CROP PROTECTION PROGRAMME

Promotion of Quality Vegetable Seed In Kenya

R8312 (ZA0582)

FINAL TECHNICAL REPORT

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List of Abbreviations

AFSTA	African Seed Trade Association
ARC	African Regional Centre
CABI	CAB International
CAN	Calcium Ammonium Nitrate
CPP	Crop Protection Programme
CSL	Central Science Laboratory
DAP	Diammonium Phosphate fertilizer
DBM	Diamond Back Moth
DEFRA	Department for Environment, Food and Rural Affairs
DFID	Department for International Development
DGISP	Danish Government Institute of Seed Pathology
DUS	Distinctiveness, Uniformity and Stability
EASCO	East African Seed Company
FS	Fieldhouse-Sasser agar
FTR	Final Technical Report
HCDA	horticultural Crops Development Authority
HRI	Horticulture Research International
ICIPE	International Centre for Insect Physiology and Ecology
IF	Immunofluoresence
ISTA	International Seed TestingAssociation
KARI	Kenya Agricultural Research Institute
KEPHIS	Kenya Plant Health Inspection Service
KFA	Kenya Farmers' Association (KFA)
Ksh	Kenyan Shillings
Lagrotech	Lowlands Agricultural and Technical Services Limited
LSC	Lagrotech Seed Company
MLT	Multilocational Trial
MoA	Ministry of Agriculture
NARL	National Agricultural Research Laboratories
NARO	National Agricultural Research Organisation
NGOs	Non Government Organisations
NPT	National Performance Trial
NRI	Natural Resources International
NSCAA	Nutrient Starch Cycloheximide Antibiotic Agar
PDA	Potato Dextrose Agar
PRA	Participatory Rural Appraisal
QA	Quality Assurance
QVSP	Quality Vegetable Seed Project
SADC	Southern African Development Community
SPSS	Statistical Package for Social Sciences
Stpro	Seed Test analysis program
UPOV	Union Internationale pour la Protection des Obtentions Vegetales
WINROCK	Winthrop Rockefeller International
Xcc	*Xanthomonas campestris* pv. *campestris*
YDC	Yeast Extract Dextrose $CaCO_2$ agar

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Executive Summary

Anticipated outputs for this project have been achieved as expected with additional achievements of development and distribution of 5 improved kale lines to farmers. The socio-economic survey identified the types of kale that farmers use, their preferences, and the sources from which farmers obtain their seed. An inventory of brassica seed in Kenya has been drawn up from commercial seed companies/local markets. Farmers' views on current seed production and marketing systems that exist in Lari division, Kenya, have been documented and the feasibility of a community based seed production and seed marketing strategy explored. PRA activities have thus made significant contributions to our understanding of farmers' perceptions and needs with respect to seed purchases. Kinale farmers expressed a strong interest in multiplying/marketing seed with improved seed health and quality. In close collaboration with KEPHIS inspectors, using international UPOV guidelines, Kinale kale has been characterised as a variety for the first time. A crucial achievement by farmers and researchers has been the selection and evaluation of 7 lines from a trial of 24 Kinale kale lines, grown on the KARI research station (Njabini). Five of these very impressive lines have now ben submitted to KEPHIS for trails for distinctiveness, stability and uniformity (DUS) and we expect that they will be in demand from farmers in the future. In order to progress to these new varieties multilocational performance trials will be continued by the current research team in a follow-on project (see below). Multilocational trials yielded enormous quantities of seed, providing the opportunity to distribute excess seed to more than 350 farmers in most kale producing areas, and to invite further feed back re. kale performance. The feasibility of a community-based approach to seed multiplication in Kinale and potential for establishing and registering a commercial seed business in Kinale has been examined and indications are that farmers are keen to pursue this approach. The project also demonstrated the cost-benefits of three different kale seed multiplication models to farmers. Good seed multiplication practice for kale and seed certification using a preferred model has been promoted, and there is now demand to go beyond this and to register and release Kinale kale seed varieties. Practical strategies for sustainable management of black rot in brassica have also been developed, by examining the presence and survival of black rot in brassica crop debris in on-station trials at KARI-NARL. Good progress has also been made in improving seed testing capacity in Kenya with two KEPHIS staff having been trained in testing seed for black rot to ISTA standards, followed up by a KEPHIS/KARI training workshop in Kenya in November 2003 attended by about 10 staff. The project has contributed to sustainable rural livelihoods in that the outputs will help farmers to produce their vegetable crops (for consumption and sale) in a safe, more effective and economic way. Benefits will include improved nutrition for whole families, better cash returns from higher yields of better quality produce and an empowerment through agricultural knowledge which will help them to make informed choices on other cropping options.

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Background

Market gardening and horticultural enterprises represent a significant source of income for many small-to-medium scale growers in Kenya. Brassicas in Kenya are grown on 40,000 ha and the 604,000 metric tons grown are an important part of the diet of Kenyans, especially in low-income groups. In Kenya, kale and cabbage are among the most important crops grown by smallholders. It has been estimated that vegetable production provides nutrition, income and employment to more than 4 million poor people in Kenya (Lenne, 2002; Ota & Lenne, 2003). Brassicas (kale and cabbage) and tomatoes are the most important vegetables for the domestic economy, being grown by over 90% of smallholders (Oruku & Ndun'gu, 2001). In the case of kale, (*Brassica oleracea*), this crop is cultivated both for home consumption and commercial purposes. Vegetable productivity is, however, constrained by both the availability and the quality of seed. Much of the seed that is currently available is expensive, imported seed, and the quality is poor.

Vegetable production in Kenya

Kenya has a land area of 583,000 km^2, 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) (Table i). 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 small-holder farmers each with approximately 1-2.5 ha of land.

Table i. The main vegetable crops grown in Kenya by area, volume and value (Source: HCDA (2002))

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

Table ii. Area and production shares of major vegetable crops in Kenya, 1992 and 2001 (adapted from Mutuku Muendo *et al*. [2004]) (Data Source: MoALRD)

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

Production trends in major vegetable crops in Kenya during the past ten years are given in Table ii. 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 have remained the same since then. This may be due to increasing difficulties faced by small-holder farmers in managing major pests and diseases of non-adapted varieties, and this 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.

On-going and recently completed projects in the peri-urban vegetables cluster have identified seed quality as a critical issue (Meeting Report for the CPP Peri-Urban Vegetables Cluster, 16-17 Oct 2002). The main issues associated with seed quality are: identity of the seed (i.e. is it the stated variety?), contamination with other species/varieties of seed, rate of germination (this is affected by transport conditions, shelf life, the practice of dumping poor quality seed), availability of the desired variety, (i.e. seed control practices which result in a monopoly), seed health and cost and value of the seed and whether appropriate packet sizes are available. Most vegetable seeds being sold in rural markets are of poor quality, because the seeds are from a mixture of varieties, and disease aspects are not taken into account when seeds are being collected. There is little selection of parent plants, resulting in poor seed, some of which can even carry seed-borne diseases. These factors result in insecurity amongst smallholder farmers, and are reflected in a demand for better quality vegetable seed. A recent study has shown that the adoption of improved varieties is high therefore there is good justification for the promotion of seed of improved quality (Oruko & Ndun'gu, 2001).

A socio-economic cross cluster survey (Oruko & Ndun'gu, 2001) has provided evidence that, although the majority of vegetable farmers obtain their seed from retail outlets, some do purchase seed from other farmers. This is especially true for kale, where 18% of farmers purchase this seed from a fellow grower. In the Kinale district of Kenya there is already some trading in farmer-saved kale seed and CPP project R7571 recently engaged farmers in participatory research on selection criteria for kale plants for seed production. Both suitable (healthy) and unsuitable (diseased) plants were offered to farmers and researchers for the production of seed, and the resulting seed was grown on for evaluation. All of the 19 farmers chose plots with researcher-selected and farmer-selected healthy seed as their preferred plots, and farmers were very happy to gain knowledge on how to improve the quality of farmer-collected seed. This research has now generated great demand from farmers to know good seed from bad in the local market, where it is not possible to know the condition of the plants (diseased or healthy) from which seed was obtained. There is a clear opportunity for Kinale farmers to brand and market quality kale seed of known origin and, as these local kales are landraces, they should not be subject to legislation. KARI has an existing Seed Unit for developing local seed multiplication schemes and has shown demand from farmers for improved vegetable seed.

In a survey of farmers around Nairobi by Oruko and Ndung'u (2001) viral infections and black rot, caused by the bacterium *Xanthomonas campestris* pv. *campestris*, were identified as the diseases of most concern to kale and cabbage growers. Thirty-nine percent of farmers reported problems with black rot in kale, and 41% reported problems in cabbage. At a meeting (*Review of The CPP Peri-Urban African Vegetables Cluster*) in October 2002, Black rot was considered to be a serious threat to kale seed production, and this potential problem was highlighted as a future research priority. Growers of vegetable Brassicas regularly suffer major losses as a direct result of black rot, with 100% crop loss often reported. The bacterium is considered to be primarily seed-borne, and early infection can be particularly significant within nursery beds. However, infection in the field can also occur through carry-over between crops in association with infected crop debris. The relative importance of infected crop debris and seed transmission is likely to be dependent on local cropping systems and environmental conditions. Clearly, black rot is a major constraint on peri-urban Brassica production. Thus, any reduction in this disease, particularly through the development of strategies for sustainable disease management, will directly benefit peri-urban farmers by increasing profitability of both smallholders and larger export growers.

Studies undertaken by KARI and NARO, into disease resistance in vegetable Brassica crops, have focussed on cabbage and cauliflower, reflecting their commercial value, notably screening for germplasm improvement from an agronomic stance. No previous studies of this type have looked at the relative susceptibility of the current recommended or landraces of *B. oleracea* to *Xcc* in Kenya. Although the deployment of resistance is widely seen as the most promising approach to control, extensive testing of a worldwide brassica germplasm collection (held at HRI), has not yet found any effective resistance to Races 1 and 4 in *B. oleracea*. However, resistance to other races can be found in *B. oleracea.* It is therefore vital to have knowledge of the races of *Xcc* which are locally present if an effective control strategy based on breeding for and deployment of resistance is to be developed. However, such a strategy is long term, with no guarantee of success, and should await the outcome of current research at HRI, where the transfer of useful resistance genes from other *Brassica* spp. into the vegetable brassicas (i.e. *B. oleracea*) is being attempted. Therefore, in the short term, the any primary means of disease control of black rot should focus on the use of clean seed and minimisation of the risk of field carry-over of the disease in crop debris.

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Project Purpose

The overall aim of the project described in this Final Technical report was to promote a sustainable system for farmer-led multiplication of kale seed for smallholder farmers in the Kinale region of peri-urban Kenya, in order to improve the quality, health and availability of kale seed to smallholder farmers. Emphasis was on farmer-to-farmer distribution under the regulation of KARI, KEPHIS and in collaboration with NGOs. The project also sought to promote the value of producing or purchasing good quality seed.

Specific objectives were to:

1. Understand farmers perceptions and market needs with respect to vegetable seed purchases
2. Evaluate potential models for sustainable seed multiplication
3. Establish a sustainable kale seed multiplication system that enables smallholders to produce healthy seed of good quality and that has an acceptable market value.
4. Promote good seed multiplication practice for kale and improve seed certification using preferred model
5. Develop a marketing strategy for the sale of improved quality seed and promote the value of producing or purchasing good quality seed
6. Develop practical strategies for sustainable management of black rot in brassica

The CPP output being addressed was: Promotion of pro-poor strategies to reduce impact of key pests, improve yield and quality of crops, and reduce pesticide hazards in peri-urban systems.

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Beneficiaries

Potential beneficiaries of this project include:

- Smallholders from the lower income categories who lack financial resources for whom sustainable production systems are needed for producing food for domestic and local markets. The producers of seed could receive added value for their enterprises from the commercial production of the seed.

- Commercial smallholders supplying urban markets and those out-growers contracted to the exporting companies

- Rural communities who may benefit from the employment opportunities provided by horticulture.

- Micro-entrepreneurs or communities who can brand and market seed who could benefit from the economic returns of selling seed.

If a sustainable seed business is developed during the lifetime of the project this will be self-financing and independent post-March 2005.

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Related Projects

The project was linked to the following projects in the DFID CPP Vegetables cluster:

- Accelerated uptake and impact of CPP research outputs in Kenya (CABI-ARC approved for funding)
- Development of private sector service providers for the horticultural industry in Kenya (ICIPE: PM being developed)
- Promotion of sustainable approaches for the management of root-knot nematode of vegetables in Kenya - (U of Reading: PM261)
- A linkage with the Rockefeller African Seed Company Investment Scheme will be sought if it is agreed that a commercial seed company should be set up.
- A linkage has been made with the "Good Seed Initiative" being developed by CABI and DGISP to explore promotion of quality seed at a regional level.

Chapter 1: Understanding farmers' perceptions and market needs with respect to seed purchases

SUMMARY

In order to understand farmer's perceptions and market needs with respect to the purchase of vegetable seed in Kenya, the preliminary phase of the Quality Vegetable Seed project sought to identify baseline information on farmers' perceptions of seed and the existing constraints by PRA. To this end, a socio-economic survey was undertaken, to identify the gaps and potential opportunities for farmers to produce and market their own, improved quality seed. This survey is presented in Part 1, below. Further information regarding the availability, distribution and supply of existing brassica seed in Kenya was obtained by additional survey, and in the form of a seed inventory. This data in presented in Chapter 1, Part 2. In order to understand how kale seed produced in Kinale is currently disseminated throughout neighbouring areas, baseline data about how far farmer produced seed in Kinale travels was also collected at the start of the project. This data is presented in Chapter 1, Part 3.

Part 1: Farmer Perception of Kale Seed Production in Lari Division, Kenya: A Survey Report

1.1 INTRODUCTION

The use of quality vegetable seed, along with other inputs and appropriate cultural management practices, is recognized as the most cost effective way of increasing crop production and productivity. In considering interventions that are likely to reverse the trend of recurring food shortages in poor countries, seed security has been recognized as having the potential for achieving significant advances in food productivity and production.

In developed countries, the formal sector provides the vast majority of seed to farmers, and the majority of farmers in these countries have access to seed from this sector. In developing countries however, the formal seed sector only supplies 5-10% of the seed that is used by farmers, despite huge investments in the sector. It is estimated that in Africa alone, 1.4 billion farmers use their own farm saved seed (AFSTA, 2002). Despite the important role played by the informal sector in meeting seed demands of farmers in developing countries, this system of seed supply, usage, handling and exchange implies that there is continuous usage of untested seed and little use of seed production technology, which inevitably leads to a degeneration of seed quality. There are various reasons why the majority of farmers in developing countries depend on the informal seed sector:

1. Inadequate access to seeds from the formal sector;

2. Failure by the formal sector to provide the wide range of cultivars and varieties desired by farmers;

3. Emphasis in the formal seed sector on hybrids which are not always suitable to the areas where smallholder farmers are located;

4. Emphasis in the formal seed sector on crops such as maize and horticultural crops, with little or no provision of seed for crops such as sorghums, millets, food legume, root and tuber crops.

Seed from these informal systems frequently has problems created by poor seed quality, such as dissemination and build up of seed borne diseases and yields far below the potential.

Formal vs Informal seed systems

The formal seed sector is controlled either by the state or by the private sector through the process of breeding, multiplication, processing, storage and distribution. Seed from the formal system is certified and meets minimum standards and discloses quality details on the labels. The informal seed sector on the other hand involves the farmers themselves providing each other and themselves with seed for sowing. The seed may be cleaned manually but is otherwise untreated. The informal seed sector is largely uncontrolled and unregulated and is largely represented by on-farm seed selection and multiplication efforts by farmers themselves, seed exchanges among farmers and the use of planting material saved from the previous crop harvest.

The informal sector has been characterised by an absence of interventions from external organizations, detachment from research and seed quality control, and the lack of any sophisticated infrastructure. The potential of this sector in enhancing seed delivery has however been recognized and in many countries there are efforts by national programmes, NGOs, International organizations etc to improve the informal seed sector. The major challenge for these organizations is to make improvements without losing the advantages, which presently make the sector attractive and preferred by the majority of smallholder farmers.

The strength of the informal seed sector lies in the maintenance and multiplication of local cultivars, which are the most adaptable to the growing areas. Attributes of such cultivars include tolerance to drought, pests and diseases, preferred plant growth form, colour of seed, and cooking and palatability attributes preferred by the consumer. Researchers see potential in incorporating researcher-developed varieties into informal systems to take advantage of attributes such as short maturity periods, pest and disease resistance, high yield and suitability for processing.

Use of farm saved kale seed

Brassica seeds have been very successfully supplied by the formal seed sector in Kenya. Some of 20 or more companies marketing brassica seeds are the East African Seed Company, Regina Seeds, and Farm Chem. Despite the presence of these companies and the various brassica varieties that they offer, there are still farmers in Kenya relying on the informal seed system for kale seeds, mostly of a "local" variety. The rationale behind the actions of these farmers can be found in the characteristics of this particular kale variety that farmers have managed to hold onto for the last 40 or so years. The desired characteristics of this variety, which according to farmers are not found in other varieties, are:

- Long harvesting period before flowering
- Growth to a height of sometimes over 2 metres
- Thick and strong stems
- Broad strong leaves that do not break easily

More on the characteristics of this variety can be found in Njuki et al, 2003.

1.1.2. THE SURVEY

Introduction

In project R7571 studies on kale seed production in Lari Division found that it is mainly done on a small scale where the main source of labour is the family. Hired labour is only used during the peak production times that are during the rainy periods. This is the case because the area is mainly dependent on rain fed agriculture. Alternatively, they buy seed from neighbouring farmers or in the market. This is because on-farm produced seed is cheaper and gives a better assurance of the expected quality. This is made possible by the general criteria used to select plants to be used for seed production. After identification, the plants are left to flower and when the pods are mature and ripening they are harvested, dried and thrashed, thus, ready for use in the farm. Some farmers leave their plants to flower and use that as animal feed. This work is detailed in the Final Technical Report for the project (Spence *et al*., 2003).

Background

Lari division has approximately 2500 kale farmers each growing kale on holdings of about 0.25 hectares (Gikonyo, personal communication). Almost all kale production in the division is rain fed. Marketing of kale in the division is not very organised and most of the farmers rely on middlemen who come to buy the kale from the capital Nairobi. Thus there is considerable price fluctuation during the year and in most cases farmers get a low price for their crop. The incentive to use inputs such as fertilizers and chemical applications is therefore low. Alternative ways of increasing production in the division are therefore required, as well as options for improving the existing marketing system.

Objectives of the survey

The main objective of the survey was to understand farmers' perceptions and market needs with respect to kale seed, and to identify existing constraints and potential opportunities for farmers to produce and market their own, improved quality seed. The specific objectives of the survey were to:

- To investigate the type of kale that farmers plant and their preferences
- To investigate farmers' sources of seeds and information on seed
- To get farmers' views on the current seed production and marketing system that exists in the division
- To get farmers' views on what improvements they would like to make on seed production and marketing
- To explore the feasibility of a community based seed production and seed marketing strategy

Methodology

Two methodologies were employed:

Focus group discussions
Three focus group discussions were held in the division to obtain information on any organization of seed production, the process of on farm production of seed that currently exists in the division and recommendations for local production of clean and healthy seed.

Questionnaire survey
Approximately 5% of the total kale producers were randomly sampled and interviewed, individually, on various aspects of kale production. In total, 129 households were interviewed (See Appendix I, PART 1: QUESTIONNAIRE ON FARMER PERCEPTIONS OF SEED PRODUCTION AND MARKETING). The farmers were surveyed from the 5 kale growing locations of Lari division. These were Kijabe, Kinale, Kamae, Kirenga and Lari. Households were interviewed on the amount of land they allocate to kale production, minimum and maximum earnings from kale production, sources of seed, general constraints in sourcing for seeds, and their recommendations for a strategy for the local production of clean kale seed.

Data Analysis methods

(Raw data obtained is contained in data set: INITIA~1. Microsoft Excel. pp. 27). Data was entered in Excel and summaries made using pivot tables. Further comparisons of the data were done using SPSS.

1.1.3 GENERAL INFORMATION ON SURVEY FARMS

Almost equal numbers of farmers were interviewed in the 5 locations irrespective of the proportion of kale produced in that location. Of the 129 respondents 66 were female and 63 were male. The average age of female respondents was 41.8 years while the average age of male respondents was 40.8 years. Table 1.1 below shows the general characteristics of the respondents.

