13%), Eldoret (18%) and Nairobi (13%) markets and retailers: in Kitale (13%), Eldoret (33%) and Nairobi (18%). The majority of sample farmers sold their vegetables to collecting wholesalers through purchasing agents who visited farms. The predominant marketing pathway identified for all vegetables in all study areas was farmer---wholesaler---retailer---consumer.

Table 2.3 show the farmers’ and traders’ shares of the consumer prices for different vegetables in different markets. Marketing efficiency was measured by calculating the percentage of the farmers’

share of the consumer price. For all vegetables surveyed in all markets, the farmers share of the consumer price was lower than the combined share of the traders although the amount varied across crops. Farmers received a higher share for kale and tomatoes than for cabbage and onion. Retailers generally received a higher share than wholesalers. Although further study is needed of the full marketing costs (including transport) incurred by traders, the results suggest that the farmers are exploited by the traders who buy their produce at low prices and sell to consumers at high prices. Hence this survey highlights considerable inefficiencies.

Table 2.3 Percentage shares of the consumer price for farmers and traders in three markets in Kenya

Market	Farmers				Wholesalers				Retailers			
	Tom.*	Cab.	Kale	Onion	Tom.	Cab.	Kale	Onion	Tom.	Cab.	Kale	Onion
	%				%				%			
Eldoret	25	22	34	18	23	26	22	34	42	52	44	48
Kitale	30	18	32	24	29	30	37	34	41	52	31	42
Nairobi	30	28	42	24	26	18	29	26	44	54	29	50

* Tom. = tomato; Cab. = cabbage

Alternative marketing systems need to be explored which shorten the supply chain from the farmer to the consumer, thereby reducing the number of middlemen. Options include direct marketing where farmers sell directly to consumers or community-based marketing organizations to reduce marketing costs for each farmer. **Development of efficient marketing structures in Kenya is likely to lead to growth in vegetable production which should, consequently, increase the demand for seed. This is likely to create opportunities and incentives for increased investment in the seed sector.**

The role of supermarkets in marketing vegetables in Kenya

Over the past 5 years, the two major supermarket chains in Kenya - Uchumi and Nakumatt - have grown from minor players to an important force with a 20% market share of urban food retail markets and nearly 50% of the supermarket sector (Neven and Reardon, 2004). Their market share is expected to grow by about 18% per year for the next 10 years. It is estimated that supermarkets in Kenya buy and sell approximately 60–70,000 t of fresh fruit and vegetables (FFV) per year, worth approximately \$15–18 million (about 4% of the total domestic market).

Uchumi, for example, has 27 stores in Kenya, of which 16 are in Nairobi, and one hypermarket in Kampala. FFV represented 7% of their total sales of KSh 8 billion in 2002 and 70% of all FFV sold through supermarkets in Kenya. The variety of FFV sold by Nakumatt and Uchumi is less than that sold by UK supermarkets but each carry upwards of 80 horticultural products in the fresh produce section of their Nairobi stores, including produce from Kenya, imported produce, and processed vegetables. Each has ambitious expansion plans, with Uchumi planning to reach 50 stores within five years (Neven and Reardon, 2004).

The two major supermarkets are regularly improving the efficiency of their procurement systems for FFV in order to reduce costs (Neven and Reardon, 2004). Until recently Uchumi sourced about 50% directly from growers (25% medium-size; 15% commercial; 10% smallholder); about 45% from brokers; and 5% imported. Uchumi also buys a small amount of packaged vegetables from the export company Sunripe. Nakumatt continues to utilize the services of specialized wholesalers but has moved away from the Mugoya Vegetable Shop to Fresh & Juicy which sources 60% of its vegetables from

smallholders. Most farmers supplying vegetables to these supermarkets live within 50 km from Nairobi.

Due to economies of scale and price competitiveness, Uchumi is now transitioning to increasingly rely on a small group (core of 100) of large suppliers referred to as “preferred suppliers” (Neven and Reardon, 2004; Peter Nderu, Uchumi, pers. comm.). These farmers have good infra-structure e.g. reliable water supply and/or irrigation system and assured and consistent product quality and supply so that procurement and transactional costs are likely to be reduced. Uchumi is therefore moving away from traditional brokers, long supply chains and reliance on smallholders. This could lead to marginalization of smallholders from supplying supermarkets unless interventions are made so that smallholders can remain in the sector. **These must include capacity building in good agricultural practices to achieve required quality and in business and organizational capability to interact with supermarkets.**

Nevertheless, there do exist opportunities for smallholders to move into niche products not currently exploited by larger farmers. For example, Family Concern, a private company combining development and business needs in the horticulture sector, has built capacity among smallholders to supply Uchumi’s Ngong hypermarket with high quality indigenous leafy vegetables (Neven and Reardon, 2004). Similarly, Iga Muka, a 30-member farmers association in Sangana on the slopes of Mount Kenya, supplies Uchumi with small quantities of high quality strawberries. Thus, the main supermarkets in Kenya are interested in identifying ways in which smallholders can continue to be part of their supply chain. This further reinforces the opportunities for improved pest and disease resistant vegetable varieties that meet quality requirements to be marketed in supermarkets.

2.5 Major constraints affecting the domestic vegetable supply chain

The major constraints affecting Kenya’s traditional domestic vegetable supply chain include:

- long supply chains with small volume transactions;
- inadequate market information especially for smallholders;
- inadequate organization among smallholders;
- market power mainly in the hands of traders and middlemen;
- poor transport systems and large distances from markets;
- poor standards and quality control;
- little or no product innovation; and
- high levels of inefficiency

These major constraints in the domestic vegetable supply chain will also need to be addressed in parallel with technical constraints if the full potential contribution of varietal improvement and improved seed systems is to be realized.

3. The domestic vegetable seed sector

3.1 The seed sector in Kenya

The seed sector in Kenya is made up of formal and informal components. The formal seed sector consists of public and private entities involved in the production and distribution of seed. The Kenya Plant Health Inspectorate Services (KEPHIS), created in 1996 under the State Corporation Act, has the responsibility for coordinating the introduction of all seed into Kenya as well as undertaking seed certification (see Chapter 5 – Current regulatory framework).

After independence, the Kenyan Government controlled the formal seed sector. Only the Kenya Seed Company (KSC) (created as a private company; then taken over by the government; and now partly privatised) was allowed to produce, import and distribute seed in Kenya. Although the KSC predominantly produced maize seed at its Kitale station, it also began importing vegetable seed, mostly from Europe. The distribution of seed to farmers was through a small number of approved distributors and sub-agents. The system was inefficient and many farmers were unable to access seed.

The formal seed sector was liberalized in 1991 as part of the structural adjustment program sponsored by the World Bank and International Monetary Fund. Private companies and organizations were licensed to produce and import seeds subject to minimum quality standards as specified by the Plant and Varieties Act, Cap. 326. All seed imported or locally produced must meet these standards. During the past decade, there has been steady growth of seed companies selling seed of a range of crops, including imported vegetable seed, especially of cabbage and tomato.

The informal seed sector consists of NGOs and other groups who multiply seed for distribution to farmers, and farmers who produce seeds for their own future use or for exchange with other farmers (Lutta et al. 2003). The informal seed sector operates outside the authority of KEPHIS and therefore seed is not tested for quality. In Kenya, the most important vegetable grown from seed produced by the informal sector is kale. It is estimated that as much as 30% of kale seed used by smallholders in Kenya is produced by the informal sector. In addition, much of the seed used in Kenya of indigenous leafy vegetables also originates from the informal sector although seed produced by AVRDC (public sector) and linked public sector organizations (e.g. FAO, Tengeru Horticultural Research Institute etc.) in Tanzania (see below) may be used by farmers in Kenya.

3.2 The vegetable seed sector in Kenya

Seed companies and characteristics of common vegetable varieties sold

Kenya has 42 registered seed companies, of which 26 are licensed to sell seed of horticultural crops. This group represents the formal vegetable seed sector as currently, as far as the study team could determine, there are no public sector activities in multiplication of seed of commonly grown vegetables (e.g. tomato, kale, cabbage and onion) in Kenya. Most seed companies have headquarters in Nairobi due to better infra-structure including telecommunication facilities. These include local companies such as Simlaw (part of KSC) and the East African Seed Company; subsidiaries of international companies e.g. Regina (part of Seminis); and South African companies e.g. Hygrotech. The study team sought information from the above mentioned seed companies (and others) as well as from the Seed Traders Association of Kenya (STAK). Feedback from STAK is also included in Chapter 5 – Current regulatory framework.

Table 3.1 shows the percentage of vegetable seed sold (volume) by four Kenyan seed companies and one agricultural supply company. The majority of seed companies surveyed indicated that vegetable seed was profitable but it was necessary to sell seed of non-horticultural crops and, in some cases, other agricultural inputs, to sustain themselves.

Table 3.1 Percentage of vegetable seed sold (volume) by selected Kenyan seed companies

Seed company	Volume of seed %
East African Seeds	36
Regina	29
Simlaw	12
Amirani	11
AgroVets	5

All seed of commonly grown varieties of cabbage and tomato sold in Kenya is imported from Europe, USA or South Africa. Imported varieties popular with smallholder farmers include cabbage varieties Gloria F1 (also known as Green Boy and Victoria) and Copenhagen Market and tomato varieties Cal J, Roma and Moneymaker. Lack of resistances to common and serious diseases are considered to be the major problems with commonly grown varieties of tomato and cabbage both by farmers and by seed companies. For onion, the main problem is poor storage capability.

Table 3.2 Characteristics of common vegetable varieties grown by smallholders in Kenya

Crop/variety	Origin	Release date	Main constraint
Gloria F1 cabbage	Daehnfeldt	>20 years	Black rot
Copenhagen Market cabbage	Denmark	1909	Black rot
Sugarloaf cabbage	?	1726	Black rot
Golden Acre cabbage	USA	1923	Black rot
Cal J VF tomato	USA	>30 years	Blight
Moneymaker tomato	UK	>30 years	Blight
Roma VF tomato	USA?	>30 years	Blight
Marglobe tomato	USA	1917	Blight
Onyx tomato	Russia	>30 years	Blight
Bombay Red onion	India	>20 years	Poor storage
Texas Grano onion	USA	1944	Poor storage
Red Creole onion	USA	>20 years?	?

As Table 3.2 shows, varieties of cabbage, tomato and onion commonly grown by smallholders are at least 20–30+ years old. All of these varieties were bred outside Kenya and are not adapted to the prevailing serious biotic constraints, including black rot and blight. Some vegetable varieties more than 100 years old, e.g. Sugarloaf cabbage, are still being offered for sale to smallholders in Kenya. Some varieties are sold under different names by different companies e.g. Gloria F1 cabbage is also sold as Green Boy F1 by Hygrotech and as Victoria by Regina. Smallholder farmers may not be aware that they are buying the same variety.

Some seed companies are beginning to sell hybrid varieties which are more recently developed. For example, Simlaw markets Markanta F1, Riama F1 and Pruktor red cabbage as well as two tomato hybrids – Kentom 1 F1 (tolerant to bacterial wilt and resistant to TMV) and Kentom 2 F1 (resistant to Tobacco Mosaic Virus) – bred in Kenya; East African Seeds sells Riama F1 and Domingo F1 tomato; Hygrotech markets Markanta F1, Riama F1, Domino F1 and Kwalata F1 tomato; while Regina sells cabbage F1 hybrids Green Challenger, Amigo, Savoy Saga and Red Dynasty as well as tomato F1 hybrids Domingo, Kwalata and the recently released variety Eden. However, to produce a cabbage variety with disease resistance is not enough. Markanta F1 was bred for improved black rot resistance. In spite of the advantages of resistance, this variety's taste is not preferred by local consumers. This emphasizes the need to build resistances into preferred types as Regina has done for the Eden F1 tomato which has similar good shelf-life characteristics as the old favourite Cal J. Although a specific survey was not carried out, farmer surveys failed to find any smallholders growing these new hybrids

even though significant numbers of smallholders in peri-urban Nairobi grow the older Gloria F1 cabbage. Further study is required to determine if the uptake is as limited as available information indicates and the reasons for lack of uptake.

Table 3.3 Retail prices of common varieties of vegetables in Kenya

Crop	Variety	Landed Cost US\$/kg	Pack Size g	Retail price KSh for four companies			
				HEA*	Kenya Seed East Africa	Regina	(Simlaw)
Tomato	Cal-J VF	39:30	10	90	185**	90	105
			100	670	670	650	690
			1000	6400	4185	5000	6400
	Money-maker	28:50	10	80	160**	80	120
			100	580	540	600	830
			1000	5600	3000	4800	6905
	Roma VF	15:00	10	70	185**	80	100
			100	440	670	600	650
			1000	4100	4185	4800	6030
	Rio Grande	38:00	10	90	-	80	-
			100	620	-	600	-
			1000	5000	-	4800	-
	Domingo F1	1077	10	1590	-	1400	1590
			100	15600	-	9600	15610
	Kwalata F1	1077	10	1590	-	-	1590
			100	15600	-	-	15600
Cabbage	Copenhagen Market	7:20	10	40	40**	20	50
			100	150	140	150	185
			1000	1240	800	930	1565
	Sugarloaf (Cape Spitz)	1:80	10	30	45**	20	-
			100	100	130	106	-
			1000	630	715	650	-
	Gloria F1 (Green Boy, Victoria)	234:00	10	370	400	400	360
			100	3100	3200	3200	3050
			1000	30000	n/a	30000	26110
	Riama F1	170:00	10	400	400	400	-
			100	3200	3200	3200	-
			1000	30000	n/a	n/a	-
	Markanta F1	170:00	10	350	400	-	-
			100	3000	3200	-	-
			1000	28800	n/a	-	-
Kale & Collards	Thousand Headed	11:70	10	45	55**	25	50
			100	180	195	180	180
			1000	1500	1100	1200	1265
	Georgia	4:00	10	35	30**	20	-
			100	100	95	90	-
			1000	880	500	550	-
Onion	Red Creole	9:80	10	55	110**	55	75
			100	300	400	400	395
			1000	2650	2800	2500	3385
	Bombay Red	8:00	10	40	110**	35	-
			100	300	330	240	-
			1000	1800	1800	1500	-
	Comet (~ Red Comet)	40:00	10	135	-	-	135
			100	985	-	-	985
			1000	8365	-	-	8365

* Hygrotech East Africa; ** Retail prices for 25g (10g pkts not sold)

Most seed companies import vegetable seed in bulk and repack it in sachets or tins ranging from 10g to 1kg (Table 3.3). For a given vegetable variety, seed is marketed under the individual company's brand name or the brand name of the parent company. Information provided on the label of each seed package is regulated by KEPHIS. Most seed companies market both OP varieties and hybrids.

All seed companies fix vegetable seed prices independently and determine the margins to distributors and retailers. The margins vary from 32–28% for wholesalers and 16% to 18% for retailers. Table 3.3 indicates that for some varieties the cost of seed varies considerably e.g. Simlaw sells 1kg Moneymaker for KSh 3000 while Regina charges KSh 6905. Smallholder farmers could reduce seed costs by seeking the best prices. But buying cheaper seed may not necessarily ensure quality. All the seed companies set minimum financial requirements that seed retailers or wholesalers must meet before being allowed to sell their products. All companies surveyed were members of the Seed Trade Association of Kenya (STAK) (see below). This should provide an avenue for greater co-operation across the sector. All seed companies identified carriage, insurance and freight (CIF), taxes, operational costs and exchange rates as the main factors determining seed prices.

OP varieties are much less expensive than hybrid varieties and are therefore more affordable by smallholders (Table 3.3). This cost differential applies even to older hybrid varieties e.g. the popular Gloria F1 cabbage. Its seed is substantially more expensive (25–30+ times) than the OP varieties Sugarloaf and Copenhagen Market. The most expensive seed of common vegetable varieties marketed in Kenya is hybrid tomato seed which is 3–4 times as expensive as older OP varieties Cal J, Moneymaker and Roma. **A key issue facing future local vegetable seed production will be to produce affordable improved hybrids or price may be a major barrier to adoption.**

Based on feedback from farmers and the MoARLD, the quality of vegetable seed sold in Kenya of commonly grown vegetable varieties is often poor (low germination, uncertain varietal fidelity, off-types, wrong crop etc.). Seed sold in small sachets of 10–25g (more affordable by smallholders) is often of poorer quality than that sold in 1 kg tins. A representative of the MoARLD noted that vegetable seed from Regina is the highest quality available in Kenya but can cost as much as ten times as much as seed from other companies. According to KEPHIS, possibly only 12 companies are selling seed of sufficiently acceptable quality: too many companies survive due to lack of farmer awareness of seed quality traits. There is no farmer compensation system if farmers lose crops due to poor quality seed. **This issue needs to be addressed if a local vegetable seed sector is to be established in Kenya.**

Seed companies distribute seed through a network of wholesalers (distributors) and retailers (stockists) using vans and small trucks. Some seed companies deliver seed through courier services. All seed companies stated that field staff, stockists and distributors are their most important sources of market information. Other sources of information cited were the media, government ministries and research institutions. All seed companies undertake promotional activities, especially for new varieties, through demonstrations or farmer field days also using posters and the media.

Constraints faced by seed companies

All seed companies said that a significant capital investment was required to enter the seed sector including infra-structure for storage and processing facilities. Other conditions for entry included registration with KEPHIS and annual licences from the Government and local authorities to sell vegetable seeds. Seed companies identified a number of constraints to growth in the vegetable seed sector (Table 3.4). These constraints will affect the growth of a competitive seed industry if they are not addressed.

Additional consultations with several seed companies also identified the lack of linkages with public sector breeders (access to germplasm and links to public sector breeding programmes) as a major constraint to development and uptake of improved vegetable varieties in Kenya. In general, the seed companies view was that the public sector lacks appreciation of the practical problems faced by the

commercial sector and that there was a perceived lack of interest by public sector institutes in promoting technologies (e.g. onion, carrot and cabbage seed production) and new varieties to seed companies. In the past, Simlaw has screened blight resistant tomato lines from AVRDC, Tanzania and has had linkages with the tomato breeder at Jomo Kenyatta University and with breeders at KARI-Thika while East African Seeds has had links with Professor van Rheenen at Moi University, for screening improved lines of French bean. For various reasons, these linkages are no longer active. **A major initial activity of any project to develop the local vegetable sector in Kenya will be to build awareness, trust and sound linkages between public sector breeders and private sector seed companies.**

Table 3.4 Constraints faced by seed companies

Constraints	Respondents %
Low quality seed	57
Varietal susceptibility to diseases and pests	57
Poor infrastructure e.g. roads	57
Sale of fake seed in the market	50
High capital investment and operational costs	43
Government regulations	43
Land fragmentation	43
Lack of capacity among stockists	43
Low demand for vegetable seed	43
Lack of commercialisation of vegetable farming	29
Low yield of vegetables due to poor husbandry	29
Cross border non-tariff barriers	29

Several seed companies e.g. Simlaw and East African Seeds also raised an emerging and potentially serious development for future production of domestic vegetables by smallholders in Kenya. Reliance on large overseas companies for imported vegetable seed of popular open pollinated (OP) varieties of tomato and cabbage may be jeopardized by company plans to phase out production of these varieties and move entirely to hybrids. The seed of hybrids is likely to be more expensive than that of OP varieties, based on current information. It is expected to become increasingly difficult to access seed of old OP varieties within the next 3–4 years. According to KEPHIS, recently imported seed lots of OP varieties of tomato and cabbage have been of poor quality suggesting that remnant stocks of old seed is making up an increasing amount of the imported seed (see Chapter 5 – Current regulatory framework). **On the other hand, this development could be an opportunity: providing a major incentive to investment in and growth of the local vegetable sector in Kenya, initially based on producing affordable OP varieties.**

Seed Trade Association of Kenya (STAK)

STAK (Seed Trade Association of Kenya), formed in 1982, is an important forum for exchange of information among seed companies. It has been funded by USAID for the past 6 years. Of the four original members, 3 were vegetable seed companies, thus there has been a long association between STAK and the vegetable seed sector. After seed liberalization in 1991, membership grew and STAK became a more formalised body in 1999 with the creation of an independent office and a secretariat. It now has 24 members e.g. seed companies and associate members such as Moi University. The STAK

offices are adjacent to those of the African Federation of Seed Trade Associations and both associations work closely together.