	Proportion	Mean age
Female respondents	51.2%	41.8 years
Male respondents	48.8%	40.8 years

Table 1.1. General characteristics of respondents

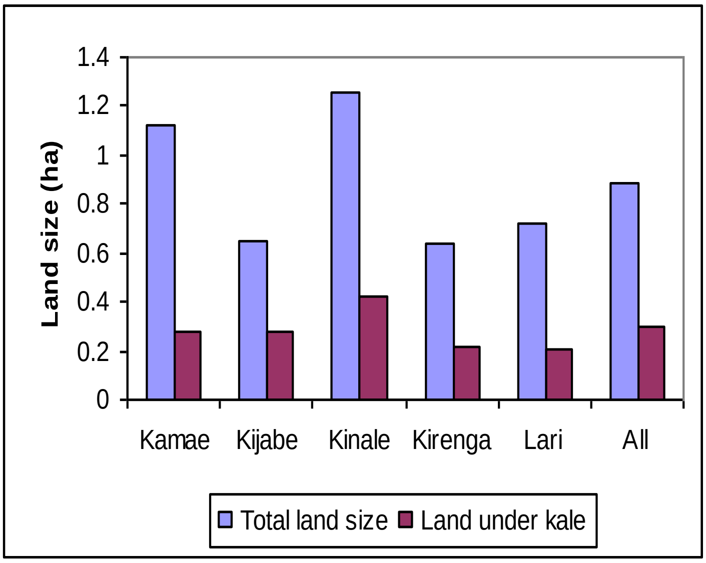


Figure 1.1. Land size and land under kale

Figure 1.1 gives a graphic presentation of the proportion of the total land size that is allocated to kale production. The average land size ranged from a low of 0.64 ha in Kirenga to a high of 1.26 ha in Kinale. The average land size for the 5 locations was 0.89 ha. Of this land, an average of 0.3 ha (33.2%) was allocated to kale production. Farmers in Kamae allocated the least percentage of their land (25%) to kale production while farmers in Kijabe allocated 43.5% of their land to kale production.

1.1.4 KALE PRODUCTION

Amount of Kale produced and annual incomes

Farmers were producing an average of 120.8 bags of kale per year. This was equivalent to 402 bags per ha per year. The amount of kale produced per farm per year was calculated based on farmer monthly estimates of the amount of kale they harvested. This amount was then multiplied by 9 months assuming that the first two months of kale production are the establishment stage and therefore no harvesting and the last few months have reduced leaf harvesting as the kale begins to flower. The lowest production per farm was in Lari where the amount produced per year per farm was 61.6 bags per farm.

Lower and upper estimates for total income were calculated by multiplying the yield by the lowest and highest prices farmers had ever received for a bag of kale. Income from kale was found to range from a minimum of Ksh 20, 842 to a maximum of 83, 038 per year. The minimum figures assume that kale is sold at minimum price throughout the year and the maximum assumes that kale is sold at the maximum price throughout the year. This of course does not happen but these figures give the minimum and the maximum amounts that farmers get given the existing price fluctuation of kale. These figures translate to a minimum and maximum amount of Ksh 69 473 and Ksh 276 793 per ha per year of kale respectively. These figures are summarised in Table 1.2.

Table 1.2. Amount of kale produced and minimum/maximum incomes

	Average (bags)	**Minimum (Ksh)**	**Maximum (Ksh)**
Amount of kale produced per farm	120.8		
Amount of kale produced per ha	402.7		
Income per farm		20 842	83 038
Income per ha		69 473	276 793

Farmers in Kinale planted an average 1.6 times per year. The minimum number of times farmers planted kale in a year was 1 while the maximum was 4. Planting of kale several times a year ensures continuous kale harvesting throughout the year.

Kale varieties commonly grown by farmers and their preferences

These are the results of discussions with two groups of farmers. The groups indicated that to select good kale, the characteristics they considered were:

- How long the kale took to flower
- Leaf size
- Leaf colour
- General size (height) of the kale plant
- Yield

Tables 1.3 and 1.4 give the types of kales that the farmers in the groups reported they use or know of, and farmer ranking of these with respect to these characteristics.

Table 1.3. Type of kale and farmer ranking (group 1)

Type of kale	Maturity	Leaf size	Leaf colour	Size of kale	Yield	Overall* rank
Kaguru	1	4	3	2	1	1
Molo	5	3	5	4	5	5
Kinale	2	1	1	1	2	2
Kale (thousand headed)	4	5	4	5	4	4
Graffaton	3	2	2	3	3	3

Table 1.4. Type of kale and farmer ranking (group 2)

Type of kale	Maturity	Leaf size	Leaf colour	Size of kale	Overall* rank
Kamolo(Molo	3	3	3	2	3
Sukuma siku	2	2	2	3	2
Matharu (Kinale)	1	1	1	1	1

Note: *As ranked by farmers in the groups

Other issues also came out with regard to these varieties. **Kaguru** can take up to 10 years to flower and therefore very few farmers ever have seed of this variety. Most of those who plant use tillers/branches of old kale plants. The leaves are also hard and when packed, one bag takes a lot of kale leaves and this is a disadvantage to farmers. The branching also compromises on the size of leaves and this variety is known for small leaves. **Kinale** is what most farmers are growing. It is easy to cook and is preferred by the buyers because of the large and green leaves. The yield is also high and since it does not crumple during packing, the amount required to fill a bag is less than for the other kale varieties.

Plate 1.1. Group giving their opinions on kale varieties

1.1.5 SOURCE OF SEED

Main sources of seed

The most common sources of kale seed for the farmers interviewed were own-farm saved seed, seed from other farmers, and purchase. Seed was purchased from other farmers, shops and from middlemen as well as from the local market. This is shown in Figure 1.2. Of those who purchased seed, 86% purchased from other farmers while only 8.8% bought from the shops. The remaining percentage purchased either from the local market or from middlemen who visited the farms selling seed.

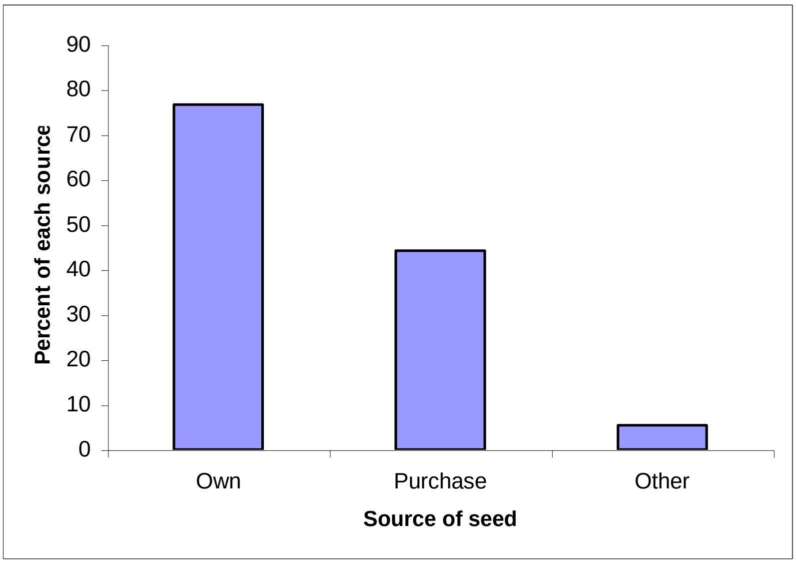


Figure 1.2. Main sources of seed for farmers in Lari

With nearly eighty percent of the farmers using own saved see, this source of seed is an important component of kale production in the division.

On farm saved seed

Reasons for using on farm saved seed

On why farmers were using own farm saved seed rather than purchasing form the retail outlets, farmers gave the following reasons;

- Saving their own seed was cheap
- There was inadequate seed from other sources of seed
- Seed from other sources especially the shops flowers early compared to the seed farmers save from their farms
- Traders in the local markets or middlemen, and sometimes even other farmers, mix the seed so it is difficult for farmers to know the identity of the seed
- They are surer of the quality of their own seed since they have observed its performance compared to seed from other sources

These sentiments are no different from what has been found elsewhere. A SADC seed security initiative report gives some of the advantages of the informal seed sector as:

- farmers do not have to pay cash for the seed nor travel to procure it
- the farmer knows the cultivars he is planting and most likely has confidence in its proven performance
- and there may not be any organised supply for that particular seed (Wobil, 1998)

What on farm seed production involves

Farmers see kale seed as a by-product of kale production. They save seed only when they need seed for the next planting season. For such farmers, any sales of kale seeds are undertaken only when the farmer has more than he needs. There are a few farmers however who target seed production for sale either to their neighbours or to the local market.

a) The first step in the production of sale is the selection of good kale for seed. Some farmers select plants for seed based on certain criteria while others do not do any selection. The criteria used by farmers includes period of flowering, position in field (boundary plants have a risk of cross pollination), big pods, thick stem, high yield, green leaf colour. In some cases farmers plant an internal boundary line of kales, which then becomes the kale for seed.
b) Once the kale has been selected, farmers wait for it to flower. Once the pods have been formed and they are mature, they are covered with nylon bags or gunny bags to prevent them from being eaten by birds.
c) When pods are ready, the seeds are harvested by cutting the upper branches of the kale together with pods. These are then put in nylon bags to ripen. This ripening process takes up to eight days.

d) The next stage is drying and this can be done in two ways. During sunny weather, the cut branches are put on rooftops where the seeds are sun dried. During the rainy season they are put over the fireplace and dried by the heat from the fire.
e) The cut branches are then threshed and put in khaki papers and stored in warm conditions. Most farmers hang them from their kitchen roofs. Depending on the storage process, the seeds can remain viable for up to 3 years.
f) Marketing of the seed is informal, with farmers exchanging amongst themselves or selling at the local market.

Management practices for on farm saved seed production

On specific management practices during the seed selection and seed production, 34.3% of the farmers indicated that they bag to prevent damage from birds, 13.1% prune the selected plants while 10% use fertilizer on the selected plants. These figures are given in Figure 1.3.

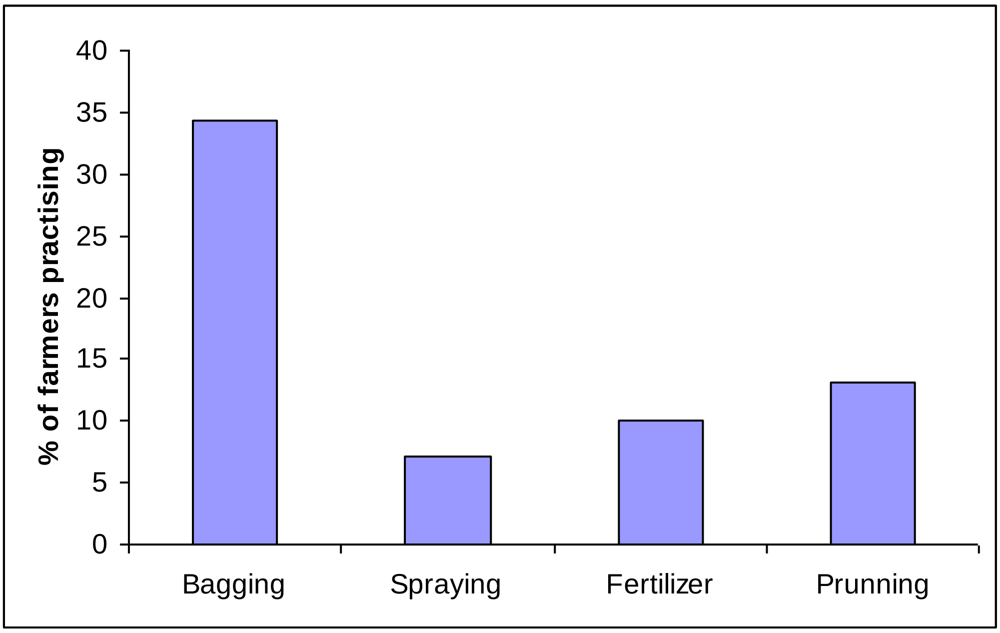


Figure 1.3. Management practices on kale for seed production

Problems with the current on farm seed production system

On farm seed production is not without its shortcomings.

- Due to the presence of other kale varieties which are unknown to farmers, there is a risk of cross pollination, especially if a farmer plants his kale on a boundary bordered by a kale variety which he does not know.
- Some farmers preserve kale for seed when it has already been over harvested and this lowers the seed quality
- Birds eat the kale seed when on the farm and during drying
- Aphids and other pests may interfere with seed production

- Seed may not be always be available, especially during drought years
- Seeds may rot, especially during the wet season since there is no proper drying mechanism
- Seeds may be from various kale varieties

Thirty one point two percent of the farmers ranked low germination as the number one problem with own farm saved seed, birds were ranked first by 24.7%, seed shortages by 15.6%, poor quality and poor varieties by 11.7% and pests and diseases by 9.1% of the farmers that were using own farm saved seed. These results are shown in Table 1.5. Other problems observed by the research team were insufficient know-how in seed production, inadequate use of farm inputs, inadequate seed processing methods, insufficient pest and disease control in the field leading to accumulation of pests and diseases and weak extension back-up due largely to lack of knowledge on kale seed production by the extension staff, as well as insufficient logistic support to reach the farmers with relevant knowledge.

Table 1.5. Constraints faced by farmers using own saved seed

	% Farmers for each rank	
	Rank 1	Rank 2
Low germination	31.2	5.2
Birds	24.7	9.1
Seed shortage	15.6	0
Poor quality /varieties	11.7	14.3
Pests and diseases	9.1	7.8

The farm saved seed system therefore faces several challenges including how to improve the production, processing and storage systems and how to improve seed quality and seed health.

Purchase of seeds from other farmers

Reasons and criteria used during purchase

Due to shortage of own-farm seed sometimes caused by farmers feeding kale to livestock as fodder, farmers purchase seed from other farmers. As a result, farmers have developed criteria for selecting good seed during purchase especially when they purchase from farmers they do not know or from farmers whose kale they have not been able to observe on farm. These criteria include colour, size, dryness, presence of rotten seed, as well as time of flowering when purchasing from farmers whose kale they have observed on farm. The most commonly mentioned criteria were size and colour.

From the group discussions it emerged that there are certain farmers within the community who are trusted as seed sources for various reasons: a) their seed is not mixed, b) they tend their kale for seed c) their kale takes long to flower d) they do not involve themselves with any kind of malpractice in the seed production process.

Farmers are wary of seed when they do not know its source. Buying from unknown sources can be risky because: a) sometimes young men roast the seed to make it have the desirable colour, but this leads to very low germination rates; b) some middlemen have been selling seed from Molo which flowers after about 3 or 4 months and therefore has a very short harvest period; c) sometimes farmers purchase seed which is so mixed it is difficult to tell its identity.

Problems with purchase of seed from other farmers

In addition to the points shown above, purchasing seed from other farmers has its own limitations:

1. There is no fixed price for seed and the price ranges from Ksh 50 to Ksh 300 for a cup (shown below) depending on the availability.

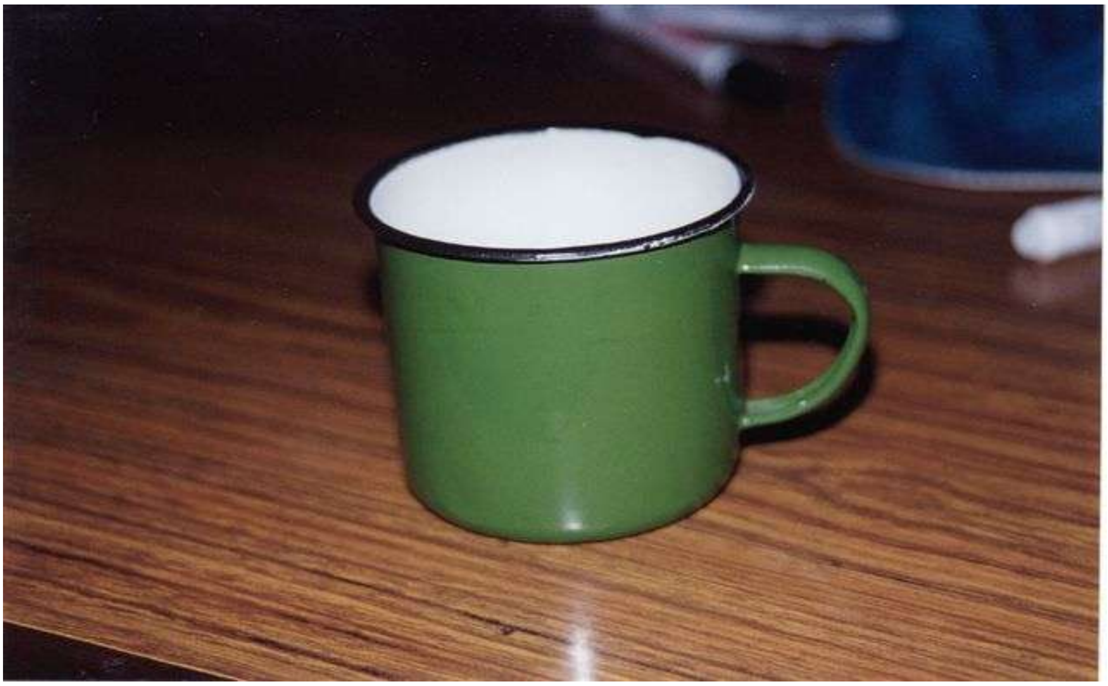


Plate 1.2. Cup used for selling seed

2. Lack of constant supply. Farmers cannot always get seed when they need it due to scarcity in some years.
3. One can at times buy bad seed because farmers mix their own seed with seed from other sources and sell it as their seed. The seed is especially mixed with seed from Molo.
4. Most farmers are only selling amongst themselves and have no outside market. This becomes a problem especially during years of over supply of seed.

5. During seasons of abundant seed supply, farmers have no other market outlets for the seed.

Advantages of purchasing seed from other farmers

The system of farmers selling seed to other farmers also has its advantages:

1. A farmer can sometimes tell good seed from bad seed especially if he has seen the kale during its growth in the seller's field
2. A farmer can get the seed on credit
3. There is usually an agreement between the seller and the buyer since they know one another
4. When a farmer does not have enough money to buy the seed, he can make an agreement with the seller that the seller puts the seed in a nursery and the buyer buys the seedlings instead of the seed.
5. Farmers can purchase more seed and store it when it is abundant and cheap.
6. Farmers do not have to go to the market or the shops to buy seed.

Farmers' ideal source of seed

Farmers were asked where they would like to get their seed from in future. The majority (74.4%) indicated that their ideal source of kale seed is their own farm saved seed while 17.6% gave their ideal source of seed as purchase from other farmers. Only 3.1% preferred to obtain their seed from the shops. This is shown in Figure 1.4. This implies that the on farm saved seed will continue to be an important source of seed for the people in this community. These results emphasize the need to improve the quality and health of the farm saved seed.

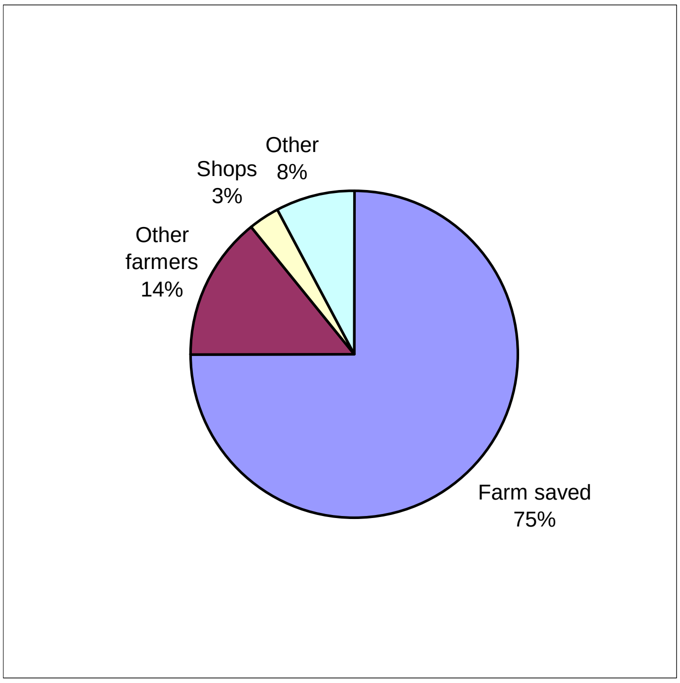


Figure 1.4. Farmers ideal source of seed

Chapter 1: Understanding farmers' perceptions and market needs with respect to seed purchases

Part 2: A survey of the availability, distribution and supply of existing brassica seed in Kenya; A seed Inventory

1.2.1 INTRODUCTION

As a preliminary to any project which aims to promote improved vegetable seed, it is first necessary to establish current the availability, distribution and supply of existing brassica seed in Kenya.

1.2.2 MATERIALS AND METHODS

KEPHIS provided a list of seed companies selling vegetable seed in Kenya. During the course of the project visits were subsequently made to a total of 14 key seed merchants, from whom data about the availability, distribution and supply of existing brassica seed in Kenya was gathered. (At the same time as this information was obtained, brassica seed lots of a variety of different types were collected. These seed lots were then screened for the incidence of pests and diseases, as described in Chapters 3 and 6, Sections: *Determining the health of existing kale seed in relation to fungi, bacteria and viruses* and *The incidence of Xanthomonas campestris pv. campestris in brassica seed stocks,* respectively).

1.2.3 RESULTS AND DISCUSSION

Four seed merchants provided data on the types of brassica seeds they stocked: Simlaw, Framchem, Amiran and Regina seed. This data is presented in Table 1.6. Table 1.7 summarises the total weight of brassica seed traded annually over the three year period from 2002-2004 inclusive. Those companies who contributed information to this part of the project were found to stock an array of different types of brassica seed, including four types of kale, over 20 varieties of cabbage, two types of broccoli, and four kinds of cauliflower, as well as supplying brussel sprouts, rutabaga and turnip (Table 1.6). Table 1.7 illustrates the very large quantities of seed which have been "bought in", (as opposed to being farm-produced or home grown), by key Kenyan seed merchants over the previous three years. In 2002, approximately 72,000kg of seed were imported for sale to brassica growers. This total rose to almost 90,000kg in 2003, reaching well in excess of 100,000kg by 2004. This represents an increase in the weight of seed traded between 2002 and 2004 of more than 55%. These figures clearly indicate not only the high demand for brassica seed in general, but also the clear opportunity that currently exists in the market for home-produced kale seed, as a highly desirable commercial product.

Table 1.6. Brassica Seed Inventory

COMPANY	TYPE OF SEED STOCKED				
	Kale	**Cabbage**	**Broccoli**	**Cauliflower**	**Others**
1. Kenya Seed (Simlaw)	Collards (s. Georgia)	Chinese chihili	Ritardos F1	Extra early	Brussel sprout
	Thousand headed	Copenhagen market	Calabrese	Kibo giant	Rutabaga
	Marrow stem	Copenhagen market F1		Italian giant	Turnip (early purple)
	Borecole (s. siku)	Drumhead		Snow ball	
		Glori F1			
		Golden Acre			
		Marcanta F1			
		Pruktor F1			
		Red Rock Mid			
		Savoy vertus			
		Sugarloaf			
		Sure head			
2. Farmchem	Thousand headed	Star 3308	Calabrese	Snow ball	Brussel sprouts
		Copenhagen market			
3. Amiran	Thousand headed	Copenhagen market			
	Collards	Red cabbage			
		Santa F1			
		Sugar loaf			
4. Regina seed		Amigo F1			
		Amukos			
		Copenhagen			
		Drumhead			
		Fortuna F1			
		Green challenger			
		Rinda			
		Romenco			

Table 1.7 Summary of brassica seeds traded by key Kenyan seed companies, 2002 to 2004 (seed weights in kg)

MERCHANT	2002	2003	2004
Albhai Sharriff & Sons	-	-	0.50
Amiran (K) ltd	913.42	4,118.58	564.28
EASCO	45,280.85	50,753.70	77,982.63
Farmchem Ltd	429.16	303.00	321.30
Homegrown co.	-	155.00	75.00
Hortitec (K) Ltd	-	260.00	-
Hygrotech EA Ltd	85.39	160.00	326.00
Intra Farm Services	53.00	-	-
Kenya Highlands Seed Co	120.00	154.38	215.40
KSC Simlaw	16,586.00	21,683.97	26,227.10
Regina Seeds	8,790.25	8,251.50	3,932.29
Vegpro Ltd	-	3.00	21.00
Vetagro E A Ltd	-	3,964.05	2,310.00
Vitacress (K) Ltd	-	40.00	248.00
Total	**72,258.07**	**89,847.18**	**112,223.50**

NB. Please also refer to the following Sections of Appendix I, at the end of this report:

Appendix I, PART 2: KEPHIS DATABASE – AMOUNT OF SEED TRADED FROM 2002;
Appendix I, PART 3: SMALL PACK SEED PRICELIST, HYGROTECH EAST AFRICA LTD.

Chapter 1: Understanding farmers' perceptions and market needs with respect to seed purchases

Part 3: The Dissemination of Farmer-produced Kale seed in Kinale

1.3.1 INTRODUCTION

There is a need to obtain baseline data about how far farmer-produced seed in Kinale currently travels. This was undertaken by district horticultural officers from the Ministry of Agriculture and by project staff.

1.3.2 MATERIALS AND METHODS

In order to collect data on those districts where Kinale kale "variety" is grown, in addition to the source (i.e. Kinale, Lari Division, Kiambu District), A questionnaire was developed and given to Mr. Patrick Onchieko, a horticulturist at the Ministry of Agriculture (See Appendix I, PART 4: SURVEY OF KINALE KALE "VARIETY"). He added an explanatory covering letter, before circulating the questionnaire to 30 District Agriculture Officers. In this way, a number of districts were surveyed by means of the questionnaire, via the Horticulture Department at the Ministry of Agriculture HQ. The questionnaire sought to establish which kale variety (eg. Kinale (Matharu), Thousand headed, Collards or other) was/were present in any district, to obtain an estimate of the area (in hectares) grown to each variety, and to identify source(s) from which seed was obtained (e.g. from the market place, or via friends or other contacts in the farming community).

1.3.3 RESULTS AND DISCUSSION

The Questionnaire revealed that a number of districts and divisions were growing Kinale kale. (See Table 1.8, Below). In January 2003, the furthest Kinale seed had been found was in an open-air market in Nakuru (120km from Kinale). Anecdotal evidence from traders at outdoor markets suggests that Kinale seed is recognised as being distinct from commercial varieties. It is clear that kale seed is being disseminated over a relatively broad area, further underlining the widespread demand for kale in Kenya, and the need to meet this demand by making healthy, farmer-produced kale seed readily available to growers.

Table 1.8. Summary of findings of Survey into dissemination of Kale seed

District	Kinale district seed Present or Absent ?	Estimated area (ha)	Source of seed
Nyeri (Municipality)	Present	1	Karatina mkt.
Nyeri (Othaya)	Present	9	Other farmers
Nyeri (Mathira)	Present	38.1	Karatina mkt
Nyeri (Kieni West)	Present	6	Other farmers
Embu (Nembure)	Present	0.03	Friends in Meru
Nyeri (Othaya)	Present	9	Other farmers
Murang'a	Absent	Nil	Na
Nyamira	Absent	Nil	Na
Nandi North	Absent	Nil	Na
Busia	Absent	Nil	Na
Nyandarwa	Could be present	-	-

Chapter 2: Evaluation of potential models for sustainable seed multiplication

SUMMARY

Prior to evaluating any potential models for sustainable seed multiplication, a project development meeting with agriculture staff and extension officers in Kinale (Lari office) was held. The aim of this meeting was to gather information on how farmers who are multiplying kale seed are currently organized, and identify kale farmers and farmer groups to work with. Minutes of this meeting, and points raised are presented Chapter 2, Part 1, below. The feasibility of a community-based approach to seed multiplication in Kinale is discussed in Chapter 2, Part 2; The potential for establishing and registering a commercial seed business in Kinale is discussed in Chapter 2, Part 3.

Part 1: Current organisation of kale farmers in Kinale

2.1.1 INTRODUCTION

In order to gather information on how farmers who are multiplying kale seed are organized, and to identify kale farmers/farmer groups to work with, a project meeting with agriculture staff and extension officers in Kinale (Lari office) was held during the development phase of the project. This meeting took place on 28th April 2004. It was attended by members of the project team from CABI and KARI, plus Mr Gikonyo (Head), Mr R. N. Gachuiri and Mr Mushai of the LARI Division office.

2.1.2 POINTS RAISED

The following summary notes were recorded by Dr. Noah Phiri (CABI):

- Kale is very popular in the Division, and farmers rely on the availability of farmer- produced seed;
- Different types of farmer produce seed; some are popular, some produce seeds as a side-line/additional activity;
- Farmers use a cup for measuring kale seed, and act as individuals not as an organised group;
- Every farmer in the Division produces kale (2500 farming families) in the following locations: Kinale, Bathi, Kambasa and Kijabi;

- Each family holds about 1 Ha and grow kale on 0.25 Ha;

- In Githia location kale farmers produce seed for themselves and also to assist others;

- There are no formal groups for kale seed production (by contrast, the dairy group has 40 members), but there is a church group (PEFA) where if members give money to other members they get it back with interest;

- The dairy group could be interested in producing kale seed;

- Some kale seed is sold in a local market through brokers who come and buy seed from individual farmers e.g. Kimende market (Monday) and Soko Mujinga market (every day). Soko Mujinga market is the best for kale seed;

- Local kale seed accounts for 90% of the market, with commercial seed only 10%.

Chapter 2: Evaluation of potential models for sustainable seed multiplication

Part 2: The feasibility of a community-based approach to seed multiplication in Kinale

2.2.1 INTRODUCTION

Having obtained baseline information regarding farmers' perceptions of vegetable seed production, and identified potential opportunities for farmers to produce and market their own, improved-quality vegetable seed (see Chapter 1), the next part of this study sought to evaluate the feasibility of a community-based seed multiplication system in Kinale.

2.2.2 MATERIALS AND METHODS

The information required from farmers to allow the feasibility of any community-based approach to seed production to be explored was collected as part of the socio-economic survey presented in Chapter 1 of this report. Two methodologies were employed, and they have been described in detail in the previous section. Briefly, these two methodologies were: the use of focus group discussions; the use of questionnaire surveys, which were circulated to a sample of kale producers (who were also interviewed). Data was entered in Excel and summaries made using pivot tables. Further comparisons of the data were done using SPSS.

2.2.3 RESULTS

Farmers were asked whether they would be willing to grow kale for seed production. Seventy-nine percent of the 129 farmers interviewed said they would, while the other 21% said they would not. During group discussions, however, it was established that even those who said yes had several concerns with respect to kale production for seed. These are discussed below with additional questions by the authors:

2.2.3.1 Farmers' concerns re. feasibility of community based seed multiplication system

a) The most desirable kale has the maximum amount of time between planting and flowering. It was established that some kale takes up to three years before flowering. The average period is however between 9 and 12 months. Farmers plant kale up to 4 times a year in order to ensure continuous kale harvesting throughout the year. Will it therefore be profitable or acceptable to wait for up to one year to sell seed when a farmer could be generating continuous income by selling the leaves? Can the farmer still harvest and sell the leaves as he waits for the seed? How much leaf can be harvested without compromising the quality of the seed produced?

b) Most of the seed shortage in the division occurs during periods of drought when farmers feed their kale to livestock once it has flowered. What would happen in such instances? Would all the seed cleaning efforts go to waste if farmers then use the kale as livestock feed?

c) Land sizes in Kinale are very small (see Figure 1.1, Chapter 1) and a lot of land would be required to be able to produce seed that will give good returns. How much seed can be produced per ha and how much would this cost? How competitive would the Kinale seed be in the market compared to commercially available varieties?

d) What can be done with surplus kale seed given the absence of good storage facilities? There have been recommendations for small seed producers for "farmer-seed grower" (Turner 1998) where a farmer who produces high quality crops for sale as seed from the farm can still divert them to grain for use if not sold as seed, thus avoiding most of the risks of seed production. But this cannot work for kale seed.

2.2.3.2 Conditions mentioned by farmers as necessary for seed production

Farmers were asked what conditions they thought would be necessary before they could grow kale for seed. Eighty four percent indicated that the kale production for seed must be proven to be a profitable enterprise, giving more returns than kale production for leaf harvesting. Other conditions were availability of more land, and also the availability of alternative sources of fodder, a ready market, assured seed quality and good seed yield. These conditions and the relative percentages of farmers mentioning them are given in Figure 2.1. If the above concerns were taken into account, 52% would prefer growing seed as individuals while the rest would prefer growing kale for seed in groups.

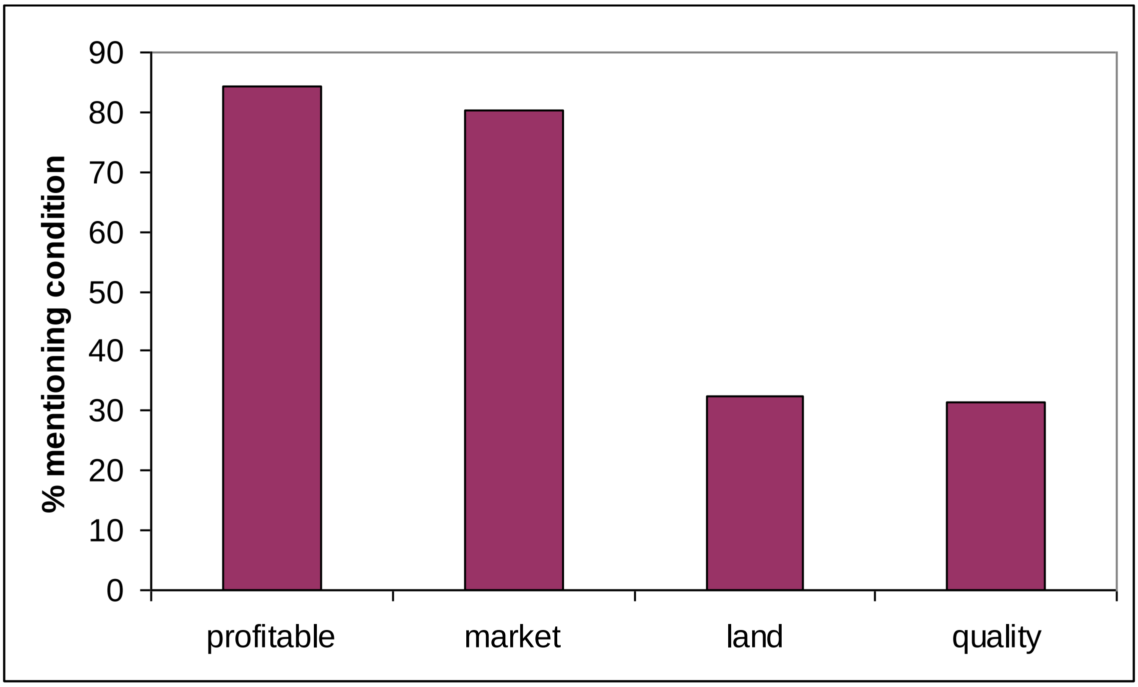


Figure 2.1. Conditions for seed production

2.2.3.3 Marketing of the kale seed and the legal implications

For any seed to be formally marketed, it must be certified and the full identity of the seed and its characteristics known. A seed merchant (or any equivalent of this) would then need to be registered to distribute and sell this seed. The original idea of the project was to have a community based seed production and marketing system. Asked on how they would want the marketing of seed to be approached, 48 % indicated that the farmer or the group growing the seed should be responsible for marketing, 38.2% of the farmers talked about the formation of a seed production and marketing cooperative, while 37.3% preferred a group marketing scheme. Only 3.9% talked about contract growing of the seed where someone contracts farmers to grow the seed and then buys it from them. The contract seed growing was not favoured by farmers as they indicated that the contracting person will then own the seed and will determine the price to the farmers. This was also related to the issues of the seed ownership as discussed below.

2.2.3.4 Issues of Intellectual Property Rights vis a vis farmer groups

Once the Kinale variety is characterised, the variety has to belong to someone. Farmers in Lari Division believe that this is a variety that has evolved with time as farmers have grown it. The variety would therefore belong to them. But who are these farmers? Is it the whole division? Is it some groups of farmers? Is it the Ministry of Agriculture on behalf of the farmers? Is it KARI? The KARI seed unit has an arrangement that farmer groups can trade in seed under their licence. However, for them to do this, the variety must be a KARI variety or a variety that has been selected or bred by KARI scientists. In this case KARI scientists would need to be involved in the selection and improvement process. Once this is done, then the KARI scientists would co-own the variety with farmers. This arrangement still has the problem of the identity of the farmers that will own the variety.

The issues of intellectual property rights also came up in a group discussion with farmers who expressed their concern that if they were involved in the seed cleaning and improvement, and another group of farmers was also involved in the process, would the two groups then have the same variety? Would they have to call it different names? Wouldn't the other individual farmers or groups of farmers steal what the group had cleaned and improved and purport to have done it themselves? How would the project protect the group of farmers that does the initial cleaning and improvement?

2.2.4 THE WAY FORWARD

Given the key farmer constraints, farmers' feelings regarding the ideal source of seed (their own farm) the short project period and the fact that the feasibility of kale production for seed is not known, the following is recommended. (These recommendations were discussed at the second planning meeting of the Project implementation team held on August 18, 2003)

1. The project needs to look at the profitability of kale production for seed compared to kale production for leaf. This would involve a cost benefit analysis

2. The project should investigate the effect of leaf harvesting on the quality and quantity of seed produced. The aim should be to provide recommendations to farmers on what amount of leaf harvesting is appropriate on plants grown for seed. At the project meeting it was agreed that an experiment would be done on station with different levels of leaf harvesting. In order to make farmers appreciate the process of kale seed production and its potential benefits, the experiment would also be done on farm with groups of farmers. Some participatory budgets would be done and a cost benefit worked out for the various levels of leaf harvesting.

3. Due to the complexity of establishing a farmer-based seed marketing system, the project should initially concentrate on cleaning and improving the seed to improve farmer access to good quality seed. The project should use farmers who are well known as good sources of seed by the community and improve the quality of seed that these farmers produce. The project team should then use the farmers identified to investigate the feasibility of having a community based seed marketing system. Due to the short life of the project, it is likely that the identified system will not be implemented during the current project life.

4. The establishment of a formal marketing system of the seed from Kinale should assessed in relation to what impacts it will have on the informal marketing system that exists within the community. Some of the guiding questions should be; will a formal marketing system pre-empt the existence of

the informal marketing system?; What implications will this have on the farmers who cannot afford to purchase seed in the formal markets.

5. Extension efforts are required to improve farmers seed production and handling practices.

6. Channels need to be developed to ensure that new varieties are delivered to these systems so that farmers can benefit from formal research.

7. Horizontal linkages between the formal and informal sectors and between the informal sector and research at different functional levels are needed. Such linkages may include links between the farmers and research institutions/NGOs/universities where farmers can get skills on seed production, processing, marketing etc.

Chapter 2: Evaluation of potential models for sustainable seed multiplication

Part 3: The potential for establishing and registering a commercial seed business in Kinale

2.3.1 INTRODUCTION

The potential for establishing and registering a sustainable commercial seed multiplication system in Kinale was examined by Dr. Moses Onim (Managing Director of Lagrotech Seed Company (LSC)). He identified LSC as playing a key role in the CABI quality kale seed development project, by providing plant breeder role in the development, and possible release of a kale variety or varieties to the farmers in Kenya, East African region, or elsewhere where the varieties will be suitable. Dr. Onim and Mr. Joseph Mito (MSc in Genetics and Plant Breeding), the Head of Research and Product Development of LSC, would collaborate on this project to play the above role, and LSC would work closely with other collaborators to select the seed growers, and register them with KEPHIS. Dr. Onim produced a report detailing the feasibility of a community-based approach to seed multiplication in Kinale, and the route to achieving a sustainable commercial seed production system. This report is contained in Appendix I, PART 5: KALE PROJECT BY CABI AND LAGROTECH SEED COMPANY. The content of this report is outlined in the following sections, below.

2.3.2 RECOMMENDED PLANS TO ALLOW SUSTAINABLE SEED PRODUCTION

There are two major options that could lead to sustainability of the activities of kale seed research, development and proposed production. Firstly, a Kinale Kale Seed Growers' Farmers Group or a Co-operative for the specific purpose of certified seed production must be formed. This Seed Growers' Group or Co-operative should then be registered with KEPHIS as a Seed Company. Secondly, existing Kale farmers must be encouraged to form a Kale Seed Producer Group or Co-operative as shown above, then the seed producers would become attached to a Seed Company, like Lagrotech. The Kale Seed Growers would then become seed growers as is the case with seed companies operating in Kenya. Lagrotech Seed Company has valuable experience in this area, where it closely works with KEPHIS and KARI to develop12 farmer groups in Western and Eastern Kenya (6 districts in each region), to grow certified seeds of various varieties of maize, sorghum, cowpeas and bean. These seeds are now marketed in the whole country. For such an arrangement to work successfully, a number of things must be put in place for both parties to operate well. These include:

- The responsibilities of the seed growers, and those of the Seed Company for which the farmers produce the seed, should be well documented.

- The Seed Company should draw seed growers' contracts with them. These contracts must clearly define the terms of seed growing and what is expected of the seed growers in order to produce certified kale seeds. The price to be paid to the seed growers per specified unit of seed must be clearly specified in the contract before the farmers undertake seed growing.