STAK's main aim is to lobby government for improved seed regulations and policies, especially to reform legislation so that it is commensurate with a liberalised and viable seed industry. It works with the MoARLD and KEPHIS. It endeavours to give the seed companies more power in dealing with constraints within the system. The main focus is on benefits to the members but some companies highlighted the need to set longer-term directions and agenda.

STAK is also the secretary of a committee set up by the Eastern and Central Africa Programme for Agricultural Policy Analysis (ECAPAPA) under the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) to facilitate the simplification and harmonization of seed regulations and legislation in the ECA region. It is hoped that this process will strengthen the voice of national seed traders associations to provide incentives for growth of private sector involvement in the seed sector in the region (see below).

Most Kenya seed companies, STAK, and one public sector breeder consulted by the study team indicated that the current regulatory system is a significant constraint to the operations of existing companies and a major potential constraint to the growth of the vegetable seed sector. The regulatory system is considered to be complex, draconian and over-regulated and KEPHIS is perceived to lack capacity, expertise, and competence (see Chapter 5 – Currently regulatory framework). There is a need for capacity building, guidance and supervision of quality control. Farmers' needs for a guarantee of quality, availability and affordability are apparently not being met by the current vegetable seed system.

The case of kale seed production in Kenya

In contrast to tomato and cabbage, much of the kale production in Kenya is from seed produced locally. Up to 100 t of seed of popular local kale varieties is produced in Molo (Nakuru district) each year by farmers contracted to East African Seeds, Simlaw and other seed companies. This is largely used by the Kenyan market although it is likely that some is also used in neighbouring countries. Farmers in Molo also produce seed for the informal sector. In Kinale (Kiambu district), kale seed produced by farmers is mainly used within the informal seed sector. It is estimated that about 30% of kale seed used by smallholder farmers in Kenya originates from the informal sector. One of the main reasons why the informal kale seed sector is so strong in Kenya is because most kale varieties sold by the formal sector in Kenya do not have the characteristics desired by a significant number of farmers and consumers namely: long harvesting period; height of 2+ m; thick strong stems; and broad strong leaves.

Ten kale seed growers in Molo were interviewed. Sixty percent of farmers were contracted by seed companies; 20% produced seed for their own use, to share with other farmers or in addition to the main vegetable crop; while 20% purchased seed from stockists or markets. Contracted farmers were provided with basic seed, extension services, inspections, and credit for farm inputs by the seed companies. All kale seed growers contracted to seed companies registered their fields with KEPHIS for inspection (including phyto-sanitary). Non-registered seed farmers' fields were not inspected by KEPHIS.

All kale seed growers in Molo applied fertilizer and pesticides to control pests and diseases. Only 25% of farmers applied manure and used irrigation. All farmers identified pests and diseases as the main constraints to kale seed production, in spite of the technical assistance provided by the seed companies. Other constraints included: unreliable weather conditions (85%); lack of capital to purchase farm inputs (75%); lack of markets for seed (55%); lack of seed production knowledge (45%); and lack of water (25%).

This model of kale seed producers linked directly to seed companies through contracts indicates that smallholders can be part of the formal seed sector for vegetable seed production in Kenya. They can be given assistance to access basic quality seed and receive technical support during seed production. Such support will help to ensure that high quality seed is produced. Because kale seed production is highly concentrated geographically (due to climatic requirements), farmers' fields producing seed for the formal sector are often adjacent to fields producing seed for the informal sector. There is potential for spill-over of improved technologies to the informal sector if support is available. KEPHIS could also widen its activities to include seed growers in the informal sector, to the benefit of the sector as a whole.

In a survey carried out in Kinale among 129 farmers producing kale seed for the informal sector, Njuki et al. (2003) also identified susceptibility to diseases and pests and low germination (probably related to disease and pest damage) as important constraints faced by farmers. Bird damage, seed shortages, and impurities were also considered important constraints. Back-up support from public sector research institutes, similar to that provided by the private sector to contracted farmers, would help farmers to deal with these constraints and to produce higher quality seed. Currently, a project (R8312) funded by the DFID Crop Protection Programme and implemented by KARI, CABI and KEPHIS, supported by CSL and Warwick HRI UK, is assisting farmers in Kinale to produce higher quality seed through selection, characterization and cleaning-up and also to improve seed multiplication methods. This project is likely to provide useful insights into varietal development of kale - there has not been any previous effort to select superior lines within the natural variability present in kale landraces in Kenya – and for improved seed production and marketing within the informal sector. Potential promotional pathways include the establishment of a seed production and marketing cooperative and licensing the variety/ies to the public or private sector. This project on kale could also provide models for improving indigenous vegetables which have also received limited research input to date.

3.3 Experiences from the vegetable seed sector in other countries in East and southern Africa

Some information was gathered on experiences from the seed sector and seed companies in Tanzania, Zimbabwe and South Africa. In comparison to the wealth of information obtained from Kenya where most effort was concentrated, the study team notes that it is incomplete and, in some cases, obtained from secondary sources. This information does provide, however, some insights into how the vegetable seed sector operates in other countries and possible opportunities for future work in Kenya and collaboration amongst various countries.

Vegetable seed sector in Tanzania

In Tanzania, liberalization of the seed sector has had positive impact on the vegetable seed industry during the past ten years (Mutuku Muendo et al., 2004). Prior to liberalization, permits and licenses for importing seed were difficult to obtain. Large amounts of vegetable seed were imported by NGOs through the Ministry of Agriculture for sale to farmers at subsidized prices. Subsidiaries of several Dutch private companies (e.g. Pop Vriend, Sluis Brothers, Rotian Seed etc.) were given permits to import vegetable seed, but the process was tedious and relatively small quantities were imported. Competition from NGOs selling subsidized seed undoubtedly hindered the development of a viable private seed sector. One advantage of liberalization was streamlining of the importation process. Currently, most vegetable seed imported into Tanzania is through commercial channels. Seed testing is carried out by the Tanzanian Official Seed Certification Agency (TOSCA) (Mutuku Muendo et al., 2004). Its mandate is to ensure that seed produced locally and also seed imported into Tanzania meets the required quality standards and approved regulations. The testing is quite stringent, to avoid dumping.

Local vegetable seed production is expanding in Tanzania (Mutuku Muendo et al., 2004). This began prior to liberalization, but has taken on a new dynamic since. Arusha is the main center for vegetable seed activities. The Ministry of Agriculture established a seed production unit under the National Vegetable Seed Program. The unit is located at Tengeru Horticultural Research Institute (THRI), is

staffed with seed production technologists and breeders, and is mandated to produce vegetable seed for the country. It has linked with companies such as Alpha Seeds to help in the distribution of the locally produced seed.

Table 3.5 lists vegetable varieties being multiplied by the seed unit. With regard to the problems identified in Kenya (see below), it should be noted that varieties of cabbage, onion and tomato are being multiplied in Tanzania. Some of these varieties are old e.g. Sugarloaf cabbage, Moneymaker and Roma tomatoes; some varieties were bred/selected in Tanzania e.g. Tengeru 97 tomato and Mangola Red onion; while some are local varieties of indigenous leafy vegetables. The seed unit is also multiplying improved hybrid varieties of tomato from the Regional Center for Africa of the Asian Vegetable Research and Development Center (AVRDC-RCA) programme (see below).

The vegetable seed production program initiated by FAO in the early 1990's has been handed over to the seed production unit and is functioning successfully. This includes some indigenous leafy vegetables such as amaranth and nightshades (see below). There is also an on-farm seed production program on seven vegetables in which extension agents train farmers in the production of quality-declared seeds, and inspect the seed for quality. A similar program in Mangola, which trained farmers in quality onion seed production, for themselves and linked to seed companies, developed the Mangola Red variety from Bombay Red onion, with higher yield and a longer storage life (Mutuku Muendo et al., 2004).

Table 3.5 Seed production of vegetable varieties in Tanzania

Crop	Varieties
Tomato	Tengeru 97*, Moneymaker, Roma, Tanya
Cabbage	Sugar Loaf
Onion	Bombay Red, Mangola Red*
Okra	Pusa Sawani
Cucumber	Ashley
Water Melon	Sugar Baby
Amaranth**	Mchicha Wa-Unga, Nyeupe
Black Nightshade**	Mnavu, Loshuu local, Ngowe Tengeru White
African Eggplant**	Black Beauty

Source: Tengeru Horticultural Research Institute; * Varieties bred in Tanzania; ** Indigenous vegetables

On-going and increasing effort is being directed at germplasm collection, evaluation and selection, and seed production of various African indigenous vegetables (AIVs), building on the efforts of the FAO programme during the 1990s. Various projects (funded by/through DGIS, AVRDC, IPGRI, Gatsby and Rockefeller [through the Maendeleo Agricultural Technology Fund]) are active in the region involving THRI, AVRDC-RCA, IPGRI, Family Concern, Farm Africa and others. There are several aims a) to collect and conserve the variability among AIVs; b) to support sustainable production through selection of better varieties and production; and c) to improve seed supply and marketing. There appears to be a growing need for a level of coordination among these projects as there is increased risk of duplication of effort and waste of resources. AVRDC-RCA has an important germplasm collection of AIV's (>1,000 lines). AVRDC-RCA is also planning a workshop on AIV's in Arusha in May 2006 depending on funds.

Table 3.6 Common African indigenous vegetables under evaluation

Common name	Scientific name
Amaranth	<i>Amaranthus</i> spp.
Ethiopian kale	<i>Brassica carinata</i>
African nightshades	<i>Solanum nigrum</i>
Spider plant	<i>Gynandropsis gynandra</i>
African eggplant	<i>Solanum</i> spp.
Jute mallow	<i>Cochorus olitorius</i>
Spinach	<i>Basella alba</i>
-	<i>Asystasia gangetica</i>
Pumpkins	Cucurbitaceae
Okra	<i>Hibiscus esculentus</i>
Rattlebox	<i>Crotalaria brevidens</i>

Regional Center for Africa of the Asian Vegetable Research and Development Center

In addition to improving 10 African indigenous vegetables, AVRDC-RCA gives priority to the promotion of the vegetable seed sector and to capacity building in vegetable technology. They will also work on improvement of tomato, soybean, cowpea, onion, cabbage and capsicum (further information is provided in Chapter 4 – Vegetable breeding capacity).

The main capacity building activity carried out at RCA is an annual 5 month residential course on all aspects of vegetable production, marketing and seed technology. It also includes a field project also carried out at RCA (this is used to provide extra research capacity). Core funding pays for 24 trainees from Africa each year. Several PhD and MSc students registered at a number of Universities e.g. Gottingen do field work at RCA. **This is a useful training facility that could be more widely used for the region.**

The RCA site has increased its land area for trials in the past few years. These include new material under evaluation; large germplasm collections of some species (e.g. 90 different African nightshades); agronomy and breeding trials. RCA's capacity for seed production and processing has also increased with 2 tonnes of seed produced each year, much of this is given away to farmers and NGO's. Some institutes and NGO's make special arrangements for seed multiplication for special projects. Although such subsidized seed production and free seed promotes materials to farmers thus enhancing uptake, it is not conducive to growth of the private seed sector and a sustainable vegetable seed sector.

To date, NGOs and NARS have been the main uptake pathway used by AVRDC-RCA for vegetable seed. In addition, 5,000 Tanzanian farmers have been trained in vegetable seed production technologies. In the future, AVRDC-RCA is planning to give priority to enhanced linkages with the private seed sector as part of its focus on the promotion of the vegetable seed sector. The Rockefeller Foundation will fund an initiative to release vegetable varieties into the commercial sector from 2005 (there are 45 potential varieties in the pipeline). The initial focus will be in Tanzania, Kenya and Uganda. MTAs will be set up with the private sector companies.

AVRDC-RCA is also working on improvements in the marketing of vegetables. Consultations have been carried out with farmer focus groups to provide information to inform retailers about farmer preferences for vegetable varieties. This also develops partnerships between suppliers and retailers whereby producers become preferred suppliers. Suppliers have also been trained in processing and packaging for the retail market.

AVRDC-RCA has recently proposed the creation of a vegetable network in Eastern and Central Africa based on varietal development and improved seed systems. Although ASARECA support this

proposal in principle, they currently do not have funds. Due to the complexity of the vegetable sector in East Africa; the large number of stakeholders involved; and the increasing number of individual, uncoordinated projects there is increasing potential for duplication of effort and waste of resources. A vegetable network would help to establish much needed coordination in this sector.

The development of a horticultural network under ASARECA was proposed by the GTZ IPM Horticulture Project based in ICIPE in 1997. During 1997 and 2000, several regional meetings were held; interest was shown by most countries involved; and a comprehensive joint research and development programme was written including links with the private sector. Unfortunately due to the inability of several country and institutional representatives to agree, the initiative collapsed.

Today, there is as much and even more critical need for a network to improve coordination and enhance linkages among the plethora of horticultural research and development projects currently in progress in East Africa. However, more thought is needed on the structure, coverage, function and membership of the network in consultation with all major stakeholders. A network narrowly focussed on varietal development and seed systems may not effectively address the broader needs of the sector, and as a result, reduce the potential contribution from improved varieties and seed systems. This is discussed in more detail in Chapter 7 – Summary, conclusions and recommendations.

Seed company in Tanzania

A visit was made to a vegetable seed company in Arusha. Enza-Zaden Africa Ltd. (E-Z) is a subsidiary of a Dutch seed company Enza-Zaden NL based in Arusha (like other Dutch seed companies e.g. Rijk-Zwaan, Pop Vriend etc.). E-Z has established a new seed multiplication site (February 2004) in Arusha. Expansion is planned if the initial efforts are successful as Tanzania is viewed as a “positive investment environment” for Dutch companies. E-Z works closely and effectively with TOSCA (in contrast to seed companies and KEPHIS in Kenya). E-Z previously carried-out vegetable seed multiplication in Kenya but this was not successful.

E-Z NL sends the parent lines to Tanzania; these are grown up in vector-proof polythene houses and crosses performed. Seed is harvested and partly processed before being sent back to E-Z NL. The production greenhouse is 1.5 ha and is multiplying tomato and cucumber seed. Currently E-Z is not carrying-out a full breeding programme for Africa but some basic breeding work is planned for the future. E-Z will send out lines for crossing and a breeder will visit for selection. An important target for African tomato is bacterial wilt resistance. E-Z is talking to AVRDC about access to their lines. The facility is also used to grow out seed from other production sites for quality control and this will be expanded outdoors in future.

Seed companies in Zimbabwe

Two companies were visited: Hygrotech, a subsidiary of Hygrotech – South Africa, active in Zimbabwe for 10 years, with a newer subsidiary in Kenya (see above) and East-West Seed (E-WZ), a subsidiary of East-West Seed International (E-WI), a successful vegetable seed company established in SE Asia more than 20 years ago. E-WI is reviewed in more detail in Chapter 6 – Initiatives to improve local vegetable production.

- Hygrotech-Zimbabwe

Hygrotech-Z is a supply and distribution company focused on large-scale commercial farmers and markets expensive, high quality hybrid seed. All seed is imported through the South African parent company. They have limited capacity and no breeding is carried out in Zimbabwe. Most of the major vegetable export companies have now left Zimbabwe (moving to Zambia and Mozambique) and Hygrotech-Z is having a difficult time. Seed companies are no longer importing seed; the demand for hybrid seed is low; and due to official exchange rates, the cost of imported seed is effectively 30% higher.

According to Hygrotech-Z, some seed companies currently operating in Zimbabwe have their own breeding and seed multiplication programmes and export seed throughout the SADC region and Kenya. They produce low quality seed of OP varieties for the smallholder market including squash, cabbage, kale, onion and tomato. Other seed companies are importing additional OP varieties. There is also increased promotion of farmer-saved seed schemes.

Recent agrarian reforms in Zimbabwe and the move to smaller farms and “new” farmers limits multiplication potential. Seed regulations have also become more difficult to manage. At the same time, the new farmers and the Government are desperate for seed. The situation has become very political with the GoZ becoming suspicious of seed companies. There is a huge challenge to train new farmers and supply necessary inputs (including seed) but there is little donor or NGO support available in Zimbabwe now.

Where seed production infra-structure is available and the demand high, however, some farmers have initiated glasshouse tomato production using indeterminate varieties with some success. **In the case of tomato, the main problems are root knot nematode, viruses and fungal diseases, which should be the targets of future breeding programmes.**

- East-West Seed, Zimbabwe

After the establishment of a successful vegetable breeding and seed production company in SE Asia, E-WI set-up a subsidiary in Zimbabwe in 2001, based at the Agricultural Research Technology (ART) farm on the outskirts of Harare. Zimbabwe was selected due to lack of access to improved vegetable varieties (thus huge opportunities); lack of competition with other companies compared with South Africa and Kenya; a suitable climate for agriculture and seed production; high standards in agricultural production and good farming knowledge (in 2001); and good infrastructure. Following the recent collapse of the agricultural sector in Zimbabwe, in retrospect it might have made a different choice today. E-WZ has one experienced breeder in addition to the manager.

After exploring the best opportunities for breeding and marketing vegetable seed, E-WZ developed a strategy for Zimbabwe based on the E-WI experience in SE Asia. This involves identifying farmers’ needs in terms of crop and constraint combinations and establishing a market base by initially introducing a choice of productive varieties from Asia. This was initiated in 2004 in one province with OP and hybrid varieties. The response to the new varieties has been positive as farmers have rarely had access to such varieties before. Variety trials are being carried out to compare local varieties with improved varieties and the best varieties will be marketed. The next step will be to initiate crosses to provide further improved OP varieties and then develop hybrids.

The experience in SE Asia indicated that the process of farmer uptake and adoption of hybrids was stepwise and took time. The most successful approach was to introduce hybrids to farmers who had successfully adopted improved OP varieties and this will be followed in Zimbabwe. It was hoped that a market would be developed through an established seed company, but due to lack of suitable partner, E-WZ will market seed directly to farmers. The next step will be to expand the product line based on the Asian experience e.g. local onions and squash have now been added. It was hoped that links with the Zimbabwe Horticultural Research Centre would be built to build local breeding capacity. Unfortunately, due to bureaucracy and unwillingness of HRC breeders to share information and varieties (possibly due to lack of IPR), E-WZ is restricted to continuing with their own breeding activities.