- The seed growing farmers will need to be trained on other technologies that will empower them to benefit best in the area of seed production. The Seed Company, KEPHIS and/or KARI will conduct such courses, if necessary, together with Agricultural inputs companies, or in any combinations of the above, as may be necessary to assure the best results.

- The Seed Company will take the responsibility of advertising and marketing the Kinale Kale Seed all over the country and beyond. This will be after the seed growers will have produced kale seed that will have met all the field KEPHIS certification standards. The seed will then be bought by the Seed Company, have all post harvest KEPHIS viability and other quality tests done and met. The seed will then be processed, dressed, packaged as required by seed laws, and marketed within Kenya and beyond.

- It will be the responsibility of the Seed Company to market and make the Kinale Kale seed widely-known through many forms of advertising; for example through posters, brochures, radio, on-farm demonstrations, and agricultural shows.

- Lagrotech Seed Company already works with over 400 seed stockists all over the country, including marketing through the Kenya Farmers' Association (KFA) that has branches all over the country. Kinale Kale seeds can be marketed to farmers through these outlets.

- These options should be discussed with project managers and collaborators in order to ensure that the best one is followed. However, for sustainability of this project in the absence of further funding, a Seed Company working with the seed producers to make any particularly promising lines available in the market as soon as possible, assuring farmers of higher income from their kale vegetable and seed production would be a better choice. This step would ensure that the best selected lines, which are subsequently developed into varieties, are widely available to farmers, not just those who farm around Lari Division (Limuru, Kinale and Njabini) and its neighborhoods. A survey to determine how far seed of these kale varieties have spread is available (see Chapter 1, Section 1.3).

<u>Chapter 3: Establishing a sustainable kale seed multiplication system</u>

SUMMARY

As a preliminary to establishing a sustainable vegetable seed multiplication system, the project sought to determine the seed health of existing kale seed in relation to fungi, bacteria and viruses. These findings are presented in Chapter 3, Part 1, below. The next steps towards the production of new varieties of high quality vegetable seed was the selection and description (full characterisation) of distinct Kinale kale lines and their seeds, through participatory activities with local farm groups. These processes are described in Chapter 3, Part 2. In order to identify a suitable kale-production/seed-multiplication model which could allow smallholders to produce healthy seed of good quality and that has an acceptable market value, the effect(s) of different leaf-harvesting regimes on plant quality were assessed, and a parallel cost-benefit analysis was conducted. The findings of these two studies are presented in Chapter 3, Part 3. In order to validate the model, it was tested on a number of farms in different regions of the district. These on-farm leaf-harvesting studies are described in Chapter 3, Part 4.

Part 1: Determining the health of existing kale seed in relation to fungi and bacteria

3.1.1 INTRODUCTION

As described in Chapter 1, Section 1.2.2, key seed merchants were visited in order to gather data about the availability, distribution and supply of existing brassica seed in Kenya. At the same time as this information gathering exercise was undertaken, brassica seeds of a variety of different types were obtained from these suppliers, and seed lots were subsequently screened for the incidence of pests and diseases, such as fungi and bacteria (for incidence of fungal disease, see also Chapter 6, Part 1: *The incidence of Xanthomonas campestris pv. campestris in brassica seed stocks*). Additional seeds were also obtained from rain-fed areas, highlands, irrigated areas, border points, local markets, as well as directly from farmers.

3.1.2 MATERIALS AND METHODS

Two groups of seeds were prepared from the various sites of collection, with 200 seeds in each group. (Table 3.1.a lists the companies and seed merchants from where these seeds were obtained, the varieties of brassicae from which they originated, and the places at which seeds were purchased). In order to allow a distinction to be drawn between the incidence of any fungi found to be borne on the outer seed coat, and those that are transmissible within the seed itself, one group of seeds was surface sterilised by washing in 10% hypochlorite solution, whereas the second group remained unwashed. Individual seeds from each group were subsequently incubated under standard laboratory conditions to support ready growth of fungal mycelium (~21^{o}C, 7-14d) on a culture medium of Potato Dextrose Agar (25% PDA). Plates were inspected regularly under a light microscope, and any fungal growth was recorded.

3.1.3 RESULTS AND DISCUSSION

A range of fungi was isolated and identified from both the surface-sterilised and unsterilised seeds (see Tables 3.1.a and 3.1.b). As expected, levels of infection recorded in surface-sterilised seeds were comparatively low, ranging from 0 – 12.5%. Species identified from these seeds included *Alternaria brassicicola* (0 – 8.5%), *Penicillium spp*. (0 - 1%), and an additional *Alternaria sp*. (0 - 4.5%), as well as a low incidence of infection with other unidentified fungi (0 - 3.5% infection). These pathogens were predominantly found in Sugarloaf-cabbage, Cabbage Copenhagen market, Golden acre cabbage, Thousand headed-kale, and in farmer-produced Collard-kale seed. Seeds that had not been surface-sterilised presented a significantly higher level of infection, both in terms of the incidnce of pathogens found, and the range of species isolated. Levels of infection ranged from 0 – 100%; species recorded included *Alternaria brassicicola* and other *Alternaria spp*. (up to 30%), *Penicillium spp*. (up to 22.5%), *Aspergillus spp*. (up to 40%), *Trichoderma spp*. (0 - 0.5%), *Ulochladium spp*. (0 - 0.5%), *Mucor* and *Mucor-like spp*. (0 - 2.5%), *Rhizopus spp*. (0 - 2%), *Fusarium spp*. (0 - 0.5%), and other unidentified fungi (up to 91%). As with the sterilised seeds, these pathogens were predominantly found in Sugarloaf-cabbage, Cabbage Copenhagen market, Golden acre cabbage, Thousand headed-kale, and in farmer-produced kale seed, as well as occurring in Drumhead and Gloria F1 cabbages respectively.

Table 3.1.a Details of seed samples tested for seed borne pathogens

Sample no.	Company/ Seed merchant	Variety	Place of purchase	Date incub-ation	Date Check	No. seeds
1	Simlaw seeds	Sugarloaf-cabbage	Bungoma	10/12/04	18/10/04	200
2	Africas best	Collards-kale	Vihiga	10/12/04	18/10/04	200
3	Simlaw seeds	Collards-kale	Butere	10/12/04	18/10/04	200
4	Simlaw seeds	Golden acre cabbage	Iten	10/12/04	22/10/04	200
5	Amiran (K)	Cabbage copenhagen market	Kakamega	15/10/04	22/10/04	200
6	Simlaw seeds	Cabbage copenhagen market	Iten	15/10/04	22/10/04	200
7	Royal suice	Cabbage copenhagen market	Baitany	15/10/04	22/10/04	200
8	EAseed	Cabbage copenhagen market	Malaba	15/10/04		200
9	EA seed	Golden acre cabbage	Eldoret	19/10/04		200
10	Simlaw seeds	Sugarloaf-cabbage	Sondu	19/10/04		200
11	EA seed	Sugarloaf-cabbage	Sondu	19/10/04		200
12	EA seed	Cabbage copenhagen market	Sondu	19/10/04		200
13	Simlaw seeds	Sugarloaf-cabbage	Sondu	22/10/04	25/10/04	200
14	Amiran (K)	Cabbage copenhagen market	Busia	22/10/04	25/10/04	200
15	Simlaw seeds	Drumhead cabbage	Kisumu	22/10/04	27/10/04	200
16	Royal suice	Drumhead cabbage	Homa Bay	22/10/04	27/10/04	200
17	Royal suice	Victoria F1 cabbage	Homa Bay	22/10/04	27/10/04	200
18	Simlaw seeds	Sugarloaf-cabbage	Kilgoris	22/10/04	27/10/04	200
19	Africas best	Collards- kale	Rongo	22/10/04	27/10/04	200
20	Africas best	Thousand headed-kale	Kapenguria	22/10/04	27/10/04	200
21	Danish (Simlaw)	Sukma siku hybrid	Bomet	11/01/04	#######	200
22	Mumias (farmer)	?	Mumias	11/01/04	#######	200
23	Luanda (farmer)	Kale	Luanda	11/01/04	#######	200
24	Bomet (farmer)	Kale	Bomet	11/01/04	#######	200
25	Keumbu (farmer)	Kale	Keumbu	11/01/04	#######	200
26	Simlaw seeds	Gloria F1 cabbage	Narok	11/01/04	#######	200
27	Narok (farmer)	?	Narok	11/01/04	#######	200
28	Keumbu (farmer)	Kale	Keumbu	11/01/04	#######	200
29	Keumbu (farmer)	Kale	Keumbu	11/01/04	#######	200
30	Africas best	Collards-kale	Kilgoris	12/02/04	#######	200
31	EA seed	Collards-kale	Kilgoris	12/02/04	#######	200
32	Royal suice	Collards-kale	Kisii	12/02/04	#######	200
33	EA seed	Collards-kale	Kisii	12/02/04	#######	200
34	Technisem	Santa F1 cabbage	Kisii	12/02/04	#######	200
35	Simlaw seeds	Thousand headed-kale	Siaya	12/02/04	#######	200
36	EA seed	Cabbage copenhagen market	Mumias	12/02/04	#######	200
37	Simlaw seeds	Collards-kale	Nyamira	12/03/04	#######	200
38	Serviceplus	Cabbage copenhagen market	Nasieku	12/03/04	#######	200
39	EA seed	Thousand headed-kale	Nasieku	12/03/04	#######	200

Table 3.1.b Incidence of pathogens following surface-sterilisation

Sample no.	No. of seeds with fungi	% infection	% infection with Alternaria brassicicola	% infection with other Alternaria spp.	% infection with Penicillium spp.	% infection with Aspergillus spp.	% infection with Trichoderma spp.	% infection with Ulochladium spp.	% infection with Mucor/Mucor-like spp.	% infection with Rhizopus spp.	% infection with other unidentified fungi
1	1	0.5	0.5	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	1	0.5	0.5	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	9	4.5	0	0.5	1	0	0	0	0	0	3
10	1	0.5	0	0	0	0	0	0	0	0	0.5
11	0	0	0	0	0	0	0	0	0	0	0
12	1	0.5	0.5	0	0	0	0	0	0	0	0
13	9	4.5	0	4.5	0	0	0	0	0	0	0
14	2	1	0	1	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0
20	26	13	0	11	0	0	0	0	0	0	2
21	1	0.5	0	0.5	0	0	0	0	0	0	0
22	7	3.5	0	2.5	0	0	0	0	0	0	1
23	25	12.5	7.5	3.5	0	0	0	0	0	0	1.5
24	3	1.5	1.5	0	0	0	0	0	0	0	0
25	2	1	0.5	0	0	0	0	0	0	0	0.5
26	0	0	0	0	0	0	0	0	0	0	0
27	7	3.5	0	0	0	0	0	0	0	0	3.5
28	22	11	8.5	2	0	0	0	0	0	0	0.5
29	9	4.5	1	3	0	0	0	0	0	0	1.5
30	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0
35	9	4.5	1	1.5	0	0	0	0	0	0	2
36	3	1.5	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0

Table 3.1.c Incidence of pathogens on unsterilised seeds

Sample no.	No. of seeds with fungi	% infection	% infection Alternaria brassicicola	% infection other Alternaria spp.	% infection by Penicillium spp.	% infection by Aspergillus spp.	% infection by Trichoderma spp.	% infection by Ulochladium spp.	% infection by Mucor spp.	% infection Mucor-like spp.	% infection Rhizopus spp.	% infection Fusarium spp.	% infection with unidentified fungi
1	5	2.5	0	0	1.5	0.5	0.5	0	0	0	0	0	0
2	2	1	0	0	0.5	0	0	0.5	0	0	0	0	0
3	2	1	0	0	0.5	0.5	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0
5	1	0.5	0	0	0	0	0	0	0	0	0	0	0.5
6	73	36.5	0.5	0	1.5	33	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0
9	15	7.5	0	0	4.5	0.5	0	0	0	1.5	1	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0
11	16	8	0	0	1.5	4	0	0	0	1	0.5	0	0
12	2	1	0	0	0	0	0	0	0	0	0	0	1
13	23	11.5	0	1	0	3.5	0	0	0	0.5	0	0	6.5
14	44	22	3.5	12	1.5	2.5	0	0	0.5	0	2	0	0
15	1	0.5	0	0	0	0	0	0	0	0	0	0	0.5
16	1	0.5	0	0	0.5	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0
18	1	0.5	0	0	0	0	0	0	0.5	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0
20	188	94	0	49	43	1	0	0	1	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0
22	200	100	0	2.5	45	40	0	0	10	0	0	0	2.5
23	200	100	0	0	0	15	0	0	0	0	0	0	85
24	198	99	8	0	0	0	0	0	0	0	0	0	91
25	46	23	1.5	0	9	0	0	0	0	0.5	0	0	12
26	1	0.5	0	0	0	0	0	0	0	0	0	0	0.5
27	40	20	2.5	12	2	0	0	0	0	1	0	0	2.5
28	109	54.5	30	3.5	6.5	0	0	0	0	2.5	0	0.5	11.5
29	100	50	4	16.5	22.5	1.5	0	0	0	2	0	0	3.5
30	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0
35	90	45	12	0	11	22	0	0	0	0	0	0	2
36	6	3	1	0	1	0	0	0	0.5	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0

Chapter 3: Establishing a sustainable kale seed multiplication system

Part 2: Developing a strategy for the sustainable and viable production of improved quality kale seed

3.2.1 INTRODUCTION

By working with farmers who grow Kinale type kales, the project research team was able to determine standard existing production practices for leafy vegetables and seed production, and to define the importance of these kales in current farming practices (see Chapter 1). Studies have shown that kale landraces in Kinale have very good qualities in terms of tolerance to viral diseases, their leaf and appearance, and also in terms of longer leaf harvesting periods than existing commercial kale varieties. However, the landrace lines are mixed, due to long-term natural crossing with different kale varieties within the main area of production, and no commercial seeds are available for these useful landraces.

Working closely with KEPHIS, the project research team and collaborators therefore sought to establish methods for isolating Kinale kale landraces, or selections from these landraces, characterising them, and developing them for release as commercial varieties. In order to achieve this, it was decided that, with the collaboration of kale growing farmers in the Lari division, several good and healthy kale plants should be selected within farmers' fields, and that these plants should be tagged and their characteristics recorded. Resulting pods on tagged plants could then be harvested, dried, and seeds collected, while still maintaining the identity of each selected single mother plant. These activities are described in Section 3.2.2, below. Seeds collected from mother plants could then be planted into single progeny rows, so that the research team and KEPHIS could then conduct full characterisation of desirable lines (see Sections 3.2.3 and 3.2.4). Section 3.2.5 of this Chapter describes how local farmers from Lari Division were invited to visit the potentially new Kinale kale lines growing on-station at Njabini KARI Research Sub-Centre, and make their own assessment of which lines appeared to be the best. Section 3.2.6 identifies those lines ultimately selected for varietal development, and Section 3.2.7 outlines a series of recommended steps which could enable seed from kinale lines selected from landraces to be developed into varieties, and this seed to be released commercially, for the market; having made initial selections of 5 potentially useful Kinale kale lines, plants of these types were then submitted to KEPHIS to allow their Distinctiveness Uniformity and Stability to be recorded, further contributing to the complete characterisation process necessary to allow these lines to be released as new commercial varieties. Part 3 of this Chapter records how field trials using selected kale lines were undertaken to evaluate three alternative seed production models, and provides cost-benefit analysis data to suggest which model would support optimum sustainable seed multiplication for growers. Part 4 catalogues how similar on-farm trials were conducted in order to validate the model.

3.2.2 SELECTION AND TAGGING OF MOTHER PLANTS

Fifteen farms were selected in Bathi, Kinale and Nyambare/Gitithia locations of Lari Division, Kiambu District. A maximum of 5 kale plants were chosen on each farm, and these were tagged just before their flowers opened (in September 2003). In order to ensure that the cleanest, healthiest and most vigorous plants were used for this stage of seed-production, tagged plants were carefully inspected for the following characteristics:

- Plants free from disease (viral, fungal, bacterial) symptoms including stunting, leaf distortion, chlorosis, necrosis, mottling, mosaic, vein clearing, leaf spots, and black rots among others.
- Plants that were at least over 8 months old.
- Plants that were relatively tall.
- Vigorously growing plants.

3.2.2.1 Pollination: handling at the flowering stage

Immediately prior to flowering, parts of the branches of the chosen tagged mother plants were either self- or open-pollinated. Before any of their flowers opened, part of the inflorescence of the selected and tagged plants was covered with muslin (cheese) cloth and another with a khaki pollination bag. The muslin cloth provided more light and ventilation than the khaki. However, neither of the two methods was very efficient, resulting in flower abortion, small immature seeds and few pods per plant. This was to prevent out-crossing. The other part of the inflorescence was left uncovered to encourage cross-pollination (Plates 3.1 and 3.2). However, at pod stage, the uncovered part of the inflorescence was also covered with muslin cloth and khaki pollination bags, in order to protect the seeds from birds. This is a common practice by farmers who save seeds of Kinale kale (Plates 3.3 and 3.4).

Plate 3.1 An inflorescence covered with a khaki paper bag

Plate 3.2 An inflorescence covered with a cheese cloth

Plate 3.3 Covering seed heads to protect from birds

Plate 3.4 Pods destroyed by birds

3.2.2.2 Handling of Seeds

On maturing and drying, both self- and open-pollinated seeds in pods were harvested and brought to NARL for further drying: Pods, while still attached to the pod stalk, were collected in separate paper bags for each of the open and self pollinated pods of all tagged plants. The bags were well labelled with farmer and plant details, and whether selfed or open pollinated. Pods from each tree bag/cloth were kept separately to avoid mixing. The pods were dried in a room with a heater set at 27±1 ºC and a fan. Light was provided by an ordinary fluorescent tube. As the pods dried, they were removed, hand-threshed and cleaned using sieves.

3.2.2.3 Characterisation of mother plants

Characterisation of the kale lines began at the on-farm selection stage (see above). The characteristics of selected mother plants were observed and described by a team of scientists from KARI, KEPHIS and CABI, comprising of plant inspectors, seed specialists, plant variety specialists and plant pathologists. The following characteristics were recorded for the mother plants:

- Plant height
- Colour of fully developed leaf
- Colour of young leaf
- Leaf shape, size, length
- Level of glycosis
- Number of ear lobes
- Angle of leaves
- Level of anthocyanin
- Canopy shape
- Inter node length

- Stem diameter
- Colour of flowers (sepals, petals)
- Number of sepals
- Number of petals
- Number of anthers
- Direction of pods
- A thousand seed weight
- Seed colour
- Seed shape

Full details of these characteristics as recorded for the mother plants used in this project are presented in Appendix I, PART 6: PLANTS AND THEIR CHARACTERISTICS. Examples of some of the characters are shown in Plates 3.5 – 3.7 (below)

3.2.2.4 Characterisation of seeds

Seed characterisation was carried out as seeds were dried and prepared for planting trials, by KEPHIS seed inspectors. The weight of 1,000 seeds from each bag/cloth was then determined. Details of seeds and seed weights as recorded for the mother plants used in this project are presented in Appendix I, PARTS 7 and 8.

Plate 3.5 Kinale kale ear robes

Plate 3.6 Kinale kale flowers showing the colour of petals and sepals

Plate 3.7 Kinale kale showing orientation of pods

3.2.3 GROWING LINES FROM SEEDS

Seeds which were harvested from open-pollinated single plants in the previous season were collected as described above. These seeds were sown at Njabini KARI Research Sub-Centre, South Kinangop on 26th February 2004. Njabini KARI Farm was established in 1964 soon after Kenya's independence in 1963. The officer in charge here is Mr. Njoroge. Njabini Research Station has a total land area of 20 acres, of which 12 acres are under crop research, 5 acres are under forest and 3 are under housing. Njabini farm is under KARI's Horticultural Research where Irish potato disease free planting material is developed. The farm is located at the foot of Aberdare mountain ranges. It's location/coordinates are: S. 00° 44´ 01.0˝, E 036° 38´ 58.3˝, and it is at an altitude of 2551 masl (metres above sea level). It is a very cold location during the months of July and August. Mean temperatures are:

- Mean minimum temperature = 6 °C (range: -3 to 22 °C).
- Mean maximum temperature = 20 °C (range: 13 to 28 °C).
- Mean average temperature = 13 °C (range: 8 to 22 °C).

Mean average Relative Humidity (RH) is 83 % (range 53 to 96 %), and total rainfall is 1110 mm/year (please note that this is for the period of March to December 2004. Rainfall data were not available before March). Figure 3.1 shows the monthly rainfall totals (mm) recorded for 2005 at Njabini Research Station. The soils here are red loams that show good water drainage, however, the kale plots showed signs of Phosphorus (P) deficiency, implying low soil pH. This is typical of such red loams in the Kenya highlands. This is despite the fact that these kale plots received phosphorus and nitrogen fertilizers.

Three nursery beds measuring 1m by 2m were prepared. Small shallow furrows that run across the nursery bed were constructed. Furrows were about 10cm apart. DAP (Diammonium Phosphate) fertilizer was added, at the rate of 5g per 1m furrow drilled, using a soda bottle top. Each line was then planted out in 3 to 4 furrows. The furrows were then covered with a little soil to avoid burying seeds too deep. Bamboo sticks measuring 2m were then constructed over the beds to form an arched frame. Fleece material was then placed over the bamboo frame and its sides tucked into the soil. This was in order to prevent the entry of insects, particularly virus vectors. Watering was done through the fleece. This was done at least thrice a week because the soil tends to retain a lot of water. On the third week after planting (week 3), the fleece was opened to spray benomyl to control downey mildew which had set in (rate 15g per 20l of water). On the fourth week the emerged seedlings were sprayed with karate (rate 50ml/20l of water), to kill of any vectors that might have entered the fleece-covered beds. A week before transplanting, the seedlings were hardened off by removal of the fleece cover and reduction of watering frequency and amount

One month prior to proposed transplanting of seedlings (which took place on 6th April 2004), a field was prepared by ploughing, in order to open it up adequately and allow stubborn couch grass to dry. This procedure was followed by a second ploughing. Harrowing was also performed twice, and transplanting took place one week after this. Holes were prepared and DAP fertilizer was applied as a basal dressing at the rate of 5g per hole. The seedlings were then planted at spacing 45cm between plants and 60cm between rows (lines). The 15 seed lines were planted in three lines each with 53 seedlings. However some lines had much fewer seedlings hence their lines were shorter. Watering was initially done thrice a week but was stopped when the rains started. On week 3 after transplanting, top dressing was done using CAN (Calcium Ammonium Nitrate) fertilizer at the rate of 5g per plant. This was immediately followed by adequate watering which enhanced the percolation of the fertilizer.

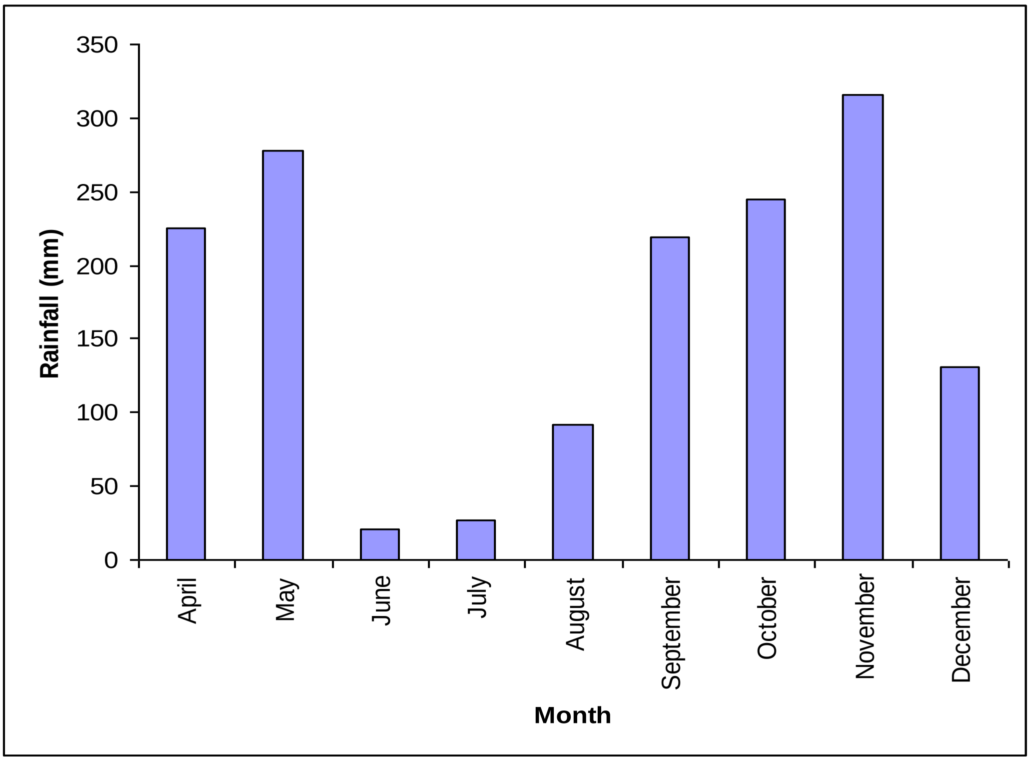


Figure 3.1 Monthly rainfall totals (mm) recorded for 2005, Njabini Station

As part of the general management of the growing lines, all agronomic practices for kale were undertaken, including regular weeding, fertiliser application, and pest management. Off types were removed, and the number was recorded for each line. In order to control any potential outbreak of the Diamond Back Moth (DBM), the pesticide Thuricide was applied at the rate of 1g/1litre of water, whenever damage and DBM were seen. Karate was applied at the rate of 48.5 ml in 15 l of water for the control of aphids which spread viruses. This was done when pests and/or damage was observed, and was followed by spot spray. Applications were necessary twice during the season. For the control of *Alternalia* leaf and pod spot, Benomyl was used at the rate of 15g in 15 l of water (1 g in 1 litre). Maconzeb was also applied for preventative purposes, when there was a threat from *Alternalia* leaf spot infection. Thiram was used at the rate of 10 g powder per 3 kg of seed. Supplementary irrigation was carried out during dry spells in the field. A bucket and a hose pipe were used in irrigating plants.

In order to prevent cross-pollination between lines about 100 plants of each line were covered with fleece which was able to keep out pollen and insects, supported by a structure made from bamboo (Plate 3.8). In order to facilitate cross-pollination within lines, one bee colony was introduced into each fleece-covered line. It was observed when selecting mother plants that selfing plants resulted in very low seed yields, implying that the kales have some degree of self-incompatibility. The bees were fed with fresh sugary water when flowers were inadequate for the bees.

3.2.4 CHARACTERISATION OF KINALE KALE LINES

Seedlings were regularly inspected, and a number of different characteristics were closely monitored throughout five distinct growth stages. (See Appendix I, PART 9: CHARACTERISATION FORM). These stages were: Seedling (34 days after sowing), vegetative (3 months post-transplanting), flowering (when plants flowered), pod (time of pod production) and seed (qualities of seeds produced). The characteristics monitored at each of these stages are summarised in Table 3.2 (below). Examples of descriptions used for each of these traits are included in the right hand column of this Table. However, the actual data recorded is withheld from this report, as it remains *Commercial in Confidence* until KEPHIS has completed full characterisation of the new potential Kinale kale commercial varieties.

Table 3.2 Characteristics recorded during assessment of 5 potential Kinale kale lines at each of five stages of plant growth from seedling to maturity

Growth stage		Characteristics monitored	Examples of descriptions used
Seedling	1	Anthocyanin of hypocotyls	Strong, medium or weak
	2	Cotyledon size	Small, medium or large
	3	Cotyledon shape	Broad or narrow
	4	Seedling colour	eg. Green yellow, lawn green*
Vegetative	1	Colour of young leaf	eg. Dark green, olive green*
	2	Leaf blade intensity of colour of young leaf	Strong, medium or light
	3	Colour of fully developed leaf	eg. Dark olive green
	4	Intensity of colour of fully developed leaf	Strong, medium, dark
	5	Leaf blade shape	Elliptic (broad), elliptic, narrow elliptic
	6	Leaf blade length	Measured in cm
	7	Leaf blade width	Measured in cm
	8	Leaf blade curvature of midrib	Weak to medium
	9	Leaf blade curling	Weak to medium
	10	Leaf blade cupping in cross section	Weak to medium
	11	Petiole attitude	Semi-erect to erect
	12	Petiole length	Measured in cm
	13	Petiole width	Measured in cm
	14	Petiole number of lobes	No. of lobes counted
	15	Plant position of growing point in relation to top of the plant	Slightly below to deeply below

Table 3.2 (Continued) Characteristics recorded during assessment of 5 potential Kinale kale lines at each of five stages of plant growth from seedling to maturity			
Growth stage		**Characteristics monitored**	**Examples of descriptions used**
Flowering	1	Anthocyanin	Absent to present (in x% of plants)
	2	Anthocyanin distribution	eg. Midrib, leaf blade margin, petiole
	3	Anthocyanin intensity	Very weak to weak
	4	Glucosity	Absent to present (weak or strong)
	5	Plant shape	eg. Pyramid, flat to dome
	6	Days to 50% flowering	Expressed as no. days from sowing
	7	Number of anthers	No. of anthers counted
	8	Colour of anthers	eg. Yellow*
	9	Number of sepals	No. of sepals counted
	10	Colour of sepals	eg. Yellow*
	11	Number of petals	No. of petals counted
	12	Colour of petals	eg. Yellow*
Pod	1	Pod width	Measured in cm
	2	Pod shape	eg. Elliptic, ovate, round
	3	Pod colour	eg. Green*
	4	Intensity of pod colour	Strong, medium, dark
	5	Pod secondary colour	Yes/no
	6	Pod secondary colour	eg. Purple*
	7	Pod curvature degree	Very slight, slight or pronounced
	8	Pod curvature shape	eg. concave
	9	Pod shape of distal part	eg. acute
	10	Length of pod stalk	Measured in cm
	11	Plant height	Measured in cm
	12	Pod length	Measured in cm
Seed	1	1000 seed weight	Measured in g
	2	Seed colour	eg. grey*
	3	Seed shape	eg. oval
	4	Seed surface	eg. smooth, rough

NB. * Specimens of plant parts were compared with colour charts, and precise nomenclature assigned to each colour recorded. For example “lawn green”, “purple madder”, “dim grey” etc. For reference purposes, full colour charts are included in Appendix I, PART 10: NAMED COLOUR CHART.

3.2.5 SELECTION OF LINES BY FARMERS FROM LARI DIVISION

After seed sowing and transplanting, the Kinale lines which were from single plant selections showed apparent differences among them at their vegetative stages. Examples of characters which were different among the lines were:

- The edge of the leaf – some were wavy while others were smooth
- Leaf size (breath and length)
- Uniformity of characters among plants e.g. height, leaf shape and orientation
- Leaf colour

These differences were clear indications that we had selected different lines from the Kinale kale landraces. Selection of the best lines was therefore initiated. (Note. Evaluation was *not* carried out on lines 5H and 2H, due to a lack of available plants, and the fact that these were transplanted later than seedlings from other selected lines. Only the lines **3H**, **7H**, **11**, **15**, **16**, **17**, **18**, **19**, **23**, **28**, **31**, **32** and **40** (i.e. thirteen in total)). Because the lines originated from the Kinale kale landraces, it was decided that the farmers who had been growing the landraces for a long time, and who were therefore the best qualified to make informed judgement as to plant quality, should be closely involved in this next evaluation stage of the selection process.

Farmer representatives from Kinale, Bathi and Gitithia were invited to select those lines which they individually thought were the best out the landraces under investigation. Representative farmers (see names in Appendix I, PART 11), were selected by their fellow farmers from Kinale, Bathi (Carbacid), and Gitithia (Uplands), three locations of Lari Division where the Kinale landrace is grown, and where the current lines were selected from. The farmers were quite a mixed group (male and female, young and old). A total of 11 farmers took part in the selection process. Each farmer was given a plastic cup and five dry maize grains. The farmers were asked to walk through and assess each line as they went along, up to the end of the row (Plate 3.9). At the end of the line, farmers were asked to evaluate the line by putting in their cup the number of grains which they felt best represented their assessment of the line. The more the grains, the higher the weight for the line, and vice versa. The farmers were asked to put the grains in their cups at the same time, thus limiting the amount of group influence. The numbers of seeds for each farmer was then recorded for each line. Each farmer was identified by a number (1-11). Below are the results of farmers' evaluation of the lines (Table 3.3). The higher the total score for each line, the better the quality of the line was deemed to be.

Plate 3.8 Plants of Kinale kale lines covered with fleece supported by a bamboo structure

Plate 3.9 Some of the farmers assessing one of the Kinale kale line at Njabini

Farmer number	Line number and score												
	18	**15**	**32**	**23**	**28**	**7H**	**3H**	**31**	**16**	**11**	**17**	**40**	**19**
1	0	3	5	5	0	3	3	0	2	4	3	4	0
2	2	3	5	5	0	2	4	4	2	0	2	5	4
3	5	3	4	5	2	3	3	3	2	3	4	4	5
4	4	2	3	5	0	2	3	1	2	0	2	2	4
5	3	2	4	5	0	2	3	0	1	2	1	3	5
6	2	3	3	4	2	3	4	3	3	3	2	2	3
7	4	3	5	5	1	3	3	4	5	2	4	4	3
8	4	3	3	5	2	3	4	2	3	2	2	3	4
9	5	5	5	5	3	4	5	4	3	4	5	4	5
10	3	4	4	5	2	2	2	3	3	1	1	1	3
11	3	4	4	4	5	2	5	3	0	3	2	5	2
Total scores	**35**	**35**	**45**	**53**	**17**	**29**	**39**	**27**	**26**	**24**	**28**	**37**	**38**
Average	3	3	4	5	2	3	4	2	2	2	3	3	3
Std Dev.	1.5	0.9	0.8	0.4	1.6	0.7	0.9	1.5	1.3	1.4	1.3	1.3	1.5

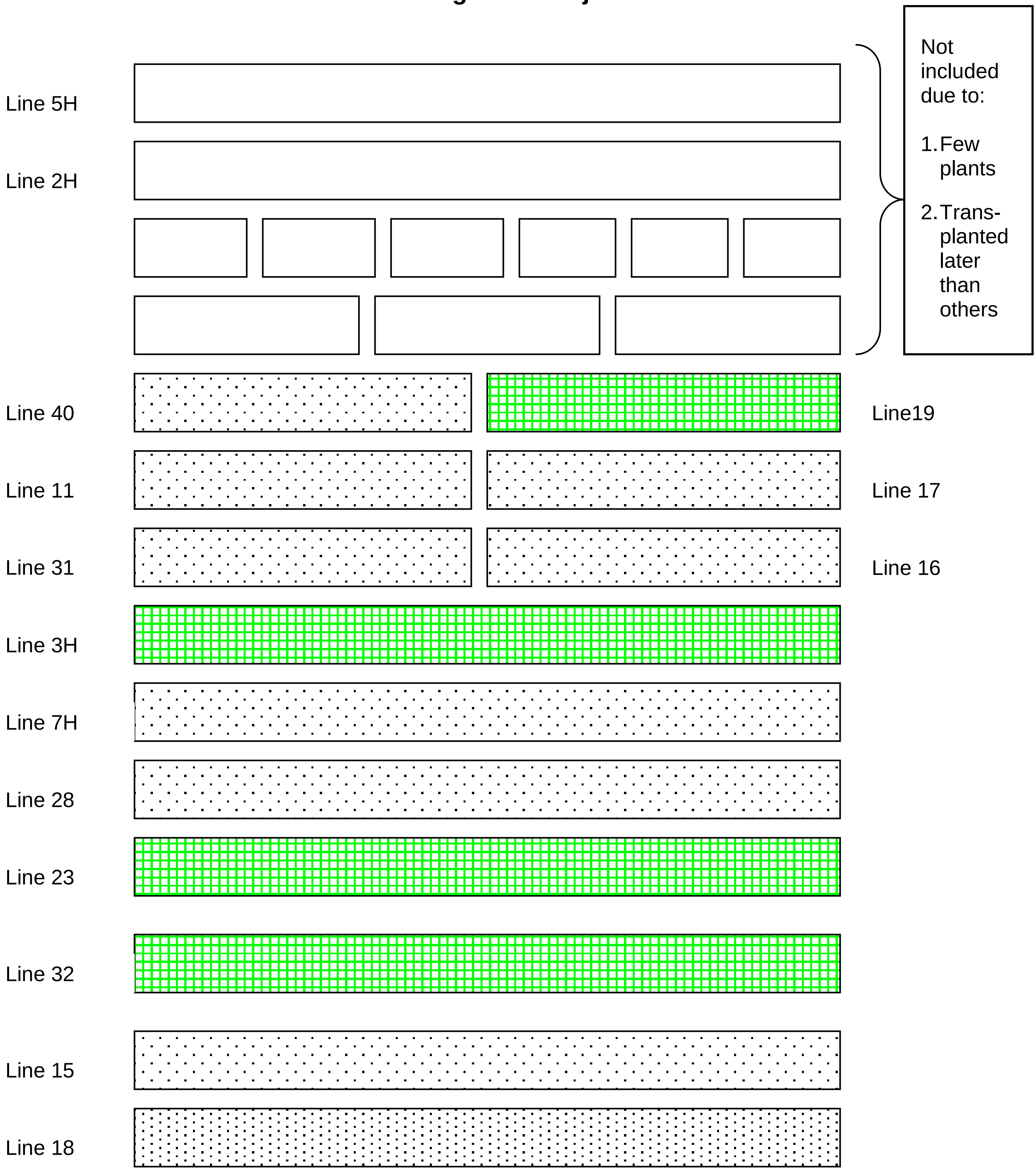
Table 3.3 Results (total and average scores, and standard deviation) of each Kinale kale line as evaluated by 11 farmers at Njabini

Line number 23 was the farmers' favourite as shown by its high total and average scores coupled with low standard deviation. Line number 28 was the worst line according to farmers (Table 3.3, above). The farmers were asked to give their criteria for selecting the lines – giving the best and the worst scores. The criteria used by farmers for quality Kinale kales (the land races they know) comprise of the following factors:

1. Good health
2. Broad leaves
3. Long internodes?
4. Dark green colour
5. Medium sized stem diameter
6. Long leaves
7. Disease free
8. Tall plants. Lowest leaves about 4 cm from the soil level.
9. Long harvesting period before flowering (about 16 weeks)
10. Seedling – 1st leaf a big distance from the soil level
11. Free of suckers – no tillering

Figure 3.2 Shows the position of selected Kinale kale lines in relation to other lines grown at Njabini research station. The final ranking of the Kinale kale lines is shown in Table 3.4. Characteristics of the best, worst and average lines as given by farmers have been presented in Table 3.5. The following is therefore the ranking of a sample of the Kinale kale lines under evaluation at Njabini, as judged by local farmers:

Figure 3.2 The position of selected Kinale kale lines (green colour) in relation to other lines grown at Njabini



Rank	**Kinale kale line**	**Remarks**
1	**23**	The best line – selected
2	**32**	Selected
3	**3H**	Selected – same as line 20
4	**19**	The last of the best four lines which were selected
5	40	
6	18	
7	15	
8	7H	Same as line number 43
9	17	
10	31	
11	16	
12	11	
13	28	

Table 3.4 Ranking of Kinale kale lines by farmers (Lines shown in green were the ones selected by farmers)

Table 3.5 Characteristics for the best and the worst line as given by farmers

Kinale line Number	Reasons farmers chose or rejected it	Pictures of the best and worst lines
23 (best line)	▪ Has no suckers ▪ The colour represents the true Kinale kale ▪ No mortality – gaps within the line ▪ Short internodes ▪ Tall plants – height ▪ Large and wide leaves. Only a few plants are needed to get a high weight ▪ Has vigorous growth ▪ Plants are uniform	
28 (worst line)	▪ Too short. This means that after only 2 harvests it will flower – lines are not being harvested in this experiment, hence can not be confirmed ▪ Emerging new leaves are not very green (are yellowish) implying that it will flower soon. ▪ Looks very much like "Kamolo" – the commercial variety being multiplied by smallholder farmers in Molo. ▪ The leaves start very close to the soil, thus making it more susceptible to diseases. No major diseases have been observed so far, hence the observation can not be confirmed at this stage.	
Line 3H (Average line)	▪ Medium height (not as tall as line 23) but has large leaves ▪ Has no suckers. ▪ Not uniform	
Line 32	▪ Not as uniform as line 23. ▪ Some plants do not show the general green colour as in line 23.	
Line 40	▪ Stunting right from the nursery ▪ The stem splits as it ages ▪ Short stems like "Kamolo" kale variety	

3.2.6 THE FINAL SELECTION OF KINALE KALE LINES

On the strength of all the data collected during the course of the characterisation work described in preceding Sections of this Chapter, and of the farmers' own assessment if the new potential Kinale kale lines grown on station at Njabini, the project team made a final selection of 5 outstanding kale lines to be submitted to KEPHIS for further characterisation (Distinctiveness, Uniformity and Stability trials) and registration as potentially new seed varieties. The identities of these lines were:

CABI 1 = Kinale line number 15

CABI 2 = Kinale Kale line number 3H

CABI 3 = Kinale line number 18

CABI 4 = Kinale line number 32

CABI 5 = Kinale line number 23

Kinale line numbers 3H, 32 and 23 were selected by both the project Research team, and also by the participating farmer groups. Lines 15 and 18 were selections based on the Research team's findings. (Plates 3.10 and 3.11 illustrate some of the outstanding characteristics of vigorously growing Kinale kale lines)

Plate 3.10 A very heavy pod-producing Kinale kale plant that requires two ladies to struggle to support its pods at Njabini KARI Sub-Station

Plate 3.11 Kinale kales lines are extraordinarily tall (most are > 2 m high)

3.2.7 SUBMISSION OF SEEDS FOR VARIETAL DEVELOPMENT

Dr. Moses Onim attended project meetings held in KARI-NAL Campus, convened by CABI and also attended by collaborating institutions. These institutions included KARI-NAL, KARI-Horticultural Research Station, Thika, KEPHIS, Nicola Spence CSL and Lagrotech Seed Company. In these meetings it was put forward that the team, including CABI scientists, KEPHIS, KARI and Lagrotech seed Company, should suggest how kale lines selected from landraces among Kinale kale farmers could be developed into commercial varieties. A series of steps were subsequently recommended which should be followed to enable seed from Kinale lines to be developed into varieties, and this seed to be released commercially, for the market. (These steps are detailed in section Appendix I, PART 5: KALE PROJECT BY CABI AND LAGROTECH SEED COMPANY).