During the development of varieties of various vegetables, E-WI has had positive interactions with AVRDC in Taiwan. In contrast, this experience has not been repeated with AVRDC-RCA. There is a perception that the AVRDC philosophy in RCA places too much emphasis on producing finished product and not enough on end-user needs.

The current focus of E-WZ breeding activities covers the priority crops: brassicas, onion, cucurbits, paprika, tomato, pumpkin, and carrots with a limited interest in indigenous vegetables (Solanaceae and Brassicaceae). **African kales** are of great interest as the kale currently marketed in Zimbabwe has rough, waxy and tough leaves. Farmers and consumers want improved kale varieties. E-WZ has collected Zimbabwe varieties and brassica and kale lines from elsewhere, including Portugal. Some initial crosses have been made but self-incompatibility problems, especially with Portuguese kale (reported to have black rot resistance), has slowed the work. There is a large demand for commercial butternut squash (*Cucurbita moschata*) which has pushed **traditional squash** (*C. maxima*), a subsistence crop, out of the market. E-WZ has introduced a *C. maxima* pumpkin hybrid that can be grown as a commercial crop but is also preferred by subsistence farmers as both the leaves and fruit can be eaten. It has powdery mildew resistance and partial virus resistance. This shows how important it is to give farmers the varieties that they need.

Paprika is a very important smallholder crop but currently there is no genetic improvement programme in Africa. The targets are resistance to powdery mildew and anthracnose. In Zimbabwe, paprika is a very low input crop but even with low yields, farmers make a living. In South Africa, paprika is a high input crop with drip irrigation, plastic mulch and high yields. Different varieties are needed for these different types of farmers and markets and E-WZ is planning to obtain the appropriate lines/varieties.

For **onion**, E-WZ's main interest is in red varieties to meet African preferences. The targets are breeding for resistance to downy mildew and anthracnose in OP varieties with short day requirement and good storage. E-WZ has extensive trials of onion varieties and accessions (including Warwick HRI Genebank accessions) and segregating populations. All onion seed production is done in SE Asia as onion will not flower in Zimbabwe.

In its attempts to foster linkages with other stakeholders, E-WZ has already identified some constraints in Zimbabwe that may be relevant to other countries in Africa. Although good public sector varieties are being produced by HRC-Z e.g. late-bolting mustard, pumpkin, onion, and indigenous vegetables (e.g. *Brassica carinata*), there appear to be **no functional mechanisms for developing public-private partnership**. Some basic seed is multiplied in Zimbabwe but there appear to be **no incentives for farmers to multiply seed** as they can earn more money by growing vegetables, due to the shortages and high demand. There are no technical reasons why Zimbabwe could not multiply seed of most vegetables commercially but it must be done professionally and farmers need to be trained. There are also expected to be difficulties in developing improved varieties of possibly a very diverse range of vegetables and multiplying seed to meet the **perceived diversity of demands in different countries**. A broad analysis of macro- and micro-preferences in eastern and southern Africa is needed. E-WZ may have to develop a wide product range to suit diverse demands which will take time and effort.

In addition, **vegetable seed is not regulated in Zimbabwe**. There are no plant breeder's rights for vegetables. Although new varieties do not have to be formally tested, they cannot be protected which reduces incentives for private companies. Hence the inherent protection in hybrids is the only option. There are also **constraints on importation of seed**: each importation must be accompanied by an extensive phyto-sanitary certificate; an International Seed Testing Association (ISTA) (Orange) certificate; and certification as GM-free. This is a barrier to seed importation and is currently especially difficult for maize imports. Finally, the recent collapse of the export market in Zimbabwe has affected input availability and support (seed and other inputs) for local vegetable production.

In spite of these difficulties, E-WZ will continue to develop improved varieties and sell vegetable seed in Zimbabwe. E-WZ also plans to explore markets elsewhere in Africa. E-WZ is being allowed to grow by E-WI although the situation in Zimbabwe will need close monitoring.

Seed companies in South Africa

The majority of seed companies in South Africa are importing and testing varieties developed by parent companies e.g. Mayfords Seeds imports Sakata varieties; Stark Ayres imports Takii varieties. Few have active breeding programmes although Mayfords has a small tomato breeding programme and Hygrotech has programmes on French beans and tomato.

In contrast to most companies, the main target market for the Danish company Daehenfeldt is smallholder farmers. The company is already selling a large amount of hybrid seed in Kenya through local companies including Simlaw and East African Seeds. It has recently relocated the majority of its cabbage breeding programme to South Africa as Africa is seen as an expanding market for early cabbage. There are also practical advantages with regard to screening lines against prevailing diseases e.g black rot and pests and increasing the number of generations that can be achieved in a year. By 2005, 90% of its cabbage breeding activities will be implemented in South Africa. The main targets are black rot resistance using marker-based technology and diamond back moth resistance when an improved screening methodology has been developed. However, seed production will continue to be done in Denmark due to on-going doubts about the ability to produce clean seed or hybrids in Africa.

Proseed is a small vegetable breeding company run by Rob Melis who also works for the African Centre for Crop Improvement (ACCI), University of KwaZuluNatal (see Chapter 4 – Breeding capacity). Proseed is breeding fine green beans for rust resistance; tomato and peppers – capsicum, chilli and paprika. Beans are the biggest product and seed is sold to Kenyan export companies such as HomeGrown. There are considerable advantages in vegetable breeding in South Africa (compared to Europe). The labour is cheap; it is possible to breed for local disease resistance; and process two crops each year (three for some crops if one has trials at the coast). Proseed is interested in breeding vegetable varieties for South Africa with potential in Kenya and is seeking a Kenyan partner.

3.4 Major constraints affecting the vegetable seed sector

The major constraints affecting the vegetable seed sector include:

- poor infra-structure especially roads;
- low quality and fake seed;
- old varieties susceptible to diseases and pests;
- high operational costs (especially investment in processing and storage facilities);
- lack of qualified distributors and retailers;
- lack of linkages with public sector breeding initiatives and public-private sector partnerships; and
- over-regulation and lack of capacity in the regulator (considered further in Chapter 5).

These constraints will need to be addressed for the future economic development of the vegetable seed sector in eastern and southern Africa. There appear to be substantial opportunities to increase yields through improved, adapted varieties; high quality and affordable seed; and enhanced knowledge and production skills.

4. Vegetable breeding capacity

Currently available vegetable breeding capacity was assessed in Kenya (most detailed assessment), Tanzania and South Africa mainly through feedback from public sector institutes (agricultural research systems and universities) and the private sector (seed companies) with past and current involvement in the vegetable sector. Some published information was also consulted. The study team also considered the potential capacity available for training in vegetable breeding, seed production and related technology. Priority breeding targets were summarized for commonly grown vegetables. Assessments were made of different vegetable breeding models and of barriers to successful breeding and uptake of the outputs of breeding programmes.

4.1 Vegetable breeding capacity in Kenya

Public sector

In Kenya, only two public sector institutes currently have expertise in domestic vegetable breeding: the University of Nairobi for onion breeding and Jomo Kenyatta University for tomato breeding (Table 4.1). However this expertise is no longer actively deployed in such vegetable breeding programmes. Several institutes have breeding programmes on beans and peas (Table 4.1).

Table 4.1 Vegetable breeding and related skills in Kenyan public sector institutes

Institute	Breeder	Expertise & potential for capacity building	Bred varieties	Current breeding activities
University of Nairobi	Dr Paul Kimani	Onion; bean; pea	Onion varieties released by the University of Nairobi: KON 1, KON 4, KON 6 and KON 7. Described in the onion handbook published by Agric Information Centre, Min of Agriculture (Fifth Edition, 1994). Snap and runner bean F5 lines and advanced lines developed, no releases yet Garden pea advanced lines developed, 1–2 candidate lines	No current activities on onion Snap and runner bean; garden pea breeding programmes linked to CIAT
Jomo Kenyatta University of Agriculture and Technology	Prof. Stephen Agong (now Deputy Vice-Chancellor)	Tomato (mainly breeding research based on publications)	No information was obtained	No current activities on tomato breeding; indigenous vegetables linked to AVRDC
Moi University	Prof. Henk van Rheenen Dr Michael Omunyin	Bean Seed technologist		Snap bean breeding programme

Institute	Breeder	Expertise & potential for capacity building	Bred varieties	Current breeding activities
Edgerton University	Dr Dorcas Isutsa	Vegetable agronomy with emphasis on indigenous vegetables		No vegetable breeding activities
KARI-Thika	Until recently there were two breeders (one was Director of KARI-Thika); currently there are no vegetable breeders at KARI-Thika	Vegetable agronomy	Tomato varieties released by KARI: Kentom 1 F1 and Kentom 2 F1	Possibly activities on snap bean breeding

In Kenya, vegetable research including breeding is undertaken by KARI's Thika Horticultural Research Centre (THRC). The centre carries out basic and strategic research while other centers and the MoARLD specialize in adaptive horticultural research and extension. The lack of linkages between the strategic research and adaptive research and extension has severely hampered delivery of research outputs to farmers and impact. KARI-Thika is mainly funded by the GoK although it also receives funding from donors such as UNDP, USAID, DFID, CIDA, JICA, Netherlands Government and World Bank for specific projects (Mutuku Muendo et al., 2004). KARI-Thika has undertaken a breeding programme on tomatoes in the past however it no longer has any active vegetable breeding expertise. It also has no seed technologist and no operational seed production unit. It currently works on the agronomy of French beans, runner beans, some Asian vegetables and indigenous vegetables. Severe understaffing in horticulture in KARI seriously limits the scope of what THRC can do. In comparison, there are eight maize breeders in KARI distributed in various research centers and targeting different agro-ecological zones in the country.

In March 2004, the GoK presented its "Strategy for revitalising agriculture 2004–14", in which radical reform proposals are presented on how to make the agricultural sector and its supporting research and extension systems more efficient in Kenya's economic development. In parallel, the GoK and the World Bank developed a new project to support the realization of the new strategy – the "Kenya Agricultural Productivity Project" (KAPP). The objective of the KAPP is "to contribute to sustainable increase of Kenya's agricultural productivity and improvement of livelihoods of its rural communities through improved performance in agricultural technology supply and demand system". In particular, the project will endeavour to foster links between research extension (MoARLD) and the private sector in Kenya to improve extension methods and delivery systems. Already the MoARLD has established a secretariat at KARI headquarters to build linkages between the research and extension systems. KARI has developed an Agricultural Research Investment Scheme (ARIS), which has a Business Development Unit that publicizes research activities to the industry and finds out ways through which they can play a role in research programs. Discussions are in progress on building linkages with the private sector. KARI hopes that once trust is built that the private sector will support research in horticulture.

Professor Stephen Agong, Jomo Kenyatta University of Agriculture and Technology, strongly believes that economic development in the vegetable sector in Kenya depends on improved varieties and good quality seed. Although various public sector institutes, especially universities, have been actively involved in vegetable breeding in the past, the system was not conducive to promoting varieties: registration costs were too high and the universities have no experience in marketing seed. Locally

bred, improved vegetable varieties (e.g. Kentom 1 & 2; KON 1, 4, 6 & 7) do not appear to be reaching farmers. The feedback from farmer surveys reported in Chapter 2 supports this.

Where collaboration was attempted with seed companies, it failed because of lack of trust between the public and private sector. Professor Agong feels that urgent attention is needed to educate public sector institutes on how to develop public-private partnerships e.g. how to set up MTA's and negotiate royalty agreements. KEPHIS could collect royalty payments as they have the infrastructure and information bases but he feels that there are currently too few breeders in KEPHIS to administer this process properly.

The Plant Breeders Association of Kenya (PBAK) is fairly active, meets regularly, organises plant breeders' open days and workshops, and holds an AGM. It has the potential to act as the coordinator of an initiative to build public-private sector partnerships to link public sector breeding initiatives with private sector seed companies in Kenya but on Prof. Agong's own admission would need further support to do this. Whether the PBAK has the capacity and/or expertise to carry out this coordination role requires further investigation. The PBAK membership currently includes public sector breeders, KEPHIS and several seed companies. **The Seed Trade Association of Kenya (STAK) is also a member and a joint initiative between PBAK and STAK may be the most appropriate way forward.**

Professor Agong has a strong interest in improving African indigenous vegetables. He feels that this area could possibly provide an economic base for a Kenyan vegetable breeding industry as there should be no competition from foreign companies. However as other groups are already active in this field e.g. AVRDC-RCA (**which is not a PBAK member**) and E-WZ, there is a need for enhanced coordination in order to avoid duplication of effort.

Private sector

Seed companies in Kenya employ professional staff including agronomists as sale representatives in different parts of Kenya and breeders and agronomists for seed testing in their own laboratories. The number of professionals employed varies from two (small to medium companies) to six (large companies) (Wanyonyi, 2004). None of the breeders employed by Kenyan seed companies are currently involved in vegetable breeding programmes but could be considered as a potential resource for future vegetable breeding efforts.

Most international and/or subsidiary seed companies operating in Kenya depend strongly on the technical support from and facilities of parent companies to carry out varietal development. For example, Regina, as part of Seminis Seeds, can call on a comprehensive network of research facilities around the world to breed for resistance to vegetable disease problems in Kenya. Regina is currently screening cabbage breeding lines for resistance to black rot. The source of resistance came from a Korean variety. The best lines will be further developed, then sent back to Kenya for screening, and resistant varieties will be developed. Similarly, Hygrotech relies on breeding support from its headquarters near Pretoria, South Africa for improved varieties of French bean for rust resistance and tomato for virus resistance. Such back-up support reduces the need to establish local breeding programmes by seed companies but could be more costly.

Both Regina and Hygrotech as well as other seed companies in Kenya have excellent trial facilities at main operational sites and numerous demonstration sites throughout the major vegetable production districts of Kenya. Grower awareness of new varieties is developed through field days at demonstration sites. Similar facilities and systems could be utilized if local vegetable breeding programmes were established in Kenya. Regina also provides extension support especially on sound crop management practices for its new and established vegetable varieties. Regina considers that it is worth the effort but realizes that not all growers that receive extension advice will necessarily grow its varieties.

Some seed companies e.g. Regina and Hygrotech work closely with the export vegetable sector supplying French bean seed and other export crops. Hygrotech, however, raised concerns about continued reliance on the export vegetable sector as its main client for seed. A growing problem is that the varieties used by export companies are largely determined by European retailers which may change varieties quickly according to consumer demands. This can leave seed companies with considerable quantities of unsold seed. In contrast, smallholder farmers producing for the domestic sector are more conservative with respect to varietal turnover. This makes the local market attractive to Hygrotech and it is considering developing local breeding programmes. This conservatism is reflected in the continued cultivation of 20–30+ year old varieties such as Gloria F1 cabbage and Cal J tomato, in spite of their susceptibility to prevailing diseases. At the same time this may also be due to lack of awareness of new varieties; inability to afford the seed of new varieties (especially for tomatoes); lack of alternative varieties with farmer- and consumer-preferred characteristics; and other reasons.

Technical feasibility of breeding and producing seed of commonly grown vegetables in Kenya

According to Peter Frampton of Regina, Dr Paul Kimani of the University of Nairobi, and Professor Agong of Jomo Kenyatta University (for seed multiplication), **there are no technical reasons why OP varieties of commonly grown vegetables such as tomato, cabbage, carrot and onion cannot be bred in Kenya and, in addition, quality seed multiplied.** It should be noted that multiplication of seed of tomato, cabbage and onion is being done in Tanzania (see above). However, past attempts by Simlaw and East African Seeds to produce seed of cabbage, carrot and onion in Kenya were abandoned due to difficulty, risk, cost and lack of varietal stability.

Approximately 150 tonnes of kale seed is produced in Kenya annually, mainly in Molo and Kinale (see above). In Western Kenya, there is some production of seed of European, American and Indian varieties of Asian vegetables (e.g. okra, capsicum, eggplant) through farmers contracted to East African Seeds and other companies. There is also some commercial tomato multiplication at Loitoketok and Njoro. With the exceptions of Kentom 1 F1 and Kentom 2 F1, the capability to produce seed of F1 hybrids has not yet tested. It is probable that lack of technical awareness and knowledge; lack of breeding skills and capacity; and lack of communication between breeders and seed companies and generically between the public (KARI, Universities) and private sectors (seed companies) are key factors why companies continue to rely on imported seed.

Capacity building

There is capability for training in breeding and allied disciplines in several Kenyan Universities (Table 4.1). This is dispersed across different universities. For example, good capability for training in onion and tomato breeding exists in the University of Nairobi and in Jomo Kenyatta University of Agriculture and Technology (JK), respectively. JK offers training up to PhD in Horticultural Science which includes vegetable breeding. JK also has funds from AVRDC-RCA to carry out improvement in the indigenous vegetables: *Amaranthus* spp., *Solanum nigrum*, and *Brassica carinata*. The Department of Horticulture, Edgerton University at Nakuru, has capacity to provide training in vegetable agronomy and is especially interested in indigenous vegetables. According to Dr Paul Kimani of the University of Nairobi: Kenya has the personnel to provide training but lacks the development of a coherent programme and the support for training.

Vegetable breeding targets in Kenya

Table 4.2 Key breeding targets in commonly grown vegetables in Kenya

Crop	Target constraint
Cabbage	Black rot (<i>Xanthomonas</i>); wilt (<i>Peronospora</i>);
Kale	Black rot
Tomato	Late & early blight; bacterial wilt (<i>Ralstonia</i>); viruses
Onion	Improved storage; short day

Feedback was sought from public and private sector institutes on the key breeding targets for commonly grown vegetables in Kenya. For cabbage, the major problem is black rot (*Xanthomonas*) with wilt (*Peronospora*) being a major seedling disease. For tomato, the major diseases are late and early blight, bacterial wilt and viruses. Cabbage is also affected by a number of serious pests including diamond back moth, American boll worm and looper. It is strongly emphasized that this should be used for guidance only; feedback from farmers is most necessary.

4.2 Breeding capacity in Tanzania

Horticultural research in Tanzania is mainly done in Tengeru Horticultural Research Institute (Horti Tengeru – THRI) and to some extent in Sokoine Agricultural University (Mutuku Muendo et al. 2004). Although in the past Horti Tengeru had reasonable breeding capacity, it currently has no vegetable breeders or breeding programmes, with the exception of maintaining already bred varieties. It receives funding from the GoT and from donor projects. The current staff complement of Horti Tengeru includes the Officer-in-charge, based in the Selian Centre near Arusha, and seven researchers at Tengeru: one physiologist/seed technologist (MSc) who is involved in some breeding activities and six agronomists (4 BSc, 1 MSc, 1 PhD) of whom two are plant pathologists. Some researchers have collaborative projects with AVRDC-RCA. Horti Tengeru purchased a seed processing unit but this has not yet been installed due to lack of personnel.

AVRDC – RCA is actively involved in screening and selection in a number of vegetable crops but relies on its headquarters in Taiwan to do the actual crossing mainly due to lack of breeding capacity in RCA. It has the advantage of being able to draw on a sizeable genetic resource collection at headquarters. AVRDC-RCA have identified 16 vegetable species for improvement, including 6 exotic species (tomato, soybean, cowpea, onion, cabbage and capsicum) and 10 indigenous vegetables including Amaranthus, Ethiopian mustard, spider plant, nightshades, pumpkin, and okra. AVRDC-RCA works closely with Horti Tengeru and has released two tomato hybrids from AVRDC advanced lines to them.