Among key points raised were the following requirements:

i) The need to submit a portion of seed obtained from selected Kinale kale plants to KEPHIS, prior to the convention of the National Variety Release Committee, and/or undertake further multilocational trials;

ii) The need to conduct Distinctiveness, Uniformity and Stability trials;

iii) It was also recommended that a portion of seed obtained from selected Kinale kale plants should be entered for multiplications trials.

3.2.7.1 Multilocational Trials

KEPHIS convenes the National Variety Release Committee in March 2005. This Committee is made up of all seed companies and organizations that intend to enter their various crop varieties to be tested in the National Performance Trial (NPT). These trials are conducted at several locations across the country where the varieties are tested against many other similar varieties entered for NPT by other seed companies and organizations. These varieties are also tested against about five commercial checks that are already released and are being marketed. If the entered lines or land races, on average, do significantly better than the checks across trial sites over a period of three years (seasons), then they are released for commercial production and marketing. However, if the entered lines or land races are found to be markedly superior in terms of their measurable attributes (for example, yield, disease and pest resistance, or earliness), then the entries may be pre-released after only one or two NPT trials, if the organization that entered the lines fight for pre-release. A fee is also paid to KEPHIS for every line (land race) entered for NPT every year (season). There is not, in fact, any need to submit seed from the selected Kinale kale lines for NPT, as kale is not mandatory for testing. However, the project team made the decision to conduct multilocational trials (MLT) such that further data can be collected re. various performance parameters. Once the new varieties have been registered, then access to such data will make the process of variety release much easier.

Kale seeds labelled CABI 1-5 have now been planted in nurseries at Njabini, Kabete, Kari, Thika, and Murea, along with three comparitive varieties: *Collards*, *Thousand-headed* and *Sukuma Siku.* Resulting seedlings will be transplanted in May. Lagrotech have established nurseries at farmer training centres in West Kenya at 6 sites: Maseno, Kisii, Siaya, Kisumu, (Agric. Shows, Kenya), Kari-kaka mega and Lisuka (Lagrotech research farm). Seedlings will be raised in a central place then transplanted on site. Parameters measured will be the same across all MLT sites. These will include leaf yield, time to flower, and susceptibility to pests and diseases, in particular black rot. (see also Chapter 7 of this report)

3.2.7.2 Distinctiveness, Uniformity and Stability Trials

In order to determine the extent of variability within Kinale kale lines, a proportion of the seed collected from tagged mother plants was supplied to KEPHIS for planting (see previous Sections), such that subsequent plants could then be assessed for Distinctiveness, Uniformity and Stability (DUS). This process allows superior lines to be selected for further development into varieties. It is an important step towards the release of any potentially new variety, where the descriptor for each line that has been developed in the characterization phase is verified. The descriptors of each variety must be supplied to KEPHIS for filing, so that KEPHIS seed inspectors can use them during variety field inspections for seed production by seed growing farmers.

The five selected Kinale kale lines have now been submitted to KEPHIS for DUS and confirmation of their characteristics. For the purposes of comparison, two standard varieties of commonly-grown kale were also submitted. These are: *Thousand-headed* and *Collards*. In addition to these seven lines, KEPHIS will include commercial varieties that they have which may be more uniform, to allow further comparisons to be drawn. In order to contribute to this process, any data obtained during this project which relates to the particular characteristics of the five selected Kinale kale lines has also been provided to KEPHIS. DUS trials will be conducted in two different agro-eco zones, where seed production and leaf production will be monitored. Figure 3.3 shows the lay out of the five selected lines for the DUS experiment at Njabini.

3.2.7.3 Multiplication Trials

It was also recommended that a portion of seed obtained from selected Kinale kale plants should be entered for multiplications trials by the research team. Although KEPHIS usually only allows for seed increase of varieties or lines that have either been recommended for release or pre-release by the National Variety Release Committee, it is usually advisable to start seed increase earlier since once a variety is officially released, the amount of seed required by the market is usually very big. Multiplication of lines are currently being conducted in screenhouses at Njabini research station, in preparation for release.

Figure 3.3 LAY OUT OF THE LINES AND PLANTS IN DUS EXPERIMENT AT NJABINI

PLANT #	LINE #1				LINE # 14				LINE # 21				LINE # 31				LINE # 2				LINE # 15			
1	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
2	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
3	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
4	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
5	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
6	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
7	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
8	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
9	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
10	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
11	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
12	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
13	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
14	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
15	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
16	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
17	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
18	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
19	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
20	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
21	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
22	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
23	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
24	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
25	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
26	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
27	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
28	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
29	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
30	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
31	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
32	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
33	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
34	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
35	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
36	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
37	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
38	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
39	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
40	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
41	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
42	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
43	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
44	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
45	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
46	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
47	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
48	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
49	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
50	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
51	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
52	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o

PLANT SPACING

Within rows = 0.45 m; Between rows = 0.6 m
Between lines = 2 M

Chapter 3: Establishing a sustainable kale seed multiplication system

Part 3: Identification of a suitable model for sustainable kale seed multiplication

3.3.1 INTRODUCTION: LEAF HARVESTING FREQUENCY TRIALS

For the past three years, single plant selections were made from the kale land races in Lari Division through a series of DFID-funded vegetable projects, the current one being “Promotion of quality vegetable seed in Kenya” (R8312, starting 1/4/03 and ending 31/3/05). As described in previous Sections of this report, substantial cleaning-up of the landrace selections has been made in order to come up with uniformity within the selections, and a number of lines have been chosen, which are preferred by kale farmers and consumers. However, although five of the selected lines have been submitted to the national authorities for possible registration as kale varieties, which can be grown and sold by the kale producers in the country, at the moment there is no model for multiplying seed of these lines by farmers.

3.3.1.1 Objectives

Thus the project now sought to identify a suitable model for a sustainable kale seed multiplication from kale lines established from mother plants selected on local farmland in Lari Division of Kiambu District, that will enable smallholders to produce healthy seed of good quality and that has an acceptable market value. The main objective of the trials described below was to assess the effect of harvesting leaves for different periods on the quantity and quality of seed of kale. The underlying thinking behind this was to establish whether, in order to maximise seed quantity and quality, leaves should be left on the growing plant or whether leaves can be harvested for use/sale by the grower. This approach was meant to help in the selection of the most viable model for a possible Kinale farmers’ kale seed production system. The specific objectives were:

1. Identify a suitable model for sustainable kale seed multiplication by examining the effect of harvesting leaves for different periods on the yield of kale seeds.

2. Assess the profitability of kale production for seed compared to kale production for leaves.

3. Develop a strategy for the sustainable and viable production of improved quality kale seeds.

3.3.2 MATERIALS AND METHODS

3.3.2.1 Trial design

In order to ascertain the relative effect(s) of harvesting leaves at different time intervals on the subsequent quantity and quality of kale seed production, three seed production models were evaluated. Seeds from kale produced using each of these models were then harvested, and the models were subjected to economic analysis in order to choose the most economically viable model to be used for producing/multiplying seed of the "new" kale lines when released. The alternative production models were:

A. Full leaf harvesting – kale leaves were harvested up to flowering, (at ~ 16 weeks)
B. Leaf harvesting for half the time as in A. above.
C. No leaf harvesting

NB. In the first instance, trials were replicated at the on-station site located at Njabini (KARI station in Kinangop). It is these activities which are described in the following Sections of Chapter 3, Part 3. However, in order to fully validate the preferred harvesting model, selected lines were also grown "on farm", in Kinale, Bathi and Gitithia. Data colleted from on farm sites was then used to undertake comparative cost-benefit analyses for kale production for seed with kale production for leaf, thus allowing the most economical model to be determined. These activities are described in Chapter 3, Part 4 (In particular, see Section 3.4.3.2: Cost Benefit analyses). It is therefore necessary for the reader to cross reference between Parts 3 and 4 of the present Chapter when considering some parts of subsequent data analysis.

Seeds of the five selected Kinale kale lines were sown at Njabini in February 2004, and subsequently covered with fleece. For the purposes of the leaf-harvesting trials, five seed lines were selected on the basis of the amount of seed available, and representing five different sources (farmers) from the region. Each seed lot was assigned a unique identification code, allotted according to details of the mother plant at the previous year's harvest. The first two digits relate to the year of harvest (2003); the second two digits show the farm code; the next three digits refer to the plant number at that farm; the final letter refers to whether the plant was Open- (O) or Self- (S) pollinated. These id numbers were:

03-02-006-S
03-04-010-O
03-06-016-O
03-10-023-O
03-12-029-O

Trials were set up according to a randomised split plot design, with seed production models as main plots, and with four of the five Kinale kale selections as subplots at any one site (Figure 3.4). Randomisations were generated using Genstat (Table 3.6). The plot size was 15 plants for each line, thus totalling 60 plants in the main plot. The plants were spaced at 60 cm by 60 cm.

Figure 3.4 Randomised block layout for picking trials

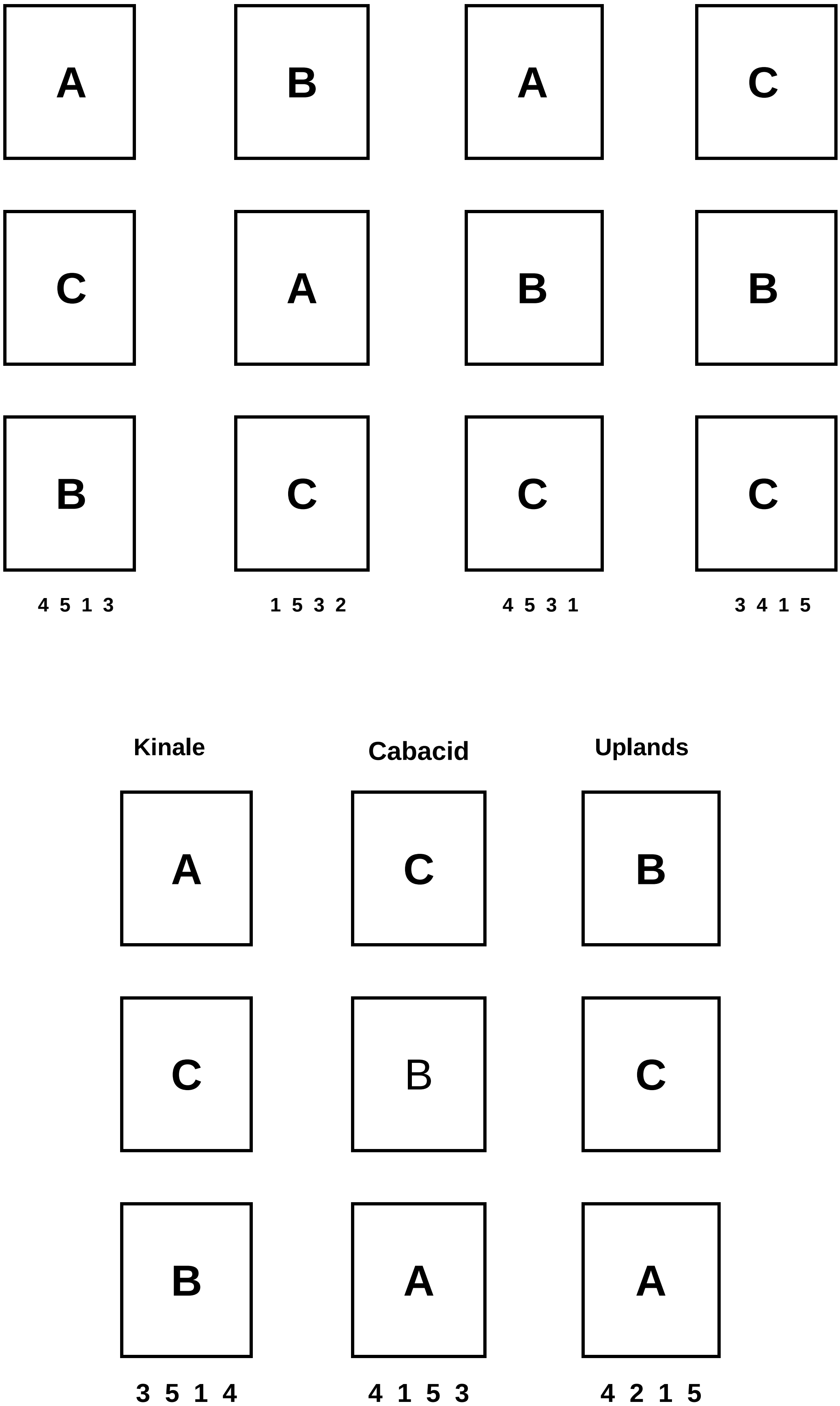


Table 3.6 Randomisations generated by Genstat 6

Site	Plot no.	Block	Plot	Treatment	Subplots				
					R1-3	R4-6	R7-9	R10-12	R13-15
Njabini	1	1	1	A	4	5	1	3	2
Njabini	2	1	2	C	4	5	1	3	2
Njabini	3	1	3	B	4	5	1	3	2
Njabini	4	2	1	B	1	5	3	2	4
Njabini	5	2	2	A	1	5	3	2	4
Njabini	6	2	3	C	1	5	3	2	4
Njabini	7	3	1	A	4	5	3	1	2
Njabini	8	3	2	B	4	5	3	1	2
Njabini	9	3	3	C	4	5	3	1	2
Njabini	10	4	1	C	3	4	1	5	2
Njabini	11	4	2	B	3	4	1	5	2
Njabini	12	4	3	A	3	4	1	5	2
Kinale	13	5	1	A	3	5	1	4	2
Kinale	14	5	2	C	3	5	1	4	2
Kinale	15	5	3	B	3	5	1	4	2
Cabacid	16	6	1	C	4	1	5	3	2
Cabacid	17	6	2	B	4	1	5	3	2
Cabacid	18	6	3	A	4	1	5	3	2
Uplands	19	7	1	B	4	2	1	5	3
Uplands	20	7	2	C	4	2	1	5	3
Uplands	21	7	3	A	4	2	1	5	3

Njabini

A	B	A	C
C	A	B	B
B	C	C	A

Kinale	**Cabacid**	**Uplands**
A	C	B
C	B	C
B	A	A

The nursery beds were covered with a fleece in order to protect the seedlings from aphids and other insect pests such as aphids, which are vectors of viral diseases. Data collected included leaf number and weight. In addition stem width was also collected. Seed yield was collected after pods mature. Each harvesting regime was replicated four times on-station.

3.3.2.1 Data analysis

Values for weight (in grams) of marketable and non-marketable leaves for each plant at each harvest date were tabulated in an Excel™ spreadsheet. The seed yield (in grams) was also tabulated in an Excel™ spreadsheet. The value of harvested leaves was estimated using a mean value per gram calculated as the mean of values estimated for bunches of leaves of known weight at different harvest dates. The value of the seed was estimated using a single value of 0.8 KSh per gram. Analysis of variance was performed on the total (leaf) yields across all harvest dates using appropriate directives in Genstat™. The significance of treatment factors was assessed on the basis of F-values (variance ratios) and the differences between individual means on the basis of their standard errors and appropriate t-values. Analysis of leaf yield data was restricted to treatments A and B only, to avoid biasing the variance due to the zero values in treatment C. The treatment of missing values presented some problems: these could have arisen either because the plant was missing, or because the plant produced zero yield of leaves or seeds. If values were missing for leaf yield and seeds, then the plant was considered to be genuinely missing, otherwise a value of zero was assigned.

3.3.3 RESULTS

Seedling emergence took place between 3 – 7 days. Leaf harvesting on treatments A and B started two weeks after transplanting seedlings in the field. There were clear visual differences between harvested and non-harvested plots, particularly in terms of stem girth and height. This necessitated collecting extra data on stem diameter. However, treatment B seemed to recover very quickly after harvesting stopped. Full raw data for leaf yield and stem diameter for all plants monitored at Njabini station can be seen in the following datasets: *Kinale kale harvest data – October 04. PROJECT: PROMOTION OF VEGETABLE SEED IN KENYA. Effect of kale leaf Harvesting on seed production. Njabini on-station trial: Yield data 26/05/04-02/09/04. Treatment A = Full Harvest; Treatment B = Half Harvest (stopped on 08/07/04) Microsoft Excel dataset 104pp*. (Details of data and data sets obtained during on farm trials are described in Chpter 3, Part 4).

3.3.3.1 Stem diameter

There were differences in stem diameter among plants in the different treatments (seed production models). Plants in the half harvest treatment had the biggest stems, followed by the no harvest treatment (Figure 3.5). Although one might expect plants that had experienced no leaf harvest to have had the thickest stems, this result may be explained by the fact that some plants in the no harvest had much bigger stems, some with diameter of up to 8.7 cm, while other plants within the treatment had diameter as low as 0.5 cm. This could be attributed to competition resulting from vigorous growth by plants in this group.

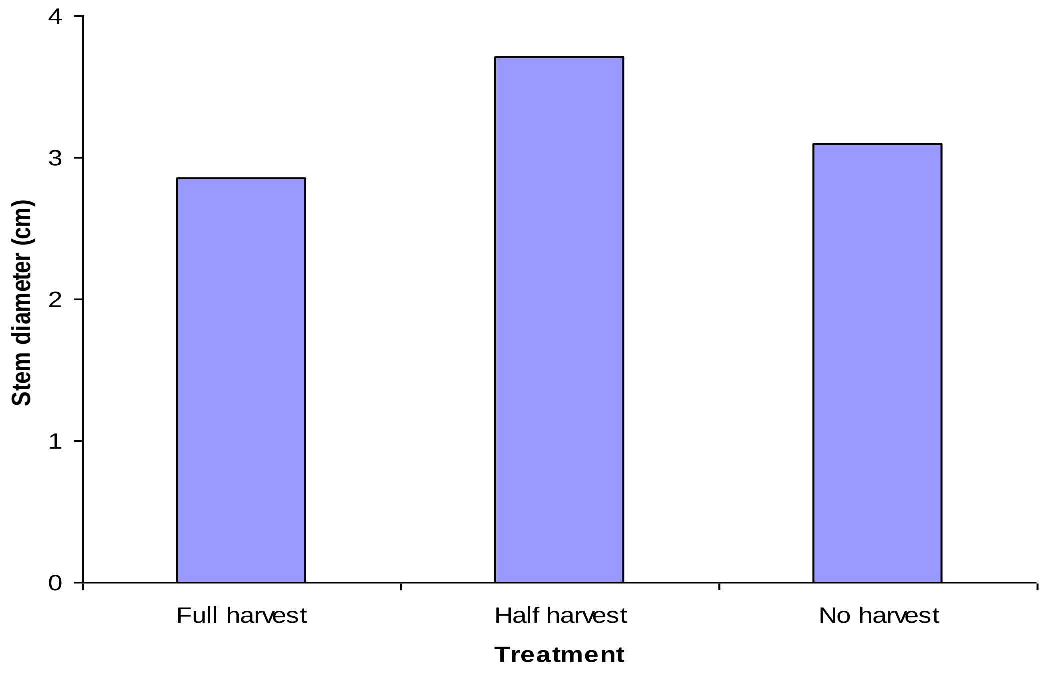


Figure 3.5 Stem diameter (cm) from different harvesting models in the on-station trial at Njabini.

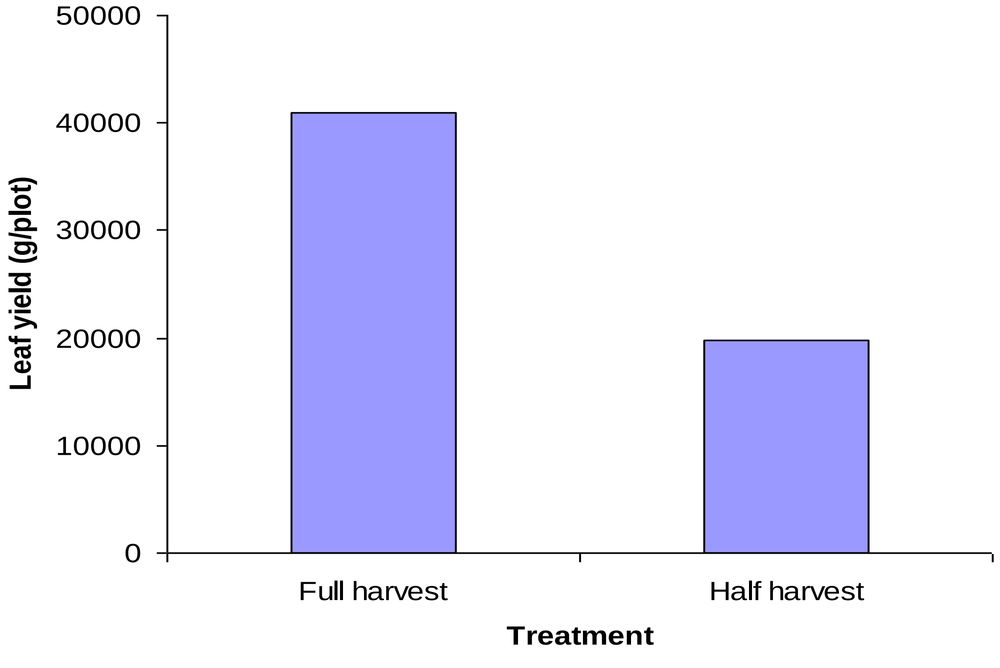


Figure 3.6 Leaf yield (g/plot) from the two seed multiplication models in the on-station trial at Njabini

3.3.3.2 Leaf yield

Leaf yield on-station was high. Full harvest treatment produced a leaf yield of up to 41 kg/plot (Figure 3.6).

Marketable leaf yield

(Analyses presented in Table 3.7). There were significant differences between treatments, lines, and a significant line/site interaction. Treatment A (full harvest) gave a leaf yield almost double that of Treatment B (half harvest), as no leaves were harvested from Treatment C, the yield was nil. The leaf yield of Line 2 was significantly greater than Lines 1 and 5, and Line 6 was greater than Line 1. The interaction effect was mainly due to a relatively poorer leaf yield of Line 1 at Njabini compared to the other sites (presumably because it flowered earlier). Leaf yields appeared to be greater at Njabini and Gitithia but these were not significant.

Non-marketable leaf yield

(Analyses presented in Table 3.8). There was a significant difference between sites and a marginal difference between lines. The weight of rejected (non-marketable) leaves was greater at Njabini than at the other sites and line 2 had lower weight of rejected leaves than the others.

3.3.3.3 Seed harvest data

Raw data for per plant seed weight, and 1000 seed weight/bulk respectively is presented in the datasets listed above. See also Dataset: *EVALUATION OF KINALE KALE HARVESTING MODELS – SEED YIELD DATA – APRIL 2005*. Seed weight data was obtained only for those plants which flowered and which produced seed within the project timescale.

Seed yield

(Analyses presented in Table 3.9). There were significant differences between sites (see Chapter 3, Part 4), treatments and lines. Treatment A (full harvest) gave significantly lower seed yields than treatments B and C. Although treatment C gave the highest seed yields, this was not significantly greater than treatment B. Seed yields were significantly much greater at Njabini than at the other (farm) sites. Presumably this was the result of many plants failing to flower in the warmer climates at the on-farm sites. Also, at Njabini the crop was managed very intensively and watered regularly. Line 1 gave significantly higher seed yield than lines 2 and 6, and line 5 gave a significantly higher yield than line 2.

Table 3.7 Variate analysis: Marketable leaf yield

Source of variation	d.f.(m.v.)	s.s.	m.s.	v.r.	F pr.
block stratum					
site	3	6342293	2114098	2.62	0.225
Residual	3	2420305	806768	3.4	
block.treat stratum					
treat	1	1.9E+07	1.9E+07	79.06	0.003
treat.site	3	778493	259498	1.09	0.472
Residual	3	711794	237265	3.2	
block.treat.line stratum					
line	3	1136759	378920	5.11	0.01
treat.line	3	32583	10861	0.15	0.931
line.site	9	2641132	293459	3.95	0.006
treat.line.site	9	1138469	126497	1.7	0.16
Residual	18	1335974	74221	2.16	
block.treat.line.plant stratum					
	763(21)	2.6E+07	34395		
Total	818(21)	6E+07			
	Treatment	**A**	**B**	**C**	
		601.5	302.7	0	
	se	23.77	23.77		
	Line	**1**	**2**	**5**	**6**
		400.5	497.2	436.7	474.1
	se	18.8	18.8	18.8	18.8
	Site	**Njabini**	**Kinale**	**Gitithia**	**Bathi**
		506.9	339.4	504.9	292.9
	rep.	480	120	120	120
	se	41.00	81.99	81.99	81.99
	Line	**Site**	**Njabini**	**Kinale**	**Gitithia**
	1		387.8	392.2	591.3
		rep.	120	30	30
	2		566.6	343.1	594.7
		rep.	120	30	30
	5		518.2	275.6	441.5
		rep.	120	30	30
	6		555.1	346.9	392.2
		rep.	120	30	30
	se		43.78	87.55	87.55

Table 3.8 Variate analysis: Non-marketable leaf yield					
Source of variation	**d.f.(m.v.)**	**s.s.**	**m.s.**	**v.r.**	**F pr.**
block stratum					
site	3	1389351	463117	68.22	0.003
Residual	3	20366	6789	0.69	
block.treat stratum					
treat	1	110533	110533	11.18	0.044
treat.site	3	64053	21351	2.16	0.272
Residual	3	29651	9884	0.88	
block.treat.line stratum					
line	3	134037	44679	3.96	0.025
treat.line	3	27729	9243	0.82	0.5
line.site	9	71277	7920	0.7	0.699
treat.line.site	9	18520	2058	0.18	0.993
Residual	18	202887	11272	3.08	
block.treat.line.plant stratum					
	763(21)	2793017	3661		
Total	818(21)	4739888			
	Line	**1**	**2**	**5**	**6**
		68.6	34.9	56.8	44.9
	se	7.33	7.33	7.33	7.33
	Site	**Njabini**	**Kinale**	**Gitithia**	**Bathi**
		86.5	2.4	2.2	8.5
	rep.	480	120	120	120
	se	3.76	7.52	7.52	7.52

Table 3.9 Variate analysis: Seed yield					
Source of variation	**d.f.(m.v.)**	**s.s.**	**m.s.**	**v.r.**	**F pr.**
block stratum					
site	3	2653396	884465	92.87	0.002
Residual	3	28570	9523	0.88	
block.treat stratum					
treat	2	271144	135572	12.5	0.007
treat.site	6	132896	22149	2.04	0.203
Residual	6	65082	10847	0.8	
block.treat.line stratum					
line	3	252025	84008	6.17	0.002
treat.line	6	41261	6877	0.51	0.799
line.site	9	110953	12328	0.91	0.534
treat.line.site	18	22780	1266	0.09	1
Residual	27	367533	13612	2.11	
block.treat.line.plant stratum					
	1155(21)	7442604	6444		
Total	1238(21)	1.1E+07			
	Treatment	**A**	**B**	**C**	
		39.8	62.7	75.2	
	se	5.08	5.08	5.08	
	Line	**1**	**2**	**5**	**6**
		79.6	40.6	62.6	54.2
	se	6.57	6.57	6.57	6.57
	Site	**Njabini**	**Kinale**	**Gitithia**	**Bathi**
		99.0	3.6	4.2	11.3
	rep.	720	180	180	180
	se	3.64	7.27	7.27	7.27

3.3.3.4 Total return

(Analyses presented in Table 3.10). The total economic return followed a similar pattern to that of seed yield (and value) due to the much higher value of seed compared to leaves. Thus there were significant differences between sites, treatments and lines. Treatment A gave significantly lower return than treatments B or C. Although treatment C gave the highest return, this was not significantly greater than treatment B. However, as many lines had not flowered it is difficult to analyse the data thoroughly. Returns were significantly much greater at Njabini than at the other (farm) sites. Line 1 gave significantly higher seed yield than lines 2 and 6, and line 5 gave a significantly higher yield than line 2.

Table 3.10 Variate analysis: Total return					
Source of variation	**d.f.(m.v.)**	**s.s.**	**m.s.**	**v.r.**	**F pr.**
block stratum					
site	3	1729861	576620	106.46	0.002
Residual	3	16248	5416	0.79	
block.treat stratum					
treat	2	119388	59694	8.68	0.017
treat.site	6	80550	13425	1.95	0.218
Residual	6	41272	6879	0.79	
block.treat.line stratum					
line	3	155620	51873	5.93	0.003
treat.line	6	27189	4532	0.52	0.79
line.site	9	68254	7584	0.87	0.565
treat.line.site	18	15812	878	0.1	1
Residual	27	236236	8749	2.11	
block.treat.line.plant stratum					
	1155(21)	4793691	4150		
Total	1238(21)	7216343			
	Treatment	**A**	**B**	**C**	
		36.8	52.7	60.2	
	se	4.05	4.05	4.05	
	Line	**1**	**2**	**5**	**6**
		65.9	35.2	52.5	46.0
	se	5.27	5.27	5.27	5.27
	Site	**Njabini**	**Kinale**	**Gitithia**	**Bathi**
		82.0	4.7	6.1	10.7
	rep.	720	180	180	180
	se	2.74	5.49	5.49	5.49
	Economic return at diff sites				
		Site			
		Njabini	**Kinale**	**Gitithia**	**Bathi**
	leaves	2.80	1.88	2.79	1.62
	seed	79.2	2.8	3.3	9.0
	total	82.0	4.7	6.1	10.6
	As % of total				
	leaves	3.4	40.1	45.8	15.3
	seed	96.6	59.9	54.2	84.7

3.3.3.5 Ranking of the Kinale kale lines

The ranking of the four lines for leaf yield was the exact reverse of the ranking for seed yield. This is presumably because lines giving high leaf yields tend to flower later or have a shorter flowering period. As the seed yield provides the major part of the potential economic return, it would be tempting to select lines which give the highest seed yield, however, as the end-use (value) of the seed is to produce plants which give a high yield of leaves, leaf yield should still be the basis for selection of lines. Of the four lines, 2 and 6 were produced the highest leaf yields and these should certainly be selected for further multiplication and evaluations.

3.3.4 DISCUSSION/CONCLUSIONS

The total economic return obtained from Kinale kale plants was highly dependent on seed yield, making up 97% of the value at Njabini, 85% at Bathi, and over 50% at Kinale and Gitithia. It is also clear that continually harvesting of leaves will reduce seed yield, and although not statistically significant, harvesting leaves for the first part of the crop (Treatment B) also appeared to reduce seed yield and overall economic return. Thus to maximise the yield of seed and economic return, it is recommended that leaves are not harvested from plants which are being used for seed production. It is also very clear that seed yields were very much higher at Njabini than at any of the farm sites, and while seed production was economically viable (compared to leaf production) at the farm sites, regular production of seed crops should be considered as more suited to the climate in the Njabini area than at the on-farm areas.

In conclusion, treatment A (full harvest) gave the highest leaf yield and the lowest seed yield, as expected. Treatment C (no leaf harvesting) gave the highest seed yields. As the value of seed is much higher than the value of leaves, these data support the no leaf harvesting model as the best seed multiplication model. This is supported strongly by the cost-benefit analysis carried out at the three on-farm sites (presented in Chapter 3, Part 4, Section 3.4.3.2), and summarised in Tables 3.11 and 3.12.

Chapter 3: Establishing a sustainable kale seed multiplication system

Part 4: Validation of the model

3.4.1 INTRODUCTION: INITIATION OF ON FARM TRIALS

On-farm evaluation of leaf-harvesting models using selected kale lines was carried out in a farmer-participatory manner: Groups of farmers were brought together in the different sites, and the three models being evaluated and related trial protocols were explained to them (Plate 3.12) (see Experimental design, below). Farmers' groups then chose a representative for each area in which the trials were to be sited (Kinale, Gitithia and Bathi, respectively). These chosen farmers were thus the contact farmers for this part of the project. The meeting to choose a representative farmer in Kinale was held on 17 February 2004, but was held on 18 February 2004 at Bathi (Cabacid) and Gitithia (Uplands). A total of 21 farmers attended the Kinale meeting, 14 at Bathi, and 21 at Gitithia. *Pastor Samuel Ndirangu Njoroge*, *Mr Peter Muhia Njoroge*, and *Mrs Tabitha Mumbi Mbuthia*, were chosen as representative farmers for Kinale, Bathi, and Gitithia, respectively. (Mr Njoroge, of LARI Division, Ministry of Agriculture organised the meetings. Mr Martin Kimani of CABI facilitated the meetings). The selection of representative farmers was based on accessibility (near to the road), farmer's willingness to serve others, farmer's recognition by others as a trusted and good communicator, availability of land for research, and water availability especially during the dry season. The farmers provided land and labour while the project provided seeds, pesticides and fertilizers. (See Appendix I, PART 11: SELECTION OF CONTACT FARMERS FOR ON-FARM TRIALS).

Plate 3.12 Farmers listening to an explanation about the experiment before choosing their representative

(Note. Although in the initial stages of this part of the project only used three contact farmer groups were used, the number of farmers participating in the project has been building up throughout the project period, from 86 to 300, thus allowing the model to be validated at a wide range of farm sites).

3.4.2 MATERIALS AND METHODS

3.4.2.1 Monthly participatory activities with farmer groups

The three representative farmers were trained in the management of the trials on 20th February 2004. The training included land preparation, planting mode, spacing, care of the crop, and recording of inputs used, costs, constraints and outputs. The three farmers and other farmers then took part in the sowing of seeds of Kinale kale lines (Plate 3.13). Monthly participatory activities were established with farmers at each of the sites. The participatory activities involved the groups of farmers who were led by the contact farmers. During each of the activities, focus group discussions were conducted to elicit farmer perceptions of the husbandry practices and the performance of the various treatments. Farmers participated in all the activities i.e. land preparation, sowing, transplanting and crop protection, leaf and seed harvesting.

During the regular fortnightly participatory harvesting, the contact farmer explained all the husbandry practices to the rest of the farmers before commencement of harvesting. Farmers monitored the crop performance throughout the cropping season. The characteristics used in the assessment of the kales included leaf size, leaf shape, vigour of the plant, length of the harvesting duration, time of onset of flowering, better seeds, number of marketable and non-marketable leaves, disease and pest resistance. Since the models needed to be evaluated to determine the most economical model to be followed in multiplying Kinale kale seed, the following additional information had to be gathered: input requirements, costs, labour demands, productivity (yield), weeding regime, income, seed cost, value of seed, consumers' (buyers') preference, shelf life, size of leaves, price of leaves and seeds per unit, quantity of seeds and leaves, leaf colour, seed colour, seed size and willingness to wait for seed production. This data would allow complete comparative cost-benefit analyses to be performed for kale production for seed with kale production for leaf. (See Appendix I, PART 12: IDENTIFICATION OF TECHNOLOGY Data collection Guide Sheets)

Plate 3.13 Seed sowing with farmers in Kinale

Plate 3.14 A nursery bed covered with a fleece in Kinale

3.4.2.2 Seed production models under evaluation

Once seeds had been sown, seedbeds were covered with a fleece, supported by split bamboo, in order to keep out aphids which are virus vectors, thus keeping out diseases (Plate 3.14). Seedling emergence took place between 3 – 7 days after sowing. Three seed production models were evaluated. These models were as described in the previous section: A. Full leaf harvesting – kale leaves were picked continuously up to flowering, (which is 16-20 weeks on farm); B. Leaf harvesting for half the time as in A. above; C. No leaf harvesting. Experimental design was as described in the previous Section, "on station". On each farm there was one plot of each treatment, comprising 15 plants (three rows of five plants) for each of the 4 lines. Each plot was assigned a unique number to facilitate recording. Husbandry practices were the same for all three treatments. Each harvesting regime was evaluated once on each of the selected farms. Each farmer was thus a single a replicate in the on-farm trial.

3.4.3 RESULTS AND DISCUSSION

Full raw data for leaf yield and stem diameter for all plants monitored in on farm validation trials can be seen in the following datasets:

Kinale kale harvest data – October 04. PROJECT: PROMOTION OF VEGETABLE SEED IN KENYA. Effect of kale leaf Harvesting on seed production. On farm trial (Gitithia): Yield data 04/05/04-09/09/04. Treatment A = Full Harvest; Treatment B = Half Harvest (stopped on 01/07/04) Microsoft Excel dataset 36pp.

Kinale kale harvest data – October 04. PROJECT: PROMOTION OF VEGETABLE SEED IN KENYA. Effect of kale leaf Harvesting on seed production. On farm trial (Bathi): Yield data 04/05/04-09/09/04. Treatment A = Full Harvest; Treatment B = Half Harvest (stopped on 01/07/04) Microsoft Excel dataset 36pp.

Kinale kale harvest data – October 04. PROJECT: PROMOTION OF VEGETABLE SEED IN KENYA. Effect of kale leaf Harvesting on seed production. On farm trial (Kinale): Yield data 04/05/04-09/09/04. Treatment A = Full Harvest; Treatment B = Half Harvest (stopped on 01/07/04) Microsoft Excel dataset 34pp.

3.4.3.1 Farmer observations of the treatments

Figures 3.7 and 3.8 illustrate the relative effects of the three different harvesting regimes on stem diameter and leaf yields, respectively. Full seed harvest data is presented in Dataset: *EVALUATION OF KINALE KALE HARVESTING MODELS – SEED YIELD DATA.*

For the full leaf harvesting (16 weeks) farmers observed that:

- The plants had less vigour due to poor soil arising from soil compaction
- The average stem girth of plants was smaller than the average stem girth of plants in the half and no-harvest models
- The plants appeared weaker due to continuous harvesting
- The leaves were small and pale green in colour
- There was likely to be continuous income from leaf harvest
- There was low seed yield potential

For half harvesting (8 weeks) farmers observed that:

- It allowed late flowering
- Had high leaf yield
- It produced medium sized leaf (more marketable)
- The soil was covered by the leaves that drop thereby providing mulch

For the no leaf harvesting farmers observed that:

- There was high potential for seed yield
- There was late flowering
- Incomes from seed were more likely to be higher

The farmers indicated that they preferred kale plants that flower late since it allows long harvesting of leaves. The kale leaves should be broad and strong so that they do not break easily. The leaves should also be uniform and dark green in colour. The kales should have thick and strong stems with a uniform height.

There was awareness and appreciation of the importance of using good quality seeds by the farmers. High quality seeds would give high rates of germination; shelf life for the seeds would be high. In this case the value of the seeds would be high given high market demand. The yield of the leaves and the seeds would also be high thereby generating more income. The overall quality of the vegetables would also be high. There was willingness to wait for kale seed production compared to kale leaf production provided that kale production for seed would be more profitable compared to kale production for leaf.