Rockefeller has recently provided funds to support a full-time breeder at RCA which should make an important contribution. But more support is needed to build capacity in vegetable breeding in national programmes and universities in this region as the current capacity is critically low. Dr Chadha, AVRDC-RCA, feels that AIV's deserve special attention for an improvement initiative although it is not clear what the breeding targets will be.

It is clear that the limited breeding capacity in public sector institutes in East Africa is a very critical issue which severely restricts the development of improved vegetable varieties in this region.

4.3 Breeding capacity in South Africa

Vegetables and Ornamental Plants Institute (VOPI), Roodeplaat

Although, the VOPI was entirely focused on supporting the commercial farmer, in response to the Presidential Imperative Programme, it is now directing its research toward smallholder farmers driven

by black economic empowerment. In the process, the VOPI has withdrawn from breeding most vegetable crops with the exception of some open-pollinated varieties (see below).

In addition to programmes on potato and sweet potato, VOPI has initiated a programme on developing OP varieties of tomato, white pumpkin and beans (rust resistance), the seed of which is expected to be cheaper than hybrids and therefore more accessible to poor smallholders. These crops were chosen because it was felt farmers could produce their own seed relatively easily. Although cabbage and 'spinach' (*Beta* = chard) are widely cultivated in South Africa by smallholders, seed production is considered to be too difficult for farmers. However, tomato is grown widely and is important nutritionally. ARC is also interested in developing small-scale on-farm seed storage to allow farmers to use farm-saved seed. However, as yet they did not appear to have any funding for this work. AVRDC-RCA have indicated their interest to VOPI to collaborate in the OP programme.

VOPI is also interested in improving indigenous crops e.g. Amaranthus which as well as being consumed domestically, has been grown for export to Germany. One aim is to add value to the crop through processing. They are currently carrying-out simple selection of indigenous crops to improve them but this could lead to genetic erosion. There is no genetic conservation programme in place at present in South Africa.

For both the OP and indigenous crops improvement programmes, VOPI plans to establish participatory breeding and selection programmes with initial selection done by VOPI followed by further selection by farmers on-farm. VOPI would maintain the 'basic' seed. There is an interest in the use of molecular markers to monitor genetic drift or response to local selection.

Both VOPI and ACCI (see below) identified poor functioning of the extension service in South Africa, especially for vegetables, as a major limitation in promoting improved varieties to farmers. Also the commercial vegetable sector is not well organised compared to the fruit sector. There is no national trial system for vegetables in South Africa. To get around these problems, VOPI is trying to work with farmer co-operatives (often an extended family) where one farmer produces seed for the others. ARC is also looking for a company to 'buy into' the OP scheme.

VOPI do have PhD students and have potential for training students from other African countries.

African Centre for Crop Improvement (ACCI), University of KwaZuluNatal

The ACCI runs a programme through the University of KwaZuluNatal (KZN) offering PhD training in plant breeding in order to build capacity in national research programmes in Africa. The programme is funded by Rockefeller. Students from African countries with a background in plant science spend two years at KZN University. All students must have a permanent position in their own countries to return at the completion of the programme. The first year is a foundation year. The second year covers advanced topics in plant breeding and is taught in blocks by visiting lecturers from outside South Africa. Students also develop their PhD projects and are taught accounting and budgeting so that they can budget their resources throughout their projects. Years 3–5 are spent in their own countries carrying out their PhD projects as part of their jobs backed-up by visits from ACCI tutors.

One of the advantages of the programme is that it keeps students in Africa working on African crops. Past training in plant breeding at US universities did not prepare students sufficiently for the realities and difficulties of implementing a breeding programme in Africa. However, one disadvantage of this programme is the condition that students must have a permanent position in their own countries to return to. With respect to Kenya and Tanzania, there are currently very few or no vegetable breeders in public sector institutes e.g. KARI and Horti Tengere. One option would be to reallocate existing breeding capability away from crops such as maize to vegetables.

Mark Laing, Director of ACCI, felt that the ACCI could provide PhD training in vegetable breeding as it already has several staff with backgrounds in vegetable breeding (e.g. Rob Mellis and Walter di

Milano). ACCI also has a link with Daehnfeldt for cabbage breeding. He also felt that publicly funded vegetable breeding programme should give emphasis to OP varieties for smallholders but at the same time acknowledged that concentrating on OP varieties may not provide sufficient incentives for growth of the private vegetable seed sector.

The main constraints to growth of the vegetable sector in South Africa and elsewhere in Africa are considered to be the lack of vegetable breeders; poor extension services which severely limits the uptake of new varieties; the high cost of capital investment to establish breeding and seed production facilities; and lack of understanding of licensing agreements. It was also considered that seed distribution is a problem due to distance, poor transport systems and small seed packets. In some countries, seed regulations especially for imported seed can be a barrier due to the potential for corruption and added costs. **Capacity building in breeding and seed production is not enough in itself, there is also a complementary need for training in seed health and marketing.** This could also be provided by the University of KwaZuluNatal. **Suggested target crops for East and southern Africa should be cabbage, kale, tomato, onion and chilli.**

4.4 Potential models for vegetable breeding in eastern and southern Africa

There are three potential 'models' for carrying out vegetable breeding in this region:

- a. 'Home based breeding' - development of varieties entirely in country
- b. 'Shuttle breeding' – development of varieties in country from breeding lines produced elsewhere
- c. 'Backcross breeding' – improving existing varieties by adding single key traits.

These are not necessarily exclusive.

Home based breeding

Development of varieties entirely in country has the potential advantage that it builds capacity for vegetable breeding within the country. It would allow local breeding programmes to develop which are responsive to and informed by current and changing local market requirements. However, for this to occur there needs to be enhanced linkages and interaction among the different components of the commodity supply chain; farmers, retailers and consumers. It also allows production of varieties adapted to specific local constraints.

The disadvantages of this model are that the local market may only support a limited amount of breeding activities i.e. returns are insufficient for the investment to carry out all of the activities needed to run effective breeding programmes, especially for a range of vegetables. The effort may then either be confined to 'key' crops (i.e. those with a potentially large market share) or activities such as scientific support (pathology etc.) or marketing/liaison with farmers will be reduced or omitted. This could compromise the value of the breeding activities.

Potential solutions to these disadvantages are:

- The establishment of 'public good' breeding programmes. In this case there is an acceptance by donors that the economic return on investment is going to be limited. The breeding programme is driven by the need to meet local needs rather than making profit. However, such programmes require monitoring to ensure they keep on target and are also vulnerable to changes in donor priorities with subsequent problems regarding sustainability.
- The establishment of breeding programmes on a regional rather than a national basis. This will increase the potential market and returns on investment. Generally this operates as a regionally based 'shuttle breeding' programme with the early stage breeding activities being carried out in one or two centres and trial sites for selection of locally adapted varieties located throughout the

region. This still allows a degree of responsiveness to local market needs. However, there is a larger set-up cost with the need for trial sites and ‘selectors’ throughout the region.

Shuttle breeding

A breeding programme where early stage breeding activities are carried out outside of the country and later stage breeding lines are selected for adaptation to local conditions in country has the advantage of cost reduction particularly if the centralised early generation activities are supplying breeding lines to several markets. There is also the capacity to carry out work on crops currently of less importance in the target country which may be more important elsewhere. The shuttle breeding model is currently used by a number of international breeding companies with subsidiaries in Kenya and other countries in eastern and southern Africa and by South African breeding companies with subsidiaries in other African countries and also by AVRDC-RCA (see Chapters 3 and 4 – Vegetable seed sector and Vegetable breeding capacity).

A shuttle breeding programme carries the risk of being limited in its capacity to respond to local market requirements, particularly when the ‘central’ activities are located at some distance from the end market (e.g. Europe or US) and supply ‘advanced’ breeding lines. However, this need not necessarily be the case. Effective interaction with end users and introduction of segregating breeding material (e.g. F4 lines with fixed key single gene traits such as disease resistance) in country for selection under local conditions would enable responsiveness to local market needs. This is currently happening in eastern Africa e.g. Regina’s development of a black rot resistant cabbage and AVRDC-RCA’s development of blight resistant tomatoes.

Backcross breeding

This can be home-based where the entire process is completed locally or shuttle breeding where the initial backcrosses are performed elsewhere and 2nd or 3rd backcross families returned for evaluation and selection in country. A backcross breeding programme would be most suited to markets which are currently dominated by one or a few varieties e.g. as in Kenya where the tomato market is dominated by Cal J. The main advantage of the backcross model is that the programme has clear cut targets i.e. to address weakness identified in the current market leader by the local market. In addition, as limited change in the desirable traits of the variety is intended, both farmer and consumer acceptability should be good. Also, because backcross breeding is a targeted programme, costs are relatively low.

The approach, however, is limited in its applicability to hybrid varieties particularly if (as is likely) the inbred parent lines are not available. Also, although the approach is well-suited to address specific weaknesses in otherwise acceptable varieties, it does not generate a range of breeding material to allow flexibility to respond to future changes in market requirements. It does not provide a broad basis for a future breeding programme.

Indicative timescales and resources required

Assuming that any programme is starting from scratch, it should be possible to have potentially ‘improved’ open pollinated breeding lines available for small scale testing within 4–7 years. The timescale will vary according to the crop breeding system (annual crops e.g. tomato vs. biennial crops e.g. cabbage/kale, onion) and the breeding strategy used. For example, if shuttle breeding is used and F4 breeding lines are already available, this would reduce the timescale to 3–5 years. This does not allow for set-up time to recruit and set up or rent the necessary infra-structure.

To produce the first experimental hybrids would be expected to take 3–4 years more but this would depend on the business model. There may not appear to be good reasons for producing hybrid vegetable varieties for current smallholder vegetable production systems. Hybrids deny farmers opportunity to use farm-saved seed. In addition, the effects of crop and yield variation in the field due to environmental factors e.g. seed bed conditions; transplant shock; unevenness of irrigation etc. may

result in limited benefits from hybrids over OP varieties, especially if seed is more expensive. A public good breeding programme would be more likely to focus on improved OP varieties to keep the cost of seed affordable. A more commercially orientated programme would favour hybrid production to protect the varieties, especially in countries where the regulatory system did not function well.

Assessing the needs and current constraints in the eastern and southern Africa region, a sustainable approach may be to introduce potentially useful existing OP varieties with needed traits (if available?) from breeding programmes around the world for evaluation under local conditions in phase 1. This could be done in parallel with phase 2 – the initiation of breeding programmes to produce improved, adapted (especially with needed disease and pest resistances) OP varieties to meet market requirements and to boost farmer' income before introducing hybrids in phase 3. In this phased way, improved varieties from elsewhere could be available to farmers within 2–3 years and improved, locally adapted varieties within 3–5/4–7 years. This phased approach was used successfully by East-West Seeds in SE Asia and is the model being followed by East-West Seeds in Zimbabwe. In addition, most seed companies and AVRDC are following the second and third phases under a shuttle breeding framework. **There is therefore currently a level of activity aimed at varietal improvement in the region, however, there appears to be a need to coordinate these to improve their effectiveness.**

An alternative and/or additional approach would be to explore the possibility of public-private partnerships through linking the breeding expertise of the public sector with the resources and infrastructure of the private seed sector. For example, in Kenya, Hygrotech has expressed interest in developing such partnerships and has a vision which includes smallholders. Hygrotech has an established network of good trial sites which is expanding. In addition, as they currently do not breed their own varieties, they are unlikely to be biased against marketing any varieties from the programme. A donor-funded, public sector breeder plus assistants could be based at the Hygrotech facilities in Kenya. After appropriate consultation, breeding targets could be agreed. Once funding for phases 1 and 2 (improved OP varieties), the company takes on the programme to produce hybrids and provides market feedback/information and a route for dissemination of new varieties. During the donor funded stage the facility can be used for training purposes e.g. linked to ACCI to provide facilities for field based PhD studies.

It is difficult to assess the resources required other than generically. Each case would have to be specifically assessed with respect to resources already available or potentially available (i.e. currently being used in other activities).

For home based breeding there will be a likely need for the following resources but not necessarily all at once:

Human resources:

- 1 breeder (PhD level/masters)
- 2 assistants (graduate/masters)
- Administrative support (part time)
- Casual labour for pollination and other field work

Physical resources:

- Permanent breeding and trial sites preferably with irrigation
- Office plus utilities
- Polyunnel(s) or green house(s)
- Facilities for disease screening – could be field based
- Farm based trial grounds – rented

For shuttle breeding there will be a need for the above in the ‘central’ breeding facility or an agreed supplier of breeding lines and

Likely in country resources:

- 1 Trials officer (Graduate/masters)
- 1 assistant
- Administrative support (part time)
- Casual labour for pollination and other field work

The same infra-structure as above would be required although less protected space and less area for breeding trails would be needed.

4.5 Major constraints to developing successful vegetable breeding programmes

The major constraints to developing successful vegetable breeding programmes in eastern and southern Africa include:

- lack of public sector breeding capacity and under-utilized private sector breeding capacity;
- lack of linkages between the public and private sector;
- lack of appropriate germplasm with required traits;
- lack of funding support; and
- lack of a comprehensive and coordinated programme.

These constraints will need to be addressed if improved and affordable vegetable varieties adapted to local conditions are to be successfully produced in eastern and southern Africa.

5. Current regulatory framework

5.1 Regulatory framework for vegetable seed in Kenya

Vegetable seed production and distribution in Kenya is governed by the Seeds and Plant Varieties Act (Cap. 326) of 1991. Under the Act, the Kenya Plant and Health Inspectorate Services (KEPHIS) is the main regulatory body of the seed industry. KEPHIS is a parastatal and is mandated to co-ordinate all matters related to pest and disease control; monitor the quality and levels of toxic residue in plants, soils and products; administer Plant Breeder Rights; undertake inspection, testing, certification, quarantine control, variety testing and description of seeds and planting materials; establish the machinery for educating the public on safe-use of agro-chemicals; approve import applications for seeds, plants and appropriate phytosanitary requirements and importation of such material; and be responsible for inspection of produce for export and import. More information about KEPHIS and its activities can be found on the KEPHIS website www.kephis.org.

The Seed Regulation Committee (SRC) is mandated to formulate and recommend developmental policies for the growth of the industry. Its membership is made-up of the MoALRD, KARI, KSC, HCDA, the Kenya Forestry Research Institute (KEFRI), the Kenya Farmers Association (KFA), the Kenya Farmers Union (KFU) and a member who may be co-opted to represent industry interests. It is also supposed to develop standards, recommend registration of seed merchants, recommend certification fees and act as moderator in cases of appeals by industry stakeholders.

Table 5.1 The seed regulatory framework in Kenya

No.	Activity	Actions
1	Market entry	<ul style="list-style-type: none"> Both domestic and foreign seed companies registered by KEPHIS.
2	Introduction of new varieties	<ul style="list-style-type: none"> Seed companies allowed access to local and foreign sources of varieties including national and international research institutions. New varieties tested by KEPHIS before introduction into the market.
3	Seed quality control	<ul style="list-style-type: none"> Seed certification by KEPHIS is compulsory. KEPHIS charges a fee for seed certification. The Government sets minimum standards in Kenya under the Seeds and Plant Varieties Act, Cap. 326. Truth in labelling (i.e. information indicated on seed packet label) is enforced by KEPHIS.
4	Seed imports and exports	<ul style="list-style-type: none"> All seed importers or exporters required to obtain import or export permits from KEPHIS. The seed must be accompanied by a phytosanitary certificate from the country of origin and an orange certificate from ISTA. Imported seed lots subjected to laboratory tests upon arrival.
5	Seed traders (retailers and distributors)	<ul style="list-style-type: none"> Seed traders registered by KEPHIS and premises inspected periodically.
6	Seed growers	<ul style="list-style-type: none"> Seed growers approved by seed allocation panels and registered by KEPHIS. Seed production fields subjected to regular inspection by KEPHIS after proof of origin and furnishing variety descriptors – Distinctness, Uniformity and Stability (DUS)
7	Breeders	<ul style="list-style-type: none"> Kenya signatory to UPOV 1978 KEPHIS registers all plant breeders and grants ownership of rights. Breeders' rights protected by KEPHIS.

The seed regulatory framework in Kenya covers the involvement of seed companies, seed wholesalers and retailers, and seed growers in all aspects of the sector. KEPHIS registers all seed companies, traders and seed growers. Seed certification is compulsory and KEPHIS charges a fee. The regulations

also require all seed to be tested for minimum quality standards at government laboratories as set by the Seeds and Plant Varieties Act. KEPHIS also monitors the importation and exportation of seed and issues permits.

Seed companies can access new varieties from anywhere freely. All seed companies said they have no problems accessing new varieties developed by the public research system, however very few vegetable varieties have been developed through this system. Hence most vegetable seed marketed in Kenya is of varieties bred overseas. Seed companies producing seed of newly introduced varieties must pass them through national performance trials before release. The process of introducing a new variety can take between 2 and 12 years and cost up to 12 million KSh.

Seed companies can also enter the market under simple registration conditions without necessarily showing proof of adequate infrastructure and trained personnel. This allows medium and small companies to enter the market relatively easily but it does not guarantee quality seed to farmers.

5.2 Issues raised by key stakeholders with respect to the current regulatory framework

Issues raised by seed companies

The seed law in Kenya is comprehensive and stringent. KEPHIS has concentrated most of its efforts on policing the activities of the private seed sector and less time on offering quality, timely and satisfactory services (Mutuku Muendo et al., 2004). Seed companies currently feel constrained by the restrictive, complex and difficult administrative and regulatory systems for the importation of seed; registration of new varieties; multiplication and marketing of seed etc. They feel that KEPHIS enjoys exercising regulatory, restricting powers over the seed sector rather than facilitating the sector and providing services, co-ordination and leadership in the seed industry. The seed companies suggested that this approach has been an impediment to private sector innovation and growth and has usurped the developmental role in the industry.

Since January 2004, KEPHIS has insisted on an ISTA orange certificate for all seed lots imported into Kenya. Prior to this date, although part of the regulations, it was not enforced as there existed two other tests in the system – testing by seed companies and by KEPHIS itself. This additional regulation is causing problems for the seed companies importing seed from other African countries, especially Tanzania. There are only 4 ISTA accredited laboratories in Africa. Although Kenya has an ISTA laboratory, Tanzania, where most of the French bean seed used in Kenya is produced, does not have a laboratory. Currently, seed companies have to send French bean seed to Europe for ISTA testing which is then sent back to Kenya. This is costly and the cost is passed on to the growers and, ultimately, to consumers. Inter-governmental discussions are in progress to allow seed lots from Tanzania to be tested in Kenya but it is not known when the problem will be resolved.

Currently each seed lot imported into Kenya requires 3 levels of testing: testing by the company prior to importation (phytosanitary and quality); testing by ISTA (orange certificate); and post-entry testing by KEPHIS. According to the seed companies, post-entry testing by KEPHIS often produces results that differ from those produced by the company and ISTA. There is often a need for post-entry re-testing with additional costs and delays, even for high quality seed. Under current regulations, seed must also be re-tested each six months. All seed companies contacted suggested that KEPHIS lacks both the capacity (under-staffed) and the competence to test seed (no formally trained seed technologists).

A number of seed companies as well as the STAK highlighted the need for a competent national seed technology institute in Kenya. The institute with most capability is Moi University (see Table 4.1). A meeting was held recently to review national seed technology needs and plan a training syllabus to build capacity amongst the seed companies and KEPHIS. A manual on Seed Certification, Accreditation and Quality has been prepared which is very comprehensive. The MoARLD is supportive of this initiative. Regina is currently working with Moi University to develop improved

procedures for seed testing especially for viability. It is hoped that this will provide sound evidence to KEPHIS to show that the re-testing each six months is not necessary.

Attempts are being made by several seed companies (e.g. Regina, Pennard, Hygrotech and others) to develop a more cooperative relationship with KEPHIS. Regina is also trying to establish a system of accreditation for seed companies and other private agencies whereby seed can be tested more quickly and by experts. Thus the seed companies themselves are trying to seek solutions to the critical bottlenecks created by the current regulatory framework.

Issues raised by STAK

STAK emphasized that reforms are required in the current regulatory framework in all areas: regulatory; legal; and policy. STAK is putting efforts into creating awareness on the types of reforms needed and has already produced draft documents on regulatory reforms and a national seed policy (legal and policy issues) which are under discussion with the MoALRD.

STAK also acts as the secretary to the committee established to look at harmonization of seed regulations and policies across eastern and Central Africa under ECAPAPA (see below). Useful discussions have been held with Uganda and Tanzania and agreed areas for harmonization have been identified e.g. seed certification, varietal evaluation and release.

A technical committee was established to develop a national varietal list for Kenya. This has been accomplished for most important crops but is still under development for vegetables. One of the major problems is the widespread use of old vegetable varieties for which important information is lacking e.g. breeders of many varieties are not known as many varieties pre-date the formal system of Plant Varietal Rights. Thus, there is currently no national varietal list for vegetables in Kenya. The next step will be to develop a regional varietal list for important crops. Efforts are also being made to develop a regional list of important seed-borne pathogens. The development of these documents is an important step in the process of liberalizing seed movement between the Kenya, Tanzania and Uganda as part of the regional harmonization processes. The technical committee is currently developing guidelines so that seed from any of the three countries can be processed through the ISTA laboratory in Kenya.

Of the three East African countries, Kenya has the most developed seed industry including infrastructure and machinery. Seed from Kenya can be moved to either Tanzania or Uganda without much problem due to the existence of the ISTA accredited laboratory and the operation of OECD field schemes. There is now a strong move to bring Tanzania and Uganda up to this level but this is awaiting formal approval by the respective governments.

STAK feels that the **critical** problem in Kenya is to simplify the regulatory framework. There is an urgent need to build capacity and expertise in KEPHIS to meet the needs of the major stakeholders in the system, especially the seed companies. KEPHIS is staffed by former KARI staff who are considered not to have sufficient background in seed. STAK feels that KEPHIS spends too much time regulating a small number of seed companies. More time should be spent in regulating the informal sector, which is significant for certain staple food crops. Currently, KEPHIS is not mandated to regulate this sector.

An over-regulated formal seed sector is a serious disincentive for new companies to enter the sector, and thus for the growth of the sector. Over-regulation will ultimately make seed more expensive for the grower. STAK welcomes any initiatives to support and expand the vegetable seed sector in Kenya and is looking for partnerships and support.

Issues raised by KEPHIS

The amount of seed imported into Kenya each year is substantial. During 1998 to 2002 about 1–1.5 thousand t of seed was imported each year (Table 5.2). A good proportion of this was vegetable seed, including French bean seed. KEPHIS maintains a comprehensive database of seed importations.

Table 5.2 Importations of seed into Kenya during 1998–2002

Year	Weight (t)
1998	1,514.2
1999	957.6
2000	1,264.3
2001	1,174.8
2002	1,684.7

Source: KEPHIS

In contrast to the views of the seed companies and STAK, KEPHIS sees its role as a facilitator rather than a restrictive regulator. KEPHIS is aware that seed companies complain of over-regulation but does not perceive its actions to be restrictive. There is clearly a significant lack of understanding among key stakeholders in the vegetable seed sector in Kenya.

Gladys Maina of KEPHIS explained that the quality of vegetable seed imported from Europe has noticeably decreased in recent years. This is probably the result of importation of old seed lots following the decision by European seed companies to discontinue production of OP varieties. KEPHIS feels that there is a justifiable need to be more careful and to enforce approved regulations e.g. the need for an ISTA orange certificate for all imported seed. KEPHIS considers that the decision by European seed companies to phase out OP varieties in favour of hybrids is good in spite of the implications of higher seed costs for smallholders.

Perhaps the thinking behind the KEPHIS decision to enforce the orange certificate has not been sufficiently explained to STAK and the seed companies. At the same time, perhaps the regulation should be restricted to seed of OP varieties of vegetables imported from Europe?

With regard to regulating seed quality in Kenya, **KEPHIS is strongly supportive of the need to build local vegetable breeding and seed production skills. Local breeding capacity producing locally-adapted varieties would help to achieve production of quality breeder seed. This should be an incentive for the development of partnerships between public sector breeders, seed companies and contract farmers to produce quality seed for sale in Kenya to smallholders.** Capacity building and growth of such partnerships in the local vegetable seed sector would make the tasks of KEPHIS a lot easier. KEPHIS would prefer the development of such a system rather than further growth of the informal sector. It is considered impossible to regulate the informal seed sector in Kenya; the main problems being varietal stability and seed-borne diseases. KEPHIS feels that it has an important role to play in building understanding and awareness of seed quality across the supply chain and is already working with traders and farmers on this issue.

KEPHIS also feels that the regulations to be met for registration of a new seed company are “too easy” in Kenya. Many local companies do not make sufficient capital investment to produce quality seed.

5.3 Regulatory framework for seed in Tanzania

As in Kenya, the Tanzanian seed sector had also been tightly controlled, particularly for cereals. The main regulatory body is the Tanzanian Official Seed Certification Agency (TOSCA). Its mandate was to ensure that seed produced in the country met the required quality standards and the rules and

regulations were followed. It was empowered to inspect, test, certify and control seed imports. Breeding of new varieties, seed production and seed treatment was mainly done by the GoT. The law mandated the research stations to breed improved varieties, then to pass pre-basic seed to five GoT seed multiplication farms under the Ministry of Agriculture. These were required to multiply and produce foundation seed to be sold at very cheaply to the Tanzania Seed Company (TSC). TSC was a Government parastatal mandated to take all foundation seed multiplied by the five farms. It then contracted farmers to grow certified seed, which the company would process, package and sell to companies and stockists for distribution to farmers. Retail prices were therefore heavily subsidized which created financial difficulties for the TSC. Thus, the TSC collapsed in the early 1990s. By then, farmers had also lost confidence in the quality of hybrid seeds being sold by TSC and returned to OP varieties or imported hybrids.

In 1994, the GoT liberalized the economy and the seed industry was re-structured (Mutuku Muendo et al., 2004). TOSCA and the five state farms remained, but government monopolies were eliminated. Research stations are now free to sell breeder's seed to private companies; the government seed multiplication farms; or to capable contract farmers for multiplication of foundation seed. They can also bulk seed to produce certified seed or contract other farmers to do this. The five state farms thus have taken over the role of the TSC. They can sell certified seed directly to farmers or sell the foundation/certified seed to private companies. Currently the research stations and the state farms are supposed to partially fund their programs from profits accrued from their operations. The current system appears to be competitive and dynamic.

Following liberalization in Tanzania, the Seed Act was reviewed to reflect the current government policy of a free economy, and is currently pending approval in Parliament (Mutuku Muendo et al., 2004). In contrast to Kenya, the process of liberalization of the seed sector was harmonized with liberalization of output markets which has resulted in a more flexible and workable system and seed sector in Tanzania. A key innovation in the Act is that it allows seed to be produced at village level as Quality Declared Seed (QDS), under well-defined rules and regulations applied by TOSCA. This process of village level seed production is operationalized as Community Based Seed Production (CBSP). The Tanzanian Parliament passed the Plant Breeders Rights Bill in 2002, a positive move for the seed industry.

In light of the difficulties in Kenya, such progress in reform of the Tanzanian seed sector may hold useful lessons for Kenya (Mutuku Muendo et al., 2004).

5.4 Harmonization of seed regulations in East Africa

In East Africa, the seed industry faces many different standards and regulations in each country which are costly to meet. This high cost together with variable demand reduce incentives for local and international seed companies to make investments required to provide the quantity, quality and variety of seed needed to support the expanding agricultural base. The issue was emphasized by Kenyan-based seed companies consulted by the study team including Regina, Simlaw and East African Seeds. And, it is especially so for vegetables where almost all seed of common local vegetables e.g. cabbage and tomato is imported. Harmonization and rationalization of seed policies and regulations in the region could help to establish a common regional market with an effective demand large enough to induce needed investment to establish a viable and efficient seed industry in the region.

ECAPAPA (ECA Programme for Agricultural Policy Analysis) is currently supporting a project that is seeking to address and overcome: lengthy procedures for evaluation and release of new varieties; ill-informed phyto-sanitary regulations; lack of PVP; restrictive laws and regulations on the development of local and foreign seed companies. The project is funded by the EU and will be completed in 2008 (ECAPAPA, 2002; Rohrbach et al., 2003). This will be achieved through competitive research grants, commissioned policy studies and information exchange. The main aim of rationalizing and harmonizing seed policies, laws and regulations is to reduce transactional costs and widen the market to stimulate investment, especially by the private sector.

Ten staple crop commodities were identified as priority targets for the harmonization processes in East Africa. In principle, vegetable crops such as cabbage and tomato will be brought under harmonized legislation but currently this is voluntary. Local vegetable seed production and marketing will probably remain under national regulatory procedures for the next two years but should be covered by harmonized legislation by 2008; this timeframe fits well with the outcomes and recommendations of the scoping study.

In Kenya, the seed companies welcome this important initiative to harmonize regulations and policies throughout the region but emphasize that positive changes will only happen if ECAPAPA can facilitate the three governments (Kenya, Tanzania and Uganda) to agree to resolve the cross-border problems facing the seed companies, especially with regard to importing seed into Kenya. To date, few problems have been experienced in moving seed from Kenya into Tanzania and Uganda. However Tanzania is getting increasingly concerned about the problems it faces in exporting seed to Kenya.

KEPHIS, however, is not supportive of harmonization. It is critical of the under-developed regulations and infra-structure in Tanzania and Uganda and feels that both countries will need to “substantially raise their standards” if there is to be any possibility of harmonization with Kenyan regulations. Perhaps KEPHIS is not aware of the positive progress made in liberalizing the seed sector in Tanzania. In addition, KEPHIS does not support Tanzania and Uganda using the ISTA laboratory in Kenya.

The plan to establish an East African Seed Committee with representatives of the regulators, seed traders associations and plant breeders associations for those countries that already support harmonization is seen by the study team as a positive development in resolving some of the constraints to simplify restrictive seed regulations and facilitate the harmonization process.

5.5 Major constraints affecting the regulation of the seed sector

The major constraints affecting the regulation of the seed sector in Kenya (more so than in Tanzania) include:

- restrictive, complex and difficult administrative and regulatory systems for the importation of seed, registration of new varieties, and multiplication and marketing of seed;
- lack of harmonization of seed regulations with those of other inputs (in contrast to Tanzania);
- specific barriers to harmonization of regulations affecting vegetable seed due to lack of information;
- lack of capacity in KEPHIS to satisfactorily meet its multiple roles; and
- lack of understanding between key stakeholders in the seed sector.

Over-regulation of the seed sector is a serious disincentive for innovation, entry and growth of the sector. The current regulatory system needs critical attention in parallel with technical constraints if the full potential contribution from varietal improvement and improved seed systems is to be realized.

6. Initiatives to improve local vegetable production

An assessment was made of current initiatives (established and project-based) to improve local vegetable production in eastern and southern Africa and selected, relevant initiatives in other regions. The main objectives of the assessment were to a) summarize those activities that are either complementary or could be linked to enhanced efforts to improve local vegetable production through breeding and seed production in eastern and southern Africa; b) ensure that the recommendations made by the study avoid overlap and duplication with existing initiatives; c) give further insight into the capacity available for improving local vegetable production in this region (in addition to that already discussed in the rest of the report); and d) highlight selected, relevant initiatives in other regions that may provide potential models for improving local vegetable production in eastern and southern Africa. This assessment does not attempt to provide a complete picture of all initiatives in progress.

6.1 Initiatives in eastern and southern Africa

Institute,; NGO- and organization-based

- International Centre for Insect Physiology and Ecology (ICIPE)
ICIPE is an international centre of excellence in insect scientific research and training, based in Kenya. ICIPE's mission is to help alleviate poverty, ensure food security and improve the overall health status of peoples of the tropics by developing and extending management tools and strategies for harmful and useful arthropods, while preserving the natural resource base through research and capacity building. The scope of research and training activities covers the areas of human, animal and plant environmental health in four Divisions. ICIPE's research and training activities cover most countries in East and southern Africa.

The Centre has built a team of specialists in horticultural research and training at all levels including: Training of trainers (ToT); scout training; MRLs; EUREPGAP requirements and quality management system internal audit and development of IPM manuals and training materials. Expertise covers entomology, plant pathology, biological control, bio-pesticides, integrated pest management research planning and implementation, design and performance of participatory training and learning, and postgraduate training of local researchers. In addition, ICIPE can offer pest identification services for growers. The whole team has a long-standing association with both the local and export horticultural sectors in Kenya and contacts in Tanzania, Uganda and Zimbabwe. The team has produced IPM manuals for cut flowers, brassicas, French beans, okra, tomato and mango.

The on-going activities in the horticulture sector at ICIPE (some are project-based and supported by various donors) include: mango fruit fly management; diamondback moth biocontrol-based IPM; egg parasitoids for *Helicoverpa* control; IPM for red spider mite management in tomato; French bean IPM training; okra IPM training; training of scouts in floriculture; development of private sector service providers for export horticulture; creation of a local certification body for EUREPGAP and other standards; development of Mango IPM training module; and pesticide residue trials in French beans (see www.icipe.org for more information). ICIPE is an experienced and active research leader, implementer and stakeholder in the horticulture sector in East and southern Africa and collaborates with key stakeholders across both local and export sectors. It should be a key player in future initiatives to develop a viable vegetable seed sector in eastern and southern Africa.

- CABI
CAB International is an intergovernmental membership organisation which has been active in Africa for about 20 years. The African Regional Centre - CABI-ARC – , based in Nairobi, is responsible for all CABI's activities in Africa and works in collaboration with community organisations, NGOs, NARES, IARCs, the private sector and other organisations. Its purpose is to support the generation, access to and use of knowledge for sustainable agriculture, environment management and human

development. Its expertise and skills include: stakeholder mobilisation and facilitation of institutional partnerships for research and development in pest management and information; curriculum development for IPM farmer field schools (FFSs); establishing and running Training of Trainers (TOT) courses and FFS; and development and implementation of IPM of diseases and pests. It has been active in the area of vegetable IPM in smallholder systems in East Africa for the past 10 years and currently has active programmes on ToT and FFS in vegetable IPM in Kenya and Ghana. Much of its work is project-based relying on various donors (see www.cabi-bioscience.org for more information).

One of CABI-ARC's initiatives is the *Good Seed Initiative* (see www.gsi-cabi.org). The overall objective of the GSI is the development of sustainable smallholder seed systems that improve food security of the poor and support in situ conservation of crop biodiversity. The working objectives and focus of the GSI are improvements to the quality and value of farmer-saved and farmer-traded seed: *seed as a resource and as a commodity* for building farmer-centred seed systems and enabling the poor to access and benefit from seed from sources external to the community. Lessons learnt from this initiative will be taken forward into national and regional seed systems and policies. GSI has a special focus on the needs of poor farmers and on exploration and understanding of systems to ensure the quality and health of seed available to these farmers.

Key functional outputs to which GSI intends to contribute are: improved knowledge and practices allowing healthier seed crops in the informal sector, and reducing negative environmental inputs; greater awareness of agro-biodiversity and genetic value in different genetic resources, with improved conservation of genotype biodiversity; greater appreciation by formal seed provision stakeholders of the concerns of the informal sector; more supportive and flexible policies and increasing options for synergy between the two; and active dialogue amongst a wide range of key stakeholders. It is hoped that this will enable greater integration of seed systems building from community-based quality control. To date, the GSI has held consultations and workshops and is facilitating the development of project ideas as funding proposals to donors in specific countries.

Many resource-poor farmers in the developing world lack access to seed of staple food crops from the formal sector and depend on farm-saved and farm-traded seed as their principle seed source. However, as this report has shown, however, for most commonly grown vegetables e.g. cabbage, tomato, onion and largely kale in East Africa, poor smallholder farmers depend far more on the formal sector for seed. **Thus, we suggest that improving access by poor smallholders to quality and affordable vegetable seed in East and southern Africa is more likely to be achieved through a focus on improving the formal seed sector rather than the informal sector.**

- HCDA

The Horticultural Crops Development Authority (HCDA), established in 1967, is a parastatal under the MoARDL. It is responsible for development, promotion, co-ordination and regulation of the horticultural sector in Kenya. It provides advisory services and information to the government and the industry, and regulates the industry by granting licences to export companies. It also publishes a bi-monthly magazine, Horticultural News. Readers include farmers, exporters, seed companies, input/equipment suppliers and overseas embassies.

HCDA currently provides greater support to the export vegetable sector than the domestic sector. For example, it provides specialised extension services to smallholder farmers producing export vegetables. It has established a similar supply chain control system to the large exporters: collecting produce from smallholders and transporting it to its headquarters facility near Nairobi airport. Exporters can buy the produce under contract. HCDA provides smallholders with quality seed and other inputs as well as a technical training and advice through FFSs managed by the Ministry of Agriculture. A small commission is collected from each smallholder.

HCDA has the experience and the position to provide such support across the vegetable sector in Kenya, both export and domestic. **A comprehensive programme of support for the domestic**

vegetable sector coordinated by HCDA and based on quality seed and other needed inputs; technical training and advice; and an improved marketing system would greatly increase the productivity and efficiency in the domestic vegetable sector in Kenya.

- Kenya Institute of Organic Farming (KIOF)

The Kenya Institute of Organic Farming (KIOF), an NGO, was established in 1986. It was established to encourage sustainable methods of agriculture, mainly among smallholder farmers. The initial programme consisted of farmer training and extension services and was carried out in the Central district of Kenya, including the vegetable production areas. This programme was readily accepted by farmers as it promoted farming methods appropriate to smallholder farmers having limited financial resources. It stimulated relatively quick growth of the organization. Demands for general information on organic farming grew from organizations throughout East African region.

The main activities currently carried out by KIOF include:

- Creating awareness and providing practical training in organic farming to male and female farmers (about 1000 per year), youth, extension workers, trainers and project managers.
- On-farm trials and data gathering on organic farming in medium and high potential areas in Kenya, including vegetable production areas.
- Gathering and disseminating information on organic farming throughout East Africa.
- Stimulating formation of organizations and networks on organic farming.