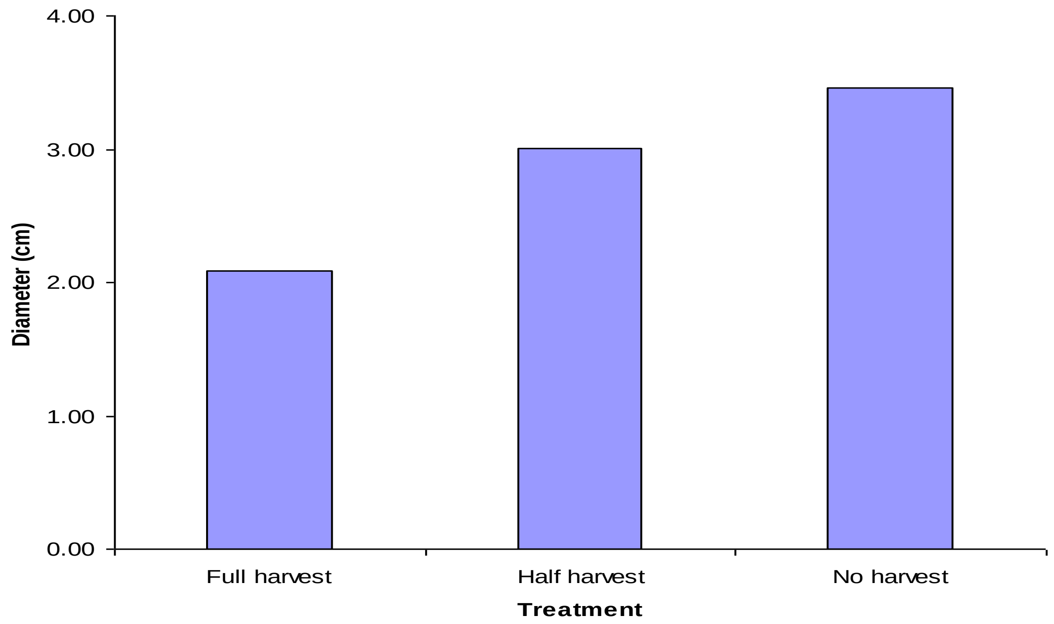


Figure 3.7 Mean stem diameter (cm) from different harvesting models in the on-farm trial

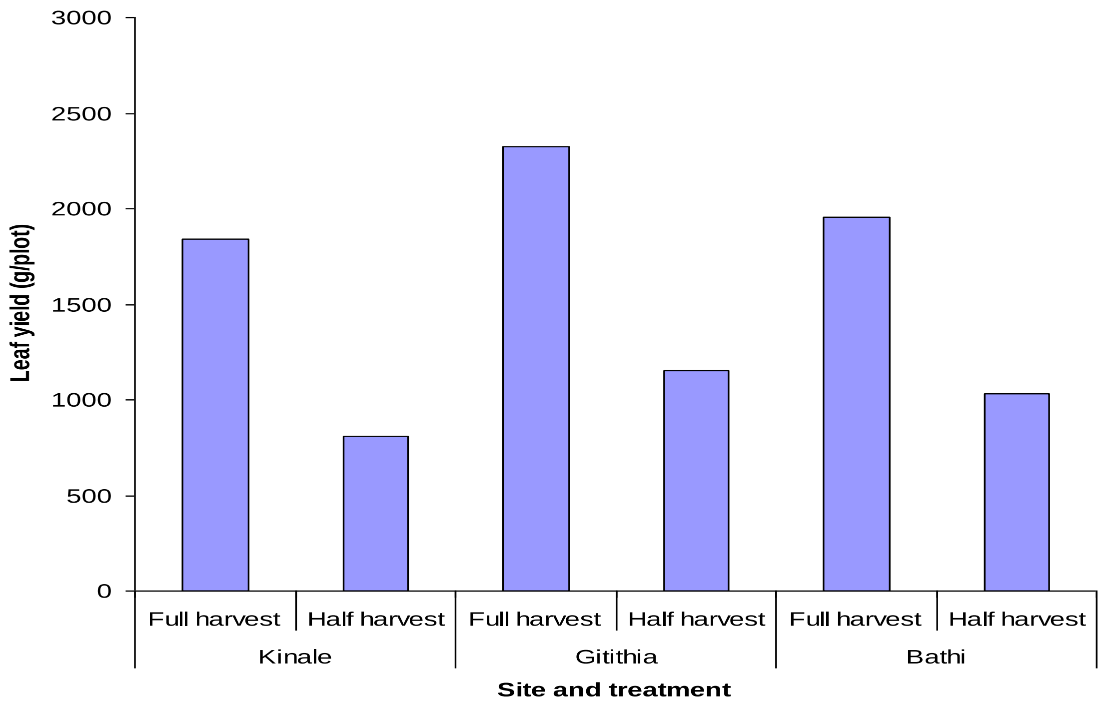


Figure 3.8 Leaf yield (g/plot) from two seed multiplication models in the on-farm trial at the different sites

3.4.3.2 Cost Benefit analyses

Assessment of the effect of the three treatments showed that they were significantly different ($F_{2, 6}$=5.08, p=0.05) in terms of their effect on the yield of seeds. The no leaf harvesting had the highest mean yield; while the full harvesting had the lowest mean seed yield. The three treatments (trials) that were executed by the farmers and the research team were compared using cost-benefit analysis. The evaluation was executed by computing all the costs incurred and the accruing benefits to the kale production process (Table 3.11).

The prices used were farm gate prices per kilogram of seeds and per kilogram of leaves produced. The computations for leaves refer only to marketable leaves. The total costs refer to an aggregation of labour, seeds, fertilizers and pesticides. Labour costs include land preparation, sowing, transplanting, weeding, pesticide application and harvesting. The labour costs were derived from discussions with the farmers. The costs for seeds, fertilizers and pesticides were derived from the market prices.

Table 3.11 Costs and benefits per hectare from the three on-farm treatments

Treatment	Output	Kinale site	Bathi site	Gitithia site
Full harvest	Leaf weight (kg)	17679.00	13753.70	25013.20
	Price of leaf per kg (Ksh.)	6.75	7.75	6.10
	Value of leaf (Ksh.)	119333.25	106591.18	152580.52
	Seed weight (kg)	448.20	198.50	448.00
	Price of seed per kg (Ksh.)	1250.00	1250.00	1250.00
	Value of seed (Ksh.)	560250.00	248125.00	610000.00
	Total costs (Ksh.)	91080.25	105277.78	92932.10
	Net benefits from seeds	469169.75	142847.20	517067.90
Harvesting half the season	Leaf weight (kg)	7502.50	7889.50	12390.70
	Price of leaf per kg (Ksh.)	6.75	7.75	6.10
	Value of leaf (Ksh.)	50641.88	61143.63	75583.27
	Seed weight (kg)	230.00	822.70	393.20
	Price of seed per kg (Ksh.)	1250.00	1250.00	1250.00
	Value of seed (Ksh.)	287500.00	1028375.00	491500.00
	Total costs (Ksh.)	87993.84	102191.36	89845.70
	Net benefits from seeds	199506.20	926183.65	401654.30
No leaf harvest	Leaf weight (kg)	0.00	0.00	0.00
	Price of leaf per kg (Ksh.)	6.75	7.75	6.10
	Value of leaf (Ksh.)	0.00	0.00	0.00
	Seed weight (kg)	718.90	784.20	1121.10
	Price of seed per kg (Ksh.)	1250.00	1250.00	1250.00
	Value of seed (Ksh.)	898625.00	980250.00	1401375.00
	Total costs (Ksh.)	84907.40	99104.90	86759.30
	Net benefits from seeds	813717.60	881145.10	1314615.70

Computations of net benefits from seeds indicate that the no leaf harvesting model is a better model for the sustainable production of seeds. The no leaf harvesting model generates the highest net benefits. Given that there were no significant differences in the husbandry practices and costs for all the treatments it is possible to compare them on the basis of gross returns also. This involved an aggregation of returns for the sale of both kale leaf and seed where possible. This comparison also reveals that no leaf harvesting model has the highest gross returns (Table 3.12).

Table 3.12 Gross income from the seed multiplication models (Ksh. per hectare)

Treatment	Leaves	Seeds	Total
Full harvest	378504.95	1418375.00	1796880.00
Half harvest	187368.77	1807375.00	1994743.80
No leaf harvest	0.00	3280250.00	3280250.00

Another approach that may be used to identify a suitable model for sustainable kale seed multiplication is the benefit cost ratio, which is the present value of benefits divided by the present value of costs. If the benefit/cost (B/C) ratio is greater than 1 then the model is good. The no leaf harvesting trial has the highest B/C ratio for all the treatments except at Bathi site (Table 3.13). The average B/C ratio for all the sites is highest for no leaf harvesting. This method again confirms that the best model for sustainable kale seed multiplication is the no leaf harvesting model.

Table 3.13 Benefit/Cost ratios for the different treatments

Treatment	Kinale site	Bathi site	Gitithia site
Full harvest	6.15	2.35	6.56
Half harvest	3.27	10.06	5.47
No leaf harvest	10.58	9.89	16.15

3.4.3.3 Assessing the profitability of kale leaf and seed production

This requires a comparison of kale production for seed with kale production for leaf; using cost-benefit analysis. The approach used is to compare the net benefits from the kale leaves and the net benefits from the kale seeds. Kale production for seed was found to be a more profitable enterprise giving more returns than kale production for leaf harvesting (Table 3.14). This again confirms that the no leaf harvesting model has the highest net benefits and is therefore the best for seed production.

Table 3.14 Net benefits from kale leaf and seed production (Ksh. per ha.)

Treatment		Kinale site	Bathi site	Gitithia site
Full harvest:	Leaves	28253.00	1313.40	59648.40
	Seeds	469169.75	142847.20	517067.90
	Total	497422.75	144160.60	576716.30
Half harvest:	Leaves	-37351.95	-41047.70	-14262.40
	Seeds	199506.20	926183.65	401654.30
	Total	162154.25	885135.95	387391.90
No leaf harvest:	Leaves	-84907.40	-99104.90	-86759.30
	Seeds	813717.60	881145.10	1314615.70
	Total	728810.20	728040.20	1227856.40

3.4.3.4 A strategy for the sustainable and viable production of improved quality kale seeds

The strategy for sustainable kale seed production is the use of the no leaf harvesting model. This should be accompanied by the selection of farmers capable and interested in the production of kale seed. Other than the financial capacity of the farmers, they should be farmers that are trusted in the community to ensure continuity of the project. Kale seed production requires an isolation distance of 1 km. However, this may not be easy to obtain in Lari Division of Kiambu District because kales are grown by almost every farmer. There are two options for this community if they are to go into kale seed production of the selected kale lines: all farmers (kale leaf and seed producers) to grow the same variety of kale; or the farmers are to carry out seed production in a different area where kales are not grown. An example of such an area is Njabini in South Kinangop.

3.4.3.5 The feasibility of a community based approach to seed multiplication

Farmers have shown considerable interest and enthusiasm in producing their own seed. This may be because they identified problems which are associated with kale seeds of their kale landraces bought from the roadside markets or seed vendors. They inquired from the project team during earlier studies how they could identify good seed among the seeds being sold on the roadside markets. They later appreciated the importance of following good kale seed production principles. The study taught the farmers how to produce good quality kale seed of kale selections from their landraces and they are agreeable to community based seed multiplication. This is attested to by the increase in the numbers of farmers that participated in the trials and farmers' willingness to work together, and the preference for the project mode of seed production. However, they need to be assisted, as a community, in group seed production when the selections are registered. The extension of the current project has already started helping the farmers in learning more about community based kale seed production. A community pilot study plot for seed production of the kale selections has already been established in Bathi, Lari Division. It is hoped that a seed company will also come in to assist in the marketing of the seed. However, some farmers may still continue with producing their own seed of the kale landraces. The major difference this time will be that they will do it better, and that they will grow the cleaned-up selections.

3.4.4 CONCLUSIONS

The evaluation of potential models for seed multiplication was based on effect on the yield of seeds. Cost-benefit analysis indicated that no leaf harvesting was the best model for kale seed production. The three treatments were very different with respect to their effects on the yield of seeds. Farmers' inspection also indicated that no leaf harvesting was the best model for sustainable seed multiplication.

Given the risks involved in agricultural production and the need for farmers to diversify, it may be necessary for further investigations to be done on the harvesting frequency to establish to what extent harvesting can be done without reducing the seed yield significantly. This can enable the farmers to produce both seeds and leaf without compromising their food self- sufficiency position.

Chapter 4: Promotion of good seed multiplication practice for kale and improved seed certification using preferred model

SUMMARY

In order to promote good seed multiplication practices for kale and to improve seed certification using the preferred model (established in the previous Chapter), it was necessary to develop suitable promotional material to promote good seed multiplication practice, and to disseminate this information to extensionists and NGOs in “Good seed multiplication practices”. These activities are described below.

Part 1: Development and Dissemination of promotional material

4.1.1 INTRODUCTION

In order to endorse good seed multiplication practice, it was necessary to develop suitable promotional material regarding good seed multiplication practice for kale and improved seed certification using the preferred model, for dissemination to local farmers and farmers groups.

4.1.2 MATERIALS AND METHODS

The text for this promotional material was drafted on the basis of the information and results collected to date (as described in previous sections of this report) relating to good practices, both in terms of husbandry and crop hygiene and pest management. A total of 2,000 leaflets (A4 size: dimensions 210mm x 297mm) and posters (A1 size: dimensions 594mm x 841mm) were produced. These leaflets and posters were distributed to farmers, along with packets of Kinale kale variety seeds, by members of the KARI/CABI/KEPHIS project team (See Chapter 7). Each farmer received three A4 sized leaflets, three A1 sized posters, and five 10g packets of seed (= 1 packet of each kinale line). Farmers were requested to keep one copy of the leaflet for their own reference purposes, and one copy of the poster for display purposes. They were asked to distribute the remaining promotional material (ie. 2 copies) to neighbouring seed-producing farmers in the project catchment. Farmers were asked to plant the five seed lines in separate plots, and to also plant a plot of the kale seed which they would normally grow. They were asked to keep a note of how each lie grew, and which line they preferred to eat (See Section 7.2).

4.1.3 RESULTS

The completed format for the leaflet and poster "How to produce quality Sukuma Wiki seed" is presented in Plate 4.1, overleaf. The total number of farmers receiving this material in various growing regions are summarised in Table 4.1, below.

Table 4.1 Distribution of literature re. Good Seed Multiplication Practice

District/Region	No. of farmers	Total no. leaflets/ posters (ie.x3)
Kinale	78	234
Kariguini	23	69
Kimende	94	282
Nyathona	106	318
Athi River	35	105
Ruiri	23	69
Total no. distributed	359	1,077

Plate 4.1 Leaflet/poster produced for dissemination: "How to produce Sukuma Wiki seed"

Chapter 5: Developing a marketing strategy for the sale of improved quality seed

SUMMARY

In order to develop a marketing strategy for the sale of improved quality seed, it was necessary suitable promotional material, emphasising the value of producing and purchasing good quality seed was developed. This activity is described below, as is the dissemination of promotional material to potential smallholder farmers, NGOs and micro-entrepreneurs through KARI, extension services, NGOs and other CPP uptake pathways in Kenya.

Part 1: Development and Dissemination of promotional material to advocate producing and purchasing good quality kale seed

5.1.1 INTRODUCTION

In order to advocate the value of producing and purchasing good quality kale seed, it was necessary to develop and disseminate suitable promotional material for dissemination to local farmers and farmers groups.

5.1.2 MATERIALS AND METHODS

Text for the promotional material was drafted on the basis of the information and results collected to date (described in previous sections of this report) re. the benefits of producing and purchasing good quality kale seed, both in terms of higher anticipated kale yields, and in terms of improved health/hygiene standards expected from certified seed. A total of 2,000 leaflets (A4 size: dimensions 210mm x 297mm) and posters (A1 size: dimensions 594mm x 841mm) was produced, and distributed to farmers, by members of the KARI/CABI/KEPHIS project team. Each farmer received three A4 sized leaflets and three A1 sized posters. Farmers were requested to keep one copy of the leaflet for their own reference purposes, and one copy of the poster for display purposes. They were asked to distribute remaining material to neighbouring seed-producing farmers in the project catchment.

5.1.3 RESULTS

The final format for the leaflet and poster “Benefits of quality seed” is presented in Plate 5.1. This literature was distributed to the same farmers/farmers groups who received literature re. Good Seed Multiplication Practice (see Table 4.1).

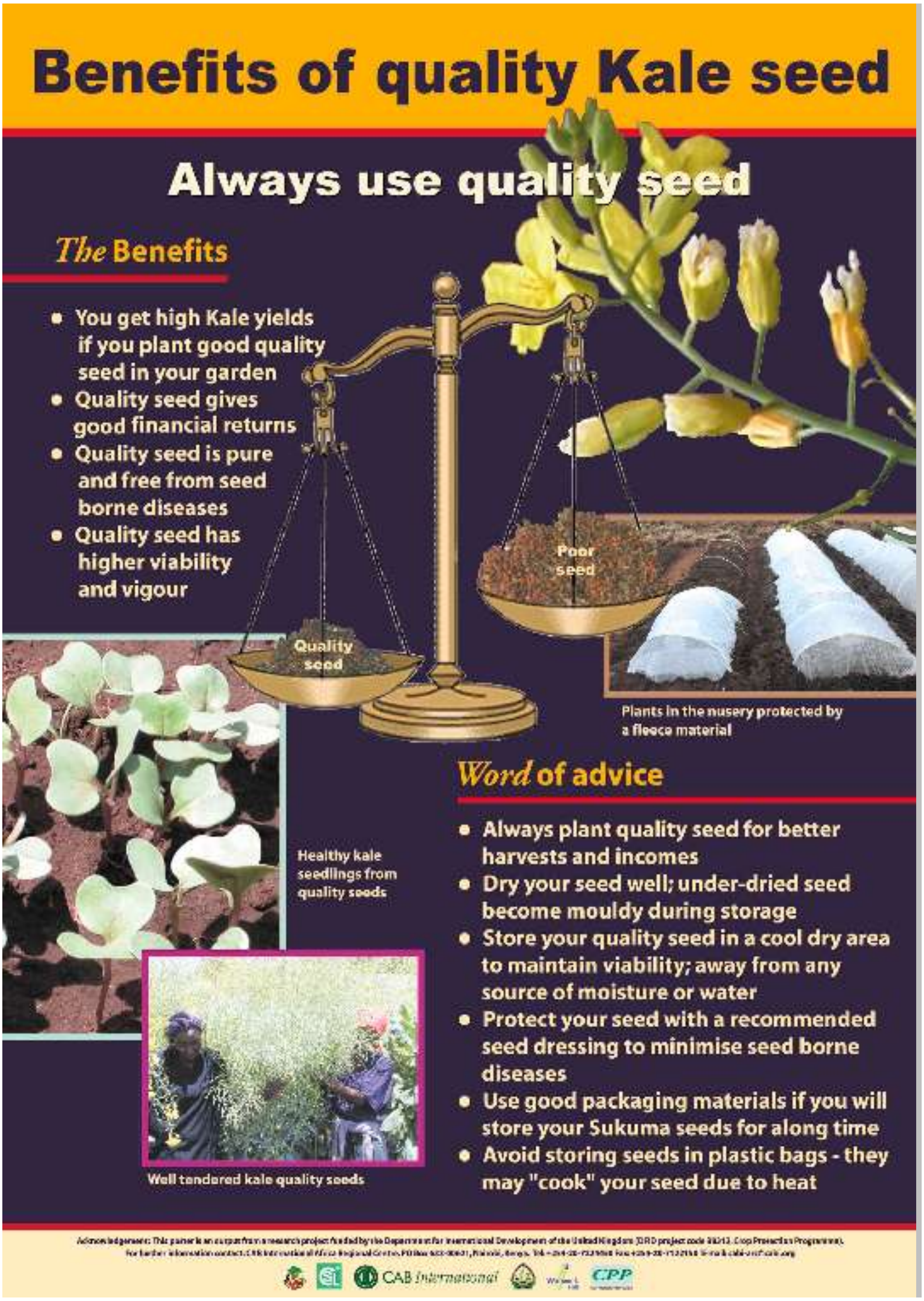


Plate 5.1 Leaflet/poster produced for dissemination: "Benefits of quality Kale seed"

Chapter 6: Developing practical strategies for sustainable management of black rot in brassicas

SUMMARY

Seed is generally considered to be the primary source and means of long-distance dissemination of *Xanthomonas campestris* pv. *campestris* (*Xcc*). In order to establish base-line data on the prevalence of *Xcc* in brassica seed stocks, brassica seed was collected from a range of sources and tested for the presence of the pathogen (see Part 1, below). Crop debris could also be a potential source of primary inoculum, therefore an experiment was conducted to examine the presence of and survival of *Xcc* in brassica crop debris (see Part 3). In order to improve local seed testing capability for black rot, key personnel from KEPHIS Plant Health Quarantine Station visited HRI for 4 weeks training and technical support in methodologies for seed testing and pathotyping *Xcc*. Dr Steven Roberts also visited the laboratories at KEPHIS and KARI-NARL to provide direct practical training for appropriate staff (see Part 4). In addition during visits to Kenya by Dr Roberts, isolations were attempted from ware and seed brassica crops (Part 2).

Part 1: The incidence of *Xanthomonas campestris* pv. *campestris* in brassica seed stocks

6.1.1. INTRODUCTION

Although seed is usually considered to be the primary source of *Xanthomonas campestris* pv. *campestris* (*Xcc*) in brassicas, there was no pre-existing data on the prevalence or incidence of the pathogen in the brassica seed used for crop production in Kenya. Clearly, it would be difficult to develop a control strategy based on the use of disease-free seed, without evidence that it could potentially be infested. This part of the project sought to address this issue by examining the incidence and prevalence of *Xcc* in brassica seed stocks obtained from a range of sources that are currently used for production. As well as providing data of direct value to the project, this exercise also served as part of the training and capacity building elements of the project (see Section 6.3).

6.1.2. MATERIALS AND METHODS

Seed collection

Samples of cabbage, kale and collards seed were purchased by KEPHIS staff from a variety of sources and locations throughout Kenya. The sources included: merchants (see Chapter 1, section 1.2.2), local markets and seed hawkers; with locations ranging