In order to accomplish the above tasks, KIOF offers three distinct services:

- Training - farmer training, student training and regional workshops.
- Research and outreach - participatory on-farm research, consultancy and demonstration gardens, including vegetables.
- Information - library, publications and a quarterly magazine - Foes of Famine.

KIOF is largely dependent on funding from various donors (especially the Netherlands) and involvement in projects to maintain the above activities.

- SOCDP – Farm Input Promotional Service (FIPS)

SOCDP is an NGO based in Western Kenya committed to improving the livelihoods of the poorest smallholders farmers in East Africa. The Farm Input Promotional Service (FIPS) has pioneered the mini-pack method in Kenya to help poor smallholders to improve vegetable production, improve nutrition and generate income. Tackling the universal problem of accessibility and affordability of inputs for poor farmers, FIPS piloted the mini-pack system in Western Kenya by re-packaging 50 kg bags of fertilizer into 100g packets and 1 kg tins of kale seed into packets of 300 seeds (2 g) which are sold together for KSh12 (<10p). In Western Kenya, the mini-pack is estimated to have reached up to 100,000 farmers. Experience has shown that the mini-pack method is a very effective in getting seed and associated inputs such as fertilizer out to smallholders. As mini-packs are sold, farmers respect their value and use them carefully. The project has also shown that most farmers return to for advice and to purchase larger quantities of inputs. More recently, a partnership with the Athi River Mining company has led to the development of Mavuno top-dressing (with N, Ca and S) in small, affordable packets. Discussions are in progress with a company in Tanzania to produce a similar product.

FIPS is currently discussing extending the mini-pack method to other vegetable crops and other parts of Kenya and Tanzania with several vegetable seed companies in the Netherlands and South Africa (Pennard, Capstone, Bakkar etc.). There is potential to establish a seed company (possibly a subsidiary of an existing company) marketing mini-packs of seed in partnership. The lesson learning from this initiative is considered very relevant for reaching poor smallholders with quality seed of improved varieties and the necessary inputs to realize the full potential of such varieties.

- Technoserve – Business solutions to rural poverty

Technoserve is an organization that helps entrepreneurial men and women in poor rural areas of the developing world – especially Africa and Latin America – to build businesses that can compete and thrive in a global free marketplace. This leads to income generation and creation of opportunity and economic growth for families, communities and countries (see www.technoserve.org for more information). It focuses on high-value products and is active in the horticulture sector in Kenya.

In a recent presentation to horticultural sector representatives in Nairobi, **Technoserve emphasized the importance of improving the productivity and efficiency of the domestic horticulture sector for the good of the sector as a whole.** Although the domestic sector dominates the export sector in volume and value, it faces immense constraints due to lack of clear market; lack of grading standards; long supply chains; and poor handling and storage. **Technoserve suggested various approaches to improve the domestic sector and to secure the future for smallholders including: improved physical markets, facilitated by government and operated by the private sector, to make markets more attractive to retailers; improved virtual markets, consisting of multiple private sector wholesalers in competition; and closer relationships between farming communities and urban retailers (as per the export model).**

As the same smallholders often grow vegetables for both export and domestic markets, the challenges they face can affect both. However, **the same advantages that attract export companies to working with smallholders e.g. low investment requirement; reduced risks; cost-effectiveness; and political protection, could also benefit the domestic sector – if domestic marketing systems were improved and smallholders organized and supported technically.**

Technoserve emphasized that most exciting opportunities exist in promoting the growth and efficiency of the domestic horticultural sector especially to support growing urban food demands. Much could be achieved by upgrading physical markets in urban areas; improving marketing systems (fostering competition between wholesalers); and building links between retailers and farmers.

Project-based

- DFID Crop Protection Programme

The DFID Crop Protection Programme has funded a cluster of inter-related, 3 year vegetable pest management projects, based in Peri-urban Nairobi, over the past ten years. The main objectives of these projects has been to develop improved IPM practices in smallholder vegetable systems. During 2003 – 2006, the CPP is giving priority to the promotion of successful technologies and associated knowledge generated to intermediate beneficiaries and farmers. Although the main focus of these projects has been smallholders growing locally-consumed vegetables, since 2003, appropriate outputs have also been directed at achieving impact across the Kenyan horticulture sector in Kenya to the benefit of all small holders in domestic and export sectors.

All projects have involved teams of researchers from UK institutes (e.g. NRI, Reading, Warwick HRI, CSL, Rothamsted, CABI, Imperial College etc.) collaborating with Kenyan researchers from KARI, CABI-ARC, ICIPE, extension staff from the MoARLD, the private sector especially Dudutech, export vegetable companies, private sector service providers, and farmers. Selected UK expertise teamed with Kenyan partner institutes has worked effectively to better understand the pest management problems in peri-urban vegetable systems in Kenya and to develop and promote solutions for some of the important biotic constraints.

Outputs from the CPP vegetable cluster projects are currently being promoted with public sector partners, farmers and with the private sector. CPP management made the decision to engage with the private sector for the promotion of research outputs in 2002. The extent to which this has occurred is unique within the CPP and is still novel amongst other agricultural research programmes. The outputs include: IPM strategies for pests of several commonly grown vegetables e.g. kale through CABI-ARC

back-stopped FFS funded by an IFAD project in Western Kenya; effective biological control agents (BCAs) with commercial potential (e.g. *PlxyGV* for control of diamond-back moth and *Pasteuria penetrans* and *Pochonia* (formerly *Verticillium*) for control of root-knot nematode with Dudutech; capacity building projects using the innovative and attractive promotional tools (manual, calendar, posters, videos etc.) developed by previous projects funded by the CPP – these tools are also being used more widely by projects funded by additional donors; and developing the concept and building capacity of private sector service providers to help smallholder out-growers for the export sector to adopt traceability systems and sound IPM and agricultural practices required under EUREPGAP. This project has stimulated others to provide sustainable training input into the export horticulture sector in Kenya to ensure that as many smallholders as possible can remain in the sector, thus ensuring on-going contributions to reducing poverty and improving livelihoods (see www.cpp.uk.com)

During the implementation of the vegetable projects, concerns were periodically raised about problems with vegetable seed quality and supply. High quality seed is fundamental to producing a quality vegetable crop and especially, to realize the benefits from the application of improved pest management technologies. **The one input that all export companies consistently provide their smallholders is quality seed.** It was strongly recommended in 2002 that the CPP should support project/s on improving vegetable seed systems in Kenya to help smallholders to gain access to high quality seed. A project was therefore funded by the CPP and implemented by KARI, CABI and KEPHIS, supported by CSL and Warwick HRI, UK to assist farmers in Kinale to produce higher quality kale seed through selection, characterization and cleaning-up and also to improve seed multiplication methods. The kale project is also covered in Chapter 3 – Vegetable seed sector.

- USAID Horticulture Project

FINTRAC established the Horticulture Development Centre (HDC) in Kenya in October 2003. One of the major objectives of this four-year USAID-funded project is to increase incomes of participating horticultural smallholders by over \$26 million. FINTRAC will work with over 35,000 of these smallholders to expand local and export sales by over \$50 million.

HDC has a core team of highly trained Kenyan agronomists who operate from mobile offices, strategically located in the most horticulturally diverse regions of Nairobi, Eldoret, Kisumu, Embu, and Mombasa. The team provides weekly technical support in marketing, research and technical assistance to diversify products and improve yields and quality. This is augmented by intermittent industry specialists drawn from the European and East African horticultural trade. FINTRAC's market-led approach to implementation involves the transfer of good agricultural practices and low-cost sustainable technologies to smallholders (see www.fintrac.com/p_kenya.asp for more information).

HDC targeted six commodity sectors during its first year work programme:

- Passion fruit (fresh and processed)
- Chilli products (hot peppers, paprika, etc.)
- Vanilla and spices
- Smallholder flowers
- Tree crops (mango and cashew)
- Local market vegetables (onion, carrot, cabbage, tomato, etc.)

The HDC is also incorporating an exciting new Business Development Services (BDS) activity into its program wherein joint-venture agreements are being organized between FINTRAC and local BDS providers to more effectively leverage extension activities and results. Discussions are underway with Del Monte, Regina Seeds, Hygrotech (SA), major supermarket chains in Kenya and fresh produce exporters.

The HDC has already established and is currently expanding demonstration plots for a variety of crops. The project is also training exporters and their out-growers in EUREPGAP procedures to ensure that they are compliant with EU requirements for export, and eligible for certification.

For its first year of operations, HDC has set specific performance targets to achieve:

- training in EUREPGAP for 50 associations and 5,000 growers. Ten associations will receive certification so that target growers can maintain production of at least 8,000 t and incomes of \$2.5 million;
 - introducing and commercialising a range of horticultural crops through at least 30 commercial demonstrations of at least three new products;
 - realizing \$2 million in gross farm gate income and \$5 million in domestic export market value generated from new product development;
 - **increasing the quantity and quality of selected horticultural crops for the domestic market through the establishment of 50 demonstrations plots for onion, garlic, okra, kale, cabbages, potatoes, bananas and tomatoes;**
 - identifying market gaps and introduce crop scheduling;
 - negotiating at least five marketing arrangements for producer organizations to supply supermarkets; and
 - increasing income from domestic sales by \$4 million.
- The Maendeleo Agricultural Technology Fund (MATF)
The Maendeleo Agricultural Technology Fund is a regional fund operating in East Africa. Established by the Rockefeller Foundation (USA) and the Gatsby Charitable Foundation (UK), the fund is managed by FARM-Africa. It seeks to promote the transfer of new agricultural technologies to farming communities by supporting innovative partnerships in order to exploit the comparative advantages of different organizations. It has been operating in East Africa since January 2002 and supports the transfer of tested and proven innovative technologies in crops, livestock, and post-harvest processing and marketing. The purpose of the fund is: to contribute to the improvement of rural livelihoods through innovative partnerships capable of promoting rapid adoption of viable agricultural technologies by farming communities in the East Africa region.

Its objectives are:

- Increasing the ability of farmers to exploit viable technologies capable of raising their productivity without undermining long-term productivity of agricultural resources.
- Fostering effective linkages between research scientists and other organisations such as NGOs, CBOs, and private sector firms working with farmers to work together in partnership to ensure effective and sustainable transfer and use of proven technologies by farming communities.
- Identifying and promoting the use of innovative mechanisms for sustained delivery of proven technologies.

The Fund has successfully selected and funded 17 projects: 8 in Kenya, 5 in Uganda and 4 in Tanzania and 18 new projects are expected to receive funding in 2004. One of the projects is: “Empowering small scale and women farmers through sustainable production, seed supply and marketing of African Indigenous Vegetables in East Africa (Kenya and Tanzania)”. More information can be found at www.maendeleo.atf.org

- CARE-REAP

The CARE Rural Enterprise Agri-Business Promotion (REAP) Project was initiated in 2000 (CARE-REAP, 2002). It evolved from a joint agri-business project proposal developed by CARE Kenya, FPEAK, KARI, University of Nairobi, HCDA and USAID. The project is being implemented in Greater Kibwezi, Makueni District of Eastern province, approximately 200 km from Nairobi. Horticultural production is carried out by several clusters of smallholders concentrated along the major rivers (Kibwezi, Athi, Thange, Makindu etc.) on approximately 3000 ha of land with access to irrigation. About 30% of the Asian vegetables (karella [bitter melon], brinjals [eggplant], chillies and okra) produced in Kenya are grown in Greater Kibwezi. Asian vegetables make-up 17% of vegetables exported to the EU.

Through the REAP project, farmers are organized into groups or production units (PUs) of 30–50 members. The farms are run by a farm manager who is employed by the farmers and reports to a committee/board of farmers working initially under the advice of REAP. The REAP management links the farmers to the market by negotiating an export contract; assists the farm manager to make the production plan to satisfy the export contract; and assists the farmers to make business and investment plans to help build their financial bases. The REAP project provides linkages with input suppliers and uses a ‘revolving fund’ (ISF) to facilitate supply of inputs. Loans are repaid at the end of the specific cropping cycle. The REAP project also offers the farmers assistance in acquiring modern irrigation infrastructure and systems through an Inputs Supply Fund (ISF), loans from which are repayable over a longer period. Once the PUs gain full managerial and financial autonomy, the REAP management uses the repaid funds to support the development of another unit.

The emphasis of the REAP project is on **farmer owned** processes rather than farmer managed processes e.g. land use, labour management, crop and variety selection/mix, etc. and group structure. Priority is given to full time farmers with 1.5 acres of land or less and relying on horticulture for their livelihood. The project relies on some initial funds for intensive capital building but ensures sustainability of the funds through loan repayment schemes. This model has potential to be used to improve the domestic horticulture sector. DFID Business Services Markets Development Programme (BSMDP)

The BSMDP was established about a year ago. Its main objective is to stimulate business transactions involving poorer households in a selected number of agricultural sub-sectors e.g. horticulture and dairy. Its outputs are: effective markets for business services and greater inclusion of smallholders and MSEs in the growth channels of selected sub-sectors. Horticulture is one of the key sub-sectors. Given the critical nature of EUREPGAP and its potential to significantly influence the role that export horticulture plays in the sustainable livelihoods of many hundreds of thousands of poor families directly involved in the sector (both out-growers and employees), the BSMDP decided to concentrate all of its initial project activities in the export horticulture sector.

The project aims to create sustainable services providers which will deliver required support to the industry and at the same time help develop the emerging market for these services. By working closely with other donor programmes, the BSMDP adds value for the benefit of the horticulture sub-sector as a whole.

Activities supported by the BSMDP include:

- apprentices in EUREPGAP and EU-PIP programme compliance programmes (with HDC and PIP);
- documentation and information on service providers (with HCDA);
- information on the implications of EUREPGAP and the EU MRL regulations;
- harmonization of export destination and Kenya in-country regulations with HDC;
- support the development and capacity building of relevant industry level associations (with FPEAK, ADHEK, HSPAK, HCDA);
- support the development and promotion of small private sector service providers (with R8297 [CPP project]);
- support the development of local private sector certification and compliance organizations (with ICIPE through AFRICERT); and
- develop and explore the potential of the Product Marketing Organization (PMO) especially to ensure continued growth of involvement of smallholders.

Complementing funding provided by the DFID CPP, the BSMDP co-developed a plan with ICIPE to provide support for the business ideas produced by the trained private sector service provider (PSSP) graduates; developed a business start-up programme for the first group of graduates and possibly future graduates; and developed a pilot programme which links PSSPs and their small business ventures to appropriate financial organizations with repayment guaranteed by contracts especially with exporters (functional) and with producer groups (in future). This contribution from the BSMDP added considerable value to the DFID CPP project directly and to an enabling environment to allow the

project to accomplish far more than perhaps was originally expected. This also shows that value of different groups/donors working together in a coordinated way in a sector that is attracting increasing funding support but is critically in need of improved organization and coordination among donors.

Although the main focus of the BSMDP is export horticulture, potential business opportunities can be found in the domestic sector e.g. strengthening the capacity of smallholders to have a greater role in marketing their produce; linking smallholders with supermarkets etc. Many smallholders growing vegetables for the export sector also grow domestic vegetables for home-consumption and sale.

- **GTZ Promotion of Private Sector Development in Agriculture**

The *Promotion of Private Sector Development in Agriculture* (PSDA) is a bilateral programme, implemented jointly by GTZ and the Ministry of Agriculture in Kenya. The project will run for 12 years; the first phase is from July 2003 to June 2006. The target groups are market oriented farmers and medium and small enterprises involved in agribusiness. The intervention areas are the high and medium potential areas of Central and West Kenya. The programme aims at improving the access of small and medium agribusiness players along selected value adding chains to agricultural markets.

The baseline survey, completed in early 2004, helped to guide the programme in selecting the particular value adding chains for targeted interventions. The survey suggested a list of agricultural enterprises, which are present in the target area and look promising for the intended programme activities. Work is already underway on the potato supply chain; other horticultural crops including carrot, cabbage, onion, tomato, French beans and passion fruit will be phased in over the next year.

Every value adding chain supported by the PSDA will be analysed in detail:

- to identify more precisely the existing players in the chains, including geographical mapping
- to quantify the market potential (i.e. local demand, the regional market, export possibilities)
- to identify the activities needed to support the private sector in the chain.

The PSDA project team were most interested in the outcome of the vegetable seed scoping study. It was that in all stakeholders' consultations to date, poor quality vegetable seed had been identified as a major constraint. The PSDA project wishes to link with a future project on economic development of sustainable vegetable seed businesses in East Africa.

Need to build linkages among initiatives in eastern and southern Africa

The above assessment shows that there are currently no comprehensive institute- or project-based programmes to breed improved vegetable varieties and improve local seed systems. However, there are a number of important initiatives to develop improved technologies and strategies for management of vegetable pests and diseases; to improve marketing systems; and to facilitate uptake of vegetable seed by smallholders that should be linked to a future initiative to improve vegetable seed systems in eastern and southern Africa to the benefit of the horticulture sector as a whole.

Above all, there is a need for an organizational framework such as a network for improved coordination of the plethora of donor projects and institute-based initiatives in progress in the horticultural sector in eastern and southern Africa in order to avoid the growing potential for overlap, duplication and waste of resources.

6.2 Initiatives in other regions

A limited number of selected initiatives in other regions are briefly reviewed. The selection was restricted to examples of relevant models for future economic development of sustainable seed businesses in eastern and southern Africa.

East-West Seeds in South-East Asia

East-West Seeds was established in the Philippines by Simon Groot (formerly of Sluis & Groot) in 1982. Until the establishment of this company, many common vegetable varieties grown in SE Asia were introduced from other countries e.g. traditional OP varieties from Europe. These varieties were not adapted to the prevailing climatic and biotic conditions and performed far below their potential. A team of vegetable breeders was assembled. Their initial emphasis was on developing an understanding of the local vegetable crops and the traits that needed improvement; assessing farmer demands for improved varieties; and then, by trial and error in most cases, developing adapted, improved varieties.

Progressively in Philippines, Thailand, Indonesia and Vietnam, East-West's teams worked with bitter gourd, cabbage, kangkong, cucumber, sweet corn, pumpkin, ridge gourd, wax gourd, tomato, watermelon, eggplant, onion, and yardlong bean (Kunz, 2002). The technology was simple: improved open pollinated varieties followed by hybrids. But it was soon realised that quality seed of improved varieties was not sufficient in itself. There was also a need to develop technology extension services for farmers. **Thus the basis of East-West's successful philosophy has been: sell seed and farmer knowledge as a package.** This is achieved through a network of field technologists who visit farms; develop relationships with key farmers; set up demonstration plots with these farmers; and provide technical back up to farmer communities on production technologies, disease management and use of pesticides. **It should be noted that the need to provide farmers with technical advice on production techniques and sound agricultural practices in the process of promoting seed of improved varieties is also followed by Regina and Hygrotech in Kenya (see Chapter 3 – Vegetable seed sector).**

The results of this private breeding initiative in SE Asia have been very successful. There has been at least 50% adoption of hybrids for all vegetables, and in the case of hybrid pumpkin, 80–90% adoption. As a result, farmers have obtained higher yields and more valuable produce. This has encouraged more intensive production: more food from less land. The money willingly paid by farmers for better seed has promoted continued varietal development by plant breeders, targeted at increasing farmers' revenues through higher yields and better quality products. In SE Asia, the development of improved, productive vegetable varieties, quality seed and farming technology have resulted in improved livelihoods for farmers, growth in the fresh produce market, economic development and changes in the market e.g. extension of growing season or continuity of supply to make the market more stable. In Vietnam alone, East-West's bitter gourd has added value to farmers by over \$15 million. East-West uses the idea of 'quality seed multiplier'. If a farmer pays one unit of currency for vegetable seed, crop revenue would increase by the multiplier effect. This ranges from 11 for bitter gourd to 62 for eggplant. Thus one dollar extra paid for improved seed of eggplant would bring the farmer an extra \$62. Thus, East-West Seed has been key to making a real difference to tropical horticulture in SE Asia.

It should be noted, however, that in the Philippines, it took East-West Seeds 8 years to become profitable. The route to profitability following this model in Africa may take longer.

Asian Vegetable Research & Development Centre (AVRDC)

AVRDC is working closely with the private seed industry in Asia. These public-private sector partnerships are growing and expanding. A recent survey of 29 Asian seed companies showed that 33% of tomato and 16% of chilli pepper cultivars to be released in the near future will contain AVRDC germplasm. Interestingly most of the companies are new and small. They are quickly converting AVRDC advanced breeding lines into cultivars which apparently sell readily. The greatest demand of the seed companies is for disease resistant materials especially for bacterial wilt, Gemini viruses and late blight in tomato and for anthracnose and viruses in peppers and chillies. Fruit quality traits are also in demand (for more information see www.avrdc.org).

Development of tomato varieties with resistance to tomato leaf curl virus in India

A research initiative, funded by the DFID Crop Protection Programme, consisting of three phased projects during 1996 to the present, has successfully developed open-pollinated, tomato leaf curl virus (ToLCV) resistant varieties in India and is currently facilitating their promotion through public and private sectors. The three tomato varieties Sankranthi, Nandi and Vybhav were developed by the University of Agricultural Sciences, Bangalore with the AVRDC South Asian Vegetable Research Network and 25 other State Agricultural Universities in India. As well as resistance to ToLCV, they also have tolerance to bacterial wilt, resistance to tomato mosaic virus, greater than 100% yield increase compared to susceptible varieties and a B:C ratio as great as 6.6:1, and have fruit qualities acceptable to farmers and consumers.

In the third phase of the project, seed is being multiplied by the Kanataka State Seed Company and NGOs such as AME and is rapidly being adopted by farmers. Due to the widespread occurrence of tomato leaf curl virus and the fact that over 60% of the tomato production area in India is sown to susceptible open-pollinated varieties, uptake and impact is likely to be considerable. Nine seed companies have already purchased breeders seed of ToLCV resistant varieties for further production of OP varieties and producing resistant hybrids. Further information can be obtained from www.cpp.uk.com.

6.3 Some potential players

Consultative Group for International Agricultural Research (CGIAR)

Considering the advantages of horticulture in improving the food security, health, and livelihoods of the poor, it is perplexing that CGIAR centres have shown very limited interest, to date, in improving domestic horticulture, with the exception of several isolated projects in Latin America, West Africa, and SE Asia. The CGIAR has provided strong support for research on cereals such as maize, sorghum and rice, and on root crops such as cassava and sweet potato. It is also ironic that this support has extended to the difficult task of bio-fortification of non-vegetable crops (i.e., enhancing the mineral and vitamin contents of maize, cassava and sweet potato) when greater support for existing vegetable production systems would not only solve nutritional deficiencies, but also grow livelihoods and contribute to reducing poverty.

It is pleasing to see that the new CGIAR strategy which is expected to be operational in 2005 plans to include a key new research priority on high value commodities (System Priority 5) including vegetables and fruits (CGIAR, 2004 and see www.cgiar.org for more information). The first step will be a global evaluation and framework to prioritise vegetable research by region. The commodity focus will include: solanaceous vegetables, crucifers, cucurbits and indigenous vegetables. It is hoped that the CGIAR, which currently has no expertise in these commodities, will take note of the extensive expertise and skills in developed country institutes in formulating its research strategy. It will be essential to link this planned future research input into on-going efforts to improve vegetable seed systems and improved management strategies and technologies for vegetable pests and diseases as well as efforts to improve marketing systems to the benefit of the horticulture sector as a whole.

Urban Harvest, the CGIAR system-wide initiative on urban and peri-urban agriculture, which works to contribute to the food security of poor urban families, and to increase the value of agricultural production in urban and peri-urban areas, currently does not have any projects specifically on improving vegetable systems in eastern and southern Africa but could be a partner in any future initiative.

African Agricultural Technology Fund (AATF)

The recently established African Agricultural Technology Foundation (AATF) is designed to remove barriers that prevent smallholder farmers in Africa from gaining access to existing agricultural

technologies, especially biotechnologies. However, the AATF is not supporting any projects on horticultural crops at present. As technologies exist to address some of the major constraints that affect domestic vegetable production in eastern and southern Africa and vegetables especially are an important smallholder crop in this region, it is hoped that AATF will include some projects on horticultural crops in future (see www.aftechfound.org for more information).

7. Summary and recommendations

The domestic horticultural sector in Kenya is expected to continue to grow due to continued urbanization and associated increases in demand. This report has shown that there are some significant constraints to future economic development of the vegetable sector in Kenya and elsewhere in eastern and southern Africa. **As the main focus of the study was on the vegetable seed sector, we have concentrated on the technical constraints that will need to be addressed if the vegetable seed sector is to meet the needs of smallholder farmers and consumers. During the course of the study, however, critical constraints in the vegetable supply chain and in seed regulations were also identified that will need to be considered if the full potential contribution from improved vegetable varieties and seed systems is to be realised for the benefit of smallholders and the sector as a whole.** The level of investment needed in each of these areas to enhance the productivity and efficiency of the domestic horticulture sector is well beyond what one source alone could finance. Active partnerships between governments, donors and the private sector will be necessary.

In this concluding section, we briefly summarize the main findings from each chapter and make recommendations about the key areas that need to be addressed if the vegetable seed sector is to grow in eastern and southern Africa.

7.1 The vegetable supply chain

- Kenyan smallholder farmers produce over 1.5 million tonnes of vegetables annually of which 90% is consumed domestically.
- The yields of cabbage, tomato and onion in Kenya are only 20–25% of those achieved by the top producing countries. **There are opportunities to increase yields through improved, adapted varieties; high quality and affordable seed; and enhanced knowledge and production skills.**
- The majority of smallholder vegetable farmers have 1–2.5 ha of land; at least primary education; regularly use inputs such as irrigation, fertilizers, and chemical pesticides; and purchase vegetable seed. **The major production constraints are pests and diseases; expensive inputs; and lack of irrigation. The major marketing constraints include low product prices, high transport costs, and lack of organized marketing systems.**
- Most vegetables produced are marketed through fresh and processed local or export markets. In Kenya, the value of vegetable production sold and consumed domestically during 1997–2001 was at least 4–5 times as large as the value exported. In addition, domestic markets generate more absolute value-added than export markets.
- Domestic horticultural produce is marketed through village markets, urban markets, small to medium size retail outlets (e.g. greengrocers, self-service grocers, kiosks, other shops etc.) and supermarkets. Urban wholesale markets play the main role in the domestic horticultural marketing system.
- The major constraints affecting Kenya's traditional domestic vegetable supply chain include: **long supply chains with small volume transactions; inadequate market information especially for smallholders; inadequate organization among smallholders; market power mainly in the hands of traders and middlemen; poor transport systems and large distances from markets; poor standards and quality control; little or no product innovation; and high levels of inefficiency.**
- The supermarkets, however, rely instead on brokers and, increasingly, on direct procurement from contracted farmers through “preferred supplier schemes”. This could lead to marginalization of smallholders from supplying supermarkets unless their capacity is built in good agricultural practices to achieve required quality and in business and organizational capability to interact with supermarkets.

Recommendations

The major constraints and inefficiencies in the domestic vegetable supply chain will need to be addressed in parallel with technical constraints if the full potential contribution of varietal improvement and improved seed systems is to be realized. Already some attempts are being made through donor-funded projects and other initiatives to improve systems of market information; improve the organization of smallholders for marketing; improve business capabilities of smallholders to negotiate with traders; and to shorten supply chains and move to higher volume transactions.

- **It will be essential for any future initiative to improve vegetable seed systems in eastern and southern Africa through technical interventions to link with projects and initiatives to improve the functioning of the vegetable supply chain to the benefit of the horticulture sector as a whole.**

Critical technical interventions can also be identified to address constraints such as: poor standards and quality control.

- **Future initiatives to improve vegetable seed systems in eastern and southern Africa should give high priority to the development of pest and disease resistant varieties adapted to local conditions and cultivated under good agricultural practices including reduced use of pesticides. This will go a long way to achieving higher quality; higher food safety standards; and product innovation that are expected to be part of an improved vegetable supply chain.**

The study has shown that improvements in production and marketing of kale, cabbage, tomato and onion would have important impacts on income levels and poverty rates. It has also shown that if marketing costs can be reduced, farm level productivity increased, and market outlets made more reliable, **smallholders already selling vegetables into domestic markets may be able to specialize more in vegetable production and thus be well poised to take advantage of expanding market opportunities.**

There also exist opportunities for smallholders to move into niche products not currently exploited by larger farmers. And, the main supermarkets in Kenya are interested in identifying additional ways in which smallholders can continue to be part of their supply chain. **This further reinforces the opportunities for improved pest and disease resistant vegetable varieties that meet quality requirements to be marketed in supermarkets.**

7.2 The domestic vegetable seed sector

- The seed sector in Kenya is made up of formal and informal components. The formal sector consists of public and private entities involved in the production and distribution of seed. The informal sector consists of NGOs and other groups multiplying seed and farmers.
- After liberalized in 1991, there has been steady growth of seed companies selling seed of a range of crops, including imported vegetable seed. **In Kenya, most vegetable seed is sold by the formal sector;** the exceptions are about 30% of kale seed and some seed of indigenous vegetables.
- Seed produced by the formal sector is strongly regulated; seed produced by the informal sector is not regulated.
- Kenya has 42 registered seed companies (locally-owned and subsidiaries of international and South African companies), of which 26 are licensed to sell seed of horticultural crops. **There is currently no public sector involvement in multiplying seed of commonly grown vegetables in Kenya.**
- **Varieties of cabbage** e.g. Gloria F1 and Copenhagen Market, **tomato** e.g. Cal J and Moneymaker, and **onion** e.g. Bombay Red, **commonly grown by smallholders, are at least 20–30+ years old;**

were bred outside Kenya; and are not adapted to the prevailing serious biotic constraints, including black rot and blight.

- **Seed of hybrid varieties of cabbage and tomato is significant more expensive than that of older OP varieties in Kenya.** This cost differential applies even to older hybrid varieties e.g. the popular Gloria F1 cabbage.
- Farmer surveys failed to identify any smallholders growing newer hybrid varieties of cabbage and tomato. Future local vegetable seed production will need to produce affordable hybrids or price may be a major barrier to adoption.
- **The quality of vegetable seed of sold in Kenya of commonly grown vegetable varieties is often poor** (low germination, uncertain varietal fidelity, off-types, wrong crop etc.). Seed sold in small sachets of 10–25g is more affordable to smallholders but often of poorer quality than that sold in 1 kg tins.
- **Phasing out of older OP varieties of cabbage and tomato to concentrate on hybrids by European seed companies could be an opportunity and major incentive to investment in and growth of the local vegetable sector in Kenya, initially based on affordable OPs.**
- In Kenya, **kale seed is mostly produced locally by smallholders in the formal and informal sectors. This could provide a model case for assessing appropriate approaches for varietal improvement and growth of the local seed sector.**
- STAK is an important voice for the formal seed sector, especially on improving seed regulations and policies, and a forum for exchange of information among seed companies.
- In Tanzania, the seed sector has followed a similar development pathway. Since liberalization, an increasing number of seed companies – both local and subsidiaries of international companies - have been established, especially in/near Arusha.
- In contrast to Kenya, **local vegetable seed production is expanding in Tanzania, especially in the public sector.** Horti Tengeru has an active seed unit multiplying seed of a number of vegetables. AVRDC-RCA also multiplies vegetable seed with NGOs. **Lessons should be learnt from this development.**
- Subsidized seed from NGOs and NARS has not been conducive to expanding the private seed sector. With Rockefeller support, however, AVRDC-RCA will now give priority to enhanced linkages with the private seed sector with 45 potential vegetable varieties ready for release.
- **Most seed companies in South Africa are importing and testing varieties developed by parent companies or associated companies. Few have active breeding programmes** although they usually have breeders on staff. In contrast, smallholder farmers are the main market for the Danish company Daehenfeldt which sells hybrid cabbage seed through Simlaw and East African Seeds in Kenya.
- In Zimbabwe, due to political and security problems, many seed companies have moved to neighbouring countries and the seed importation system, especially for hybrids, has largely collapsed.
- **One notable, unique exception is East-West Seeds Zimbabwe which is attempting to establish successful breeding programmes for local vegetables e.g. kale, paprika, onion, and squash and a vegetable seed business based on the successful East-West Seeds initiative in SE Asia.**
- The major constraints affecting the vegetable seed sector include: **poor infra-structure especially roads; low quality and fake seed; old varieties susceptible to diseases and pests; high operational costs (especially investment in processing and storage facilities); lack of qualified distributors and retailers; lack of linkages with public sector breeding initiatives and public-private sector partnerships; and over-regulation and lack of capacity in the regulator (considered further in Chapter 5).**

Recommendations

There appear to be substantial opportunities to increase yields through improved, adapted varieties; high quality and affordable seed; and enhanced knowledge and production skills and thereby foster future economic development of the vegetable seed sector in eastern and southern Africa.

- **High priority should be given to improving the linkages between the public sector breeders and private sector seed companies through building awareness and trust and, where necessary, understanding and capability so that sound partnerships can be developed to the benefit of the vegetable seed sector. The seed companies feel that the public sector lacks appreciation of the practical problems faced by them and perceive a lack of interest by public sector institutes in promoting technologies and new varieties to seed companies. Public sector representatives feel that they lack understanding, skills and confidence to develop partnerships with the seed companies e.g. how to set up MTA's and negotiate royalty agreements. Building understanding and trust between these two groups is critical to future economic development of the vegetable seed sector.**

Smallholders' needs for guaranteed quality seed, availability and affordability are not being met by the current vegetable seed system. Most affordable vegetable varieties on offer are old European varieties which are not adapted to the prevailing biotic constraints such as black rot (for cabbage) and blight (for tomato). The quality of seed is variable and poor.

- **High priority must be given to either sourcing and/or developing improved, adapted, affordable and preferred varieties of commonly grown vegetables such as cabbage, tomato and onion to the benefit of smallholders and consumers. Due to the cost of seed, it would be best to initially concentrate on OP varieties but attention is also needed to producing affordable hybrids. The plan by European seed companies to phase out commonly grown OP vegetable varieties offers an opportunity and an incentive for investment in local production of quality seed of the best current and improved OP vegetable varieties. Potential models are also being developed for local vegetable seed production through current project work on kale. This could also provide models for African indigenous vegetables.**
- **Opportunities should also be sought to build the capacity of seed distributors and retailers so that they can provide farmers with high quality product and necessary advice. Options to improve the seed regulatory system are identified below.**

7.3 Vegetable breeding capacity

- **In Kenya, there are currently no active vegetable breeding programmes in the public sector** although expertise in onion and tomato breeding is available. Breeding targets in common vegetables are known. Expertise is also available in vegetable agronomy and seed technology.
- **KARI currently does not have any vegetable breeders or active vegetable breeding programmes.** It also has no seed technologist and no operational seed production unit. Severe understaffing in horticulture in KARI seriously limits its capability in this area. In comparison, there are eight maize breeders in KARI.
- There is capability for training in several Kenyan Universities including onion and tomato breeding; horticultural science; vegetable agronomy; and seed technology.
- **In the Kenyan, plant breeding expertise is available in seed companies but is currently not being deployed in breeding programmes.** Most international and/or subsidiary seed companies depend on technical support and facilities of parent companies for varietal development. At the same time, seed companies have excellent trial and demonstration facilities throughout Kenya which could be utilized for local vegetable breeding programmes.
- Public sector representatives indicated that urgent attention is needed to educate public sector institutes on how to develop public-private partnerships. The Plant Breeders Association of Kenya (PBAK) could act as the coordinator of an initiative to build public-private sector partnerships to link public sector breeding initiatives with private sector seed companies in Kenya.
- **Public and private sector representatives indicated that there are no technical reasons why OP varieties of commonly grown vegetables such as tomato, cabbage, carrot and onion**

cannot be bred in Kenya and, in addition, quality seed multiplied. Tanzania is successfully multiplying seed of tomato, cabbage and onion. Past attempts to multiply seed of cabbage and carrot in Kenya were abandoned due to difficulty, risk, cost and lack of varietal stability.

- However, 150 tonnes of kale seed; seed of Asian vegetables; and seed of tomato is currently being multiplied in different parts of Kenya.
- **In Tanzania, Horti Tengeru currently has no vegetable breeders or breeding programmes, with the exception of maintaining already bred varieties.** It has the equipment to install a seed production unit but this has not yet been installed due to lack of personnel. Some researchers have collaborative projects with AVRDC-RCA.
- **AVRDC – RCA is actively involved in screening and selection in a number of vegetable crops e.g. tomato and African indigenous vegetables,** but relies on its headquarters in Taiwan to do the actual crossing mainly due to lack of breeding capacity in RCA.
- **Limited vegetable breeding capacity in the public sector in East and southern Africa is severely restricting the development of improved, adapted vegetable varieties in this region.**
- **In South Africa, the ACCI offers PhD training in plant breeding through the University of KwaZuluNatal (KZN)** in order to build capacity in national research programmes in Africa. The programme is funded by Rockefeller. ACCI could provide PhD training in vegetable breeding as it already has several staff with backgrounds in vegetable breeding. One of the advantages of the programme is that it keeps students in Africa working on African crops. **However, one disadvantage is the condition that students must have a permanent position in their own countries to return to. With respect to Kenya and Tanzania, there are currently very few or no vegetable breeders in public sector institutes. Breeding positions would have to be reallocated from other crops to vegetables.**
- The VOPI, Roodeplaat, is now directing its research toward smallholder farmers. It has programmes on development of OP varieties of tomato, white pumpkin and beans (rust resistance). It plans to establish participatory breeding and selection programmes with initial selection done by VOPI followed by further selection by farmers on-farm. VOPI is also interested in developing small-scale on-farm seed storage to allow farmers to use farm-saved seed. VOPI have potential for training students from other African countries.
- **There are three potential ‘models’ for carrying out vegetable breeding in eastern and southern Africa. These include: home based breeding - development of varieties entirely in country; shuttle breeding - development of varieties in country from breeding lines produced elsewhere; and backcross breeding - improving existing varieties by adding single key traits.** The advantages, disadvantages and generic resources required for these models are discussed in the report.
- The major constraints to developing successful vegetable breeding programmes in eastern and southern Africa include: **lack of public sector breeding capacity and under-utilized private sector breeding capacity; lack of linkages between the public and private sector; lack of appropriate germplasm with required traits; lack of funding support; and lack of a comprehensive programme.**

Recommendations

These major constraints will need to be addressed if improved and affordable vegetable varieties adapted to local conditions are to be successfully produced in eastern and southern Africa. Above all, the major constraint is the lack of vegetable breeding capacity in the public sector in East and southern Africa. In the past, there were vegetable breeders with active breeding programmes in universities and NARS e.g. KARI, Kenya and Horti Tengeru, Tanzania. However, in recent years, this capacity has been eroded. It is currently severely restricting the development of improved, adapted vegetable varieties in this region.

- **Highest priority should be given to re-building vegetable breeding capability in eastern and southern Africa.**

There are various options: currently under-utilized breeding skills in the private sector could be sourced; two universities in Kenya have experienced onion and tomato breeders who could train additional breeders; NARS breeders currently working on other crops could be reallocated; there is potential to be tapped in AVRDC where most breeding capacity is currently concentrated in Taiwan; and the ACCI in South Africa offers PhD's in plant breeding through a Rockefeller supported programme.

- **Existing breeding skills in the region should be initially tapped for capacity building in improving specific vegetable crops. This could be strengthened over time. It is likely that such support for the public sector research would attract private sector investment. Priority should be given to developing a coherent, supported programme.**

Advice and help is also needed on where and how to efficiently source germplasm with desired traits, especially what farmers and consumers want.

- **Highest priority should be given to those target crops where key constraints (e.g. black rot of cabbage; blight and viruses of tomato; improved storage life for onion etc.) have already been identified and in some cases, sources of traits identified and breeding programmes in progress e.g. in Tanzania.**

Potential models for vegetable breeding programmes have been proposed.

- **It is recommended that the most sustainable system – already successfully pioneered by East-West Seeds in SE Asia - would be a phased approach involving: the introduction of potentially useful existing OP varieties with needed traits from breeding programmes around the world for evaluation under local conditions (phase 1); the initiation of breeding programmes in parallel to produce improved, locally adapted (especially with needed disease and pest resistances) OP varieties to meet market requirements and to boost farmer' income (phase 2); followed by the introduction of hybrids (phase 3). In this phased way, improved varieties from elsewhere could be available to farmers within 2–3 years and improved, locally adapted varieties within 3–5/4–7 years.**

This approach could be complemented by the development of public-private partnerships through linking the breeding expertise of the public sector with the resources and infra-structure of the private seed companies for seed production. In Kenya, Hygrotech has expressed interest in developing such partnerships and has a vision which includes smallholders. Public sector institutes should be encouraged and supported to build understanding and confidence to pursue such partnerships.

7.4 Current regulatory framework

- **In Kenya, KEPHIS is the main regulatory body for the seed industry.** It is mandated to coordinate all matters related to pest and disease control; monitor the quality; administer Plant Breeder Rights; undertake inspection, testing, certification, quarantine control, variety testing and description of seeds and planting materials; approve import applications for seeds, plants and appropriate phytosanitary requirements and importation of such material; and be responsible for inspection of produce for export and import.
- KEPHIS registers all seed companies, traders and seed growers; certifies all seed; issues permits; and monitors the importation and exportation of seed.
- **Most vegetable seed marketed in Kenya is from varieties bred overseas.** Newly introduced varieties must pass through national performance trials before release which can take between 2 to 12 years and cost up to 12 million KSh.

- Seed companies can enter the market under simple registration conditions without necessarily showing proof of adequate infrastructure and trained personnel. **KEPHIS feels that the regulations for seed company registration need to be made more strict.**
- **The seed companies feel constrained by the restrictive, complex and difficult administrative and regulatory systems for the importation of seed** (e.g. the need for three levels of testing; registration of new varieties; and multiplication and marketing of seed). They do not feel that KEPHIS is providing quality, timely and satisfactory services, co-ordination and leadership in the seed industry. The seed companies suggested that this is a disincentive for innovation and growth.
- Seed companies suggested that **KEPHIS lacks both the capacity (under-staffed)** and the competence to test seed (no formally trained seed technologists). STAK feels that there is an urgent need to build capacity and expertise in KEPHIS to meet the needs of the major stakeholders in the system, especially the seed companies.
- A number of seed companies as well as the STAK highlighted **the need for a competent national seed technology institute in Kenya.** The institute with most capability is Moi University. Regina is currently working with Moi University to develop improved procedures for seed testing to provide sound evidence to KEPHIS that re-testing each six months is not necessary.
- **Attempts are being made by several seed companies to develop a more cooperative relationship with KEPHIS and to seek solutions to the critical bottle-necks created by the current regulatory framework.**
- **STAK emphasized that reforms are required in the current regulatory framework in all areas: regulatory; legal; policy and administrative.** STAK has already produced draft documents on regulatory reforms and a national seed policy (legal and policy issues) which are under discussion with the MoALRD.
- **There is currently no national varietal list for vegetables in Kenya** due to the widespread use of old vegetable varieties which lack necessary information e.g. breeders of many varieties are not known as varieties pre-date the formal system of Plant Varietal Rights. This document is an important step in the process of liberalizing seed movement between the Kenya, Tanzania and Uganda as part of the regional harmonization processes.
- **STAK feels that the critical problem in Kenya is to simplify the regulatory framework and reduce over-regulation.** Over-regulation of the seed sector is a serious disincentive for new companies to enter the sector, and thus for the growth of the sector and ultimately makes seed more expensive for the grower.
- **KEPHIS is aware that seed companies complain of over-regulation but does not perceive its actions to be restrictive. It sees its role as a facilitator. There is clearly a significant lack of understanding among key stakeholders in the vegetable seed sector in Kenya.**
- For example, KEPHIS decision to enforce the ISTA orange certificate based on deterioration of the quality of imported vegetable seed from Europe has not been sufficiently explained to STAK and the seed companies. KEPHIS feels that there is a justifiable need to be more careful and to enforce approved regulations. The seed companies see this as yet another example of over-regulation.
- **KEPHIS is strongly supportive of the need to build local vegetable breeding and seed production skills. Local breeding capacity producing locally-adapted varieties would help to achieve production of quality breeder seed.** The development of partnerships between public sector breeders, seed companies and contract farmers to produce quality seed for sale in Kenya to smallholders would make the task's of KEPHIS easier. KEPHIS feels that it has an important role to play in building understanding and awareness of seed quality across the supply chain.
- In Tanzania as in Kenya, the seed sector had also been tightly controlled and regulated by TOSCA and the GoT. In 1994, the GoT liberalized the economy and the seed industry was re-structured. In contrast to Kenya, the process of liberalization of the seed sector was harmonized with

liberalization of output markets which has resulted in a more flexible and workable system and seed sector which seed companies appreciate. **In light of the difficulties in Kenya, such progress in reform of the Tanzanian seed sector may hold useful lessons for Kenya.**

- **In East Africa, the seed industry faces many different standards and regulations in each country which are costly to meet. This reduces incentives for local and international seed companies to make investments required to provide quantity, quality and variety of seed needed to support the expanding agricultural base.**
- **ECAPAPA is currently seeking to facilitate the harmonization and rationalization of seed policies and regulations in the region to establish a common regional market with an effective demand large enough to induce needed investment for a viable and efficient seed industry in the region.**
- The major constraints affecting the regulation of the seed sector in Kenya (more so than in Tanzania) include: **restrictive, complex and difficult administrative and regulatory systems for the importation of seed, registration of new varieties, and multiplication and marketing of seed; lack of harmonization of seed regulations with those of other inputs (in contrast to Tanzania); specific barriers to harmonization of regulations affecting vegetable seed due to lack of information; lack of capacity in KEPHIS to satisfactorily meet its multiple roles; and lack of understanding between key stakeholders in the seed sector.**
- **The plan to establish an East African Seed Committee with representatives of the regulators, seed traders associations and plant breeders associations for those countries that already support harmonization is seen by the study team as a positive development in resolving some of the constraints to simplify restrictive seed regulations and facilitate the harmonization process.**

Recommendations

Over-regulation of the seed sector is a serious disincentive for innovation, entry and growth of the sector. The current regulatory system needs critical attention in parallel with technical constraints if the full potential contribution from varietal improvement and improved seed systems is to be realized. Already some attempts are being made through donor-funded projects and other initiatives to address these constraints. For example, STAK and some of the seed companies are attempting to develop a more cooperative relationship with KEPHIS and to seek solutions to the critical bottle-necks created by the current regulatory framework. STAK has already produced draft documents on regulatory reforms and a national seed policy which are under discussion with the MoALRD. ECAPAPA is facilitating the rationalization and harmonization of seed policies, laws and regulations to reduce transactional costs and widen the market to stimulate investment by the private sector.

- **It will be essential for any future initiative to improve vegetable seed systems in eastern and southern Africa to link with projects and initiatives to improve the seed regulatory system to the benefit of the horticulture sector as a whole.**
- **Opportunities should also be sought to facilitate the building of improved relations between key stakeholders in the sector especially the regulatory bodies and the seed companies.**

There is strong support from KEPHIS for building local vegetable breeding and seed production skills in terms of its contribution to local production of quality breeder seed. Because the development of a system based on partnerships between public sector breeders, seed companies and contract farmers to produce quality seed for sale to smallholders in Kenya would probably eliminate many of the critical bottlenecks and inefficiencies in the current system, this is further justification for support for improving the vegetable seed sector. This one intervention would solve both technical and regulatory issues simultaneously.

- **Effort should be given to developing national varietal list for vegetables in Kenya, Tanzania and other countries that need such a list.**

The development of such lists is an important step in the process of liberalizing seed movement between the Kenya, Tanzania and Uganda as part of the regional harmonization processes.

Progress made in liberalizing the seed sector within the broader context of liberalized markets in Tanzania has resulted in a more flexible and workable system and seed sector which seed companies appreciate.

- **In light of the progress made in Tanzania, it is recommended that future efforts to reform of the Kenyan seed sector should take note of the useful lessons learnt in Tanzania.**

KEPHIS is mandated to fulfill a daunting number of tasks which may be contributing to its lack of capacity and expertise in some areas e.g. seed technology.

- **The options to address this would be to build capacity and expertise in KEPHIS to meet the needs of the major stakeholders in the system, especially the seed companies or to reallocate particular tasks to other institutes e.g. Moi University for seed technology.**

The plan to establish an East African Seed Committee with representatives of the regulators, seed traders associations and plant breeders associations for those countries that already support harmonization is seen by the study team as a positive development in resolving some of the constraints to simplify restrictive seed regulations and facilitate the harmonization process.

7.5 Initiatives to improve local vegetable production

The assessment of initiatives showed that there are currently no comprehensive institute- or project-based programmes to breed improved vegetable varieties and improve local seed systems. However, there are a number of important initiatives to improve the vegetable sector that should be linked to a future initiative to improve vegetable seed systems in eastern and southern Africa to the benefit of the horticulture sector as a whole.

In eastern and southern Africa, relevant institute- or NGO-based initiatives include the ICIPE's Horticultural Research and Training Programme; CABI-ARC's FFS's in horticultural IPM and the Good Seed Initiative; HCDA's support to the export sector; KIOF's activities in farmer training in organic vegetable systems; SOCDP-FIPS mini-pack system of vegetable seed and fertilizer; and Technoserve's business solutions to rural poverty focussed at the horticulture sector. Although these institutes/NGOs have a commitment to improve local vegetable production, many of their activities are project-based and depend on donor funds.

ICIPE's horticultural research and training programme aims to develop improved IPM practices in smallholder horticultural systems across export and local sectors. The team has considerable experience as research leader and implementer with a range of crops including cabbage, kale, tomato, French beans, okra, mango and flowers and an extensive range of stakeholder and collaborator links. The original idea for a horticultural network in East Africa was developed by the GTZ/ICIPE team.

- **Future research on improving vegetable breeding and seed systems in the region should be closely linked to ICIPE's efforts to develop improved strategies and technologies for management of vegetable pests.**

Both the CABI's Good Seed Initiative and SOCDP-FIPS mini-pack system for vegetables merit further consideration as potential links and possible models for any future initiative for improving vegetable breeding and seed systems in Kenya.

HCDA has the experience and the position to provide support across the vegetable sector in Kenya, both export and domestic.

- **A comprehensive programme of support for the domestic vegetable sector coordinated by HCDA and based on quality seed and other needed inputs; technical training and advice; and an improved marketing system would greatly increase the productivity and efficiency in the domestic vegetable sector in Kenya.**

Technoserve has suggested various approaches to improve the domestic horticulture sector and to secure the future for smallholders including: improved physical markets, facilitated by government and operated by the private sector, to make markets more attractive to retailers; improved virtual markets, consisting of multiple private sector wholesalers in competition; and closer relationships between farming communities and urban retailers.

As the same smallholders often grow vegetables for both export and domestic markets, the advantages that attract export companies to working with smallholders e.g. low investment requirement; reduced risks; cost-effectiveness; and political protection, could also benefit the domestic sector – if domestic marketing systems were improved and smallholders organized and supported technically.

Technoserve emphasized that most exciting opportunities exist in promoting the growth and efficiency of the domestic horticultural sector especially to support growing urban food demands.

- **Future research on improving vegetable breeding and seed systems in the region should be closely linked to Technoserve's interest and potential support for upgrading physical markets in urban areas; improving marketing systems; and building links between retailers and farmers, based on elements of the export model.**

In this region, there are also notable project-based initiatives which include: the DFID CPP's cluster of inter-related, 3 year vegetable pest management projects in Peri-urban Nairobi, over the past ten years; FINTRAC-Horticulture Development Centre (HDC) USAID-funded project to increase incomes of horticultural smallholders; and the Maendeleo Agricultural Technology Fund project on empowering small scale and women farmers through sustainable production, seed supply and marketing of African Indigenous Vegetables in East Africa. Clearly such projects have finite timeframes and may not be operational when future projects on improving vegetable breeding and seed systems are initiated,

- **Future research on improving vegetable breeding and seed systems in the region should build on the knowledge bases developed by these projects.**

Lesson learning and relevant outputs from the three projects: CARE-REAP; DFID BSMDP; and GTZ PSDA on development of agri-businesses with smallholders and tackling market inefficiencies in vegetable supply chains are relevant to future research on improving vegetable breeding and seed systems in Kenya. In particular, the PSDA project indicated that **poor quality vegetable seed had been identified as a major constraint in all stakeholder consultations to date.**

- **Future research initiatives on improving vegetable breeding and seed systems in the region should seek linkages to projects addressing marketing constraints for improvement in the sector as a whole.**

Above all, the plethora of non-linked donor projects and institute-based initiatives in progress in the horticultural sector in eastern and southern Africa highlights the need for an organizational framework to avoid the growing potential for overlap, duplication and waste of resources.

- **There is a need for a network to improve coordination, linkages, efficiency and impact.**

A review of a limited number of selected vegetable seed initiatives in Asia including East-West Seeds in SE Asia; AVRDC's public-private sector partnerships with seed companies in Asia; and a series of DFID-CPP projects for developing tomato varieties with resistance to tomato leaf curl virus in India **identified potential models for future economic development of sustainable seed businesses in eastern and southern Africa.**

The following models should be considered by future research initiatives to develop economically sustainable seed businesses in the region:

- **Phased development of improved OP vegetable varieties followed by hybrids successfully used by East-West Seeds in SE Asia;**
- **Public-private sector partnerships developed by AVRDC with seed companies in Asia for promotion of vegetable varieties;**
- **Development of OP tomato varieties with the public sector in India to stimulate the interest of private seed companies.**

These models are not mutually exclusive.

7.6 General recommendations

In addition to the recommendations given above to address the major technical, regulatory and marketing constraints currently faced by the domestic vegetable sector in eastern and southern Africa, several general recommendations can be made to improve the functioning and future viability of the sector as a whole.

Need for a network

Due to the complexity of the vegetable sector in East Africa; the large and growing number of stakeholders and donors involved; and the increasing number of individual, and currently, uncoordinated projects, there is increasing potential for duplication of effort and waste of resources. A horticulture network was originally proposed by the GTZ IPM Horticulture Project based in ICIPE in 1997. Unfortunately due to lack of agreement between potential members, the idea was abandoned in 2000. Recently, AVRDC-RCA proposed a vegetable network: "Improving vegetable productivity and consumption in ASARECA member countries". ASARECA currently have no funds to support this proposal.

- **A vegetable network, under the auspices of ASARECA would help to establish much needed coordination in this sector. However, at this stage, priority should be given to further consultation on the structure, coverage, function and membership of the network in consultation with all major stakeholders.**

Such a network will need to be aware of the needs of the whole vegetable sector: varietal improvement; improved seed systems; simplified seed regulations; improved marketing systems and processing needs in order to direct investment at the best opportunities to address the most critical and priority constraints.

- **It is therefore recommended that funding should be sought to hold for a workshop involving representatives from public research organizations, private companies,**

marketing groups, supermarkets, processors, regulatory bodies etc. to discuss the structure, coverage and function of a network for the benefit of the sector as a whole.

Such a workshop would initiate the important process of building awareness of the capabilities of each potential member.

Learn from the success of the export sector

As this report has indicated, the **export vegetable sector in Kenya** has achieved remarkable growth and success. From an insignificant base, export horticulture has become the fastest growing agricultural sub-sector and one of the top five foreign exchange earners in Kenya. It consists of commercial farmers and **tens of thousands of organized smallholder farmers** closely linked to export companies, competing successfully in the highly competitive and quality conscious European market. **It is based four pillars: improved vegetable varieties; high quality seed; efficient marketing systems; and reliable technical assistance and capacity building.**

Production of vegetables for the domestic market is almost entirely by smallholder farmers.

These farmers usually have the minimum infra-structural requirements e.g. a reasonable supply of water for irrigation, land and are often in peri-urban areas, not too distant from urban markets.

However, their greatest needs are for the four basic pillars of the export sector: improved varieties; quality seed; efficient marketing systems; and reliable technical assistance and capacity building.

In many cases, the same smallholder farmers are growing vegetables for both the export and domestic sectors. These smallholders are the common denominator for transfer of knowledge and technologies from the export to the domestic sector. Significant opportunities therefore exist for smallholders to benefit from the learning experiences of the export sector.

- **It is strongly recommended that support from governments, donors and the private sector be tapped to transfer relevant learning experiences and the technical expertise and skills from the Kenyan export sector to improve the domestic vegetable sector based on the four basic pillars, which is also an appropriate model for the domestic vegetable sector.**

7.7 Conclusion

Through the development of robust partnerships between appropriate stakeholders (international, regional, national public and private sector), improved, adapted vegetable varieties could be bred and appropriate, affordable and sustainable seed delivery systems could be developed in eastern and southern Africa. Much needed vegetable breeding capacity in the region would be significantly strengthened; environment and human health would be improved through reduced use of pesticides; livelihoods would be enhanced through income generation and employment opportunities; and widespread delivery of adapted and affordable seeds would be promoted in a financially sound manner. In addition, viable public-private sector partnerships would be created and fostered for future sustainable national and regional economic growth.

This study has identified some exciting opportunities for addressing the major constraints to future economic development of sustainable vegetable seed businesses in eastern and southern Africa. We conclude that research input in, and development support for, an improved domestic vegetable sector is overwhelmingly justified by its potential to reduce poverty and improve the livelihoods of the poor, not the least through increasing the availability and lowering the cost of a range of nutritious vegetables. Already, the necessary technologies and skills are available both in the region and in developed countries to address the major constraints in the region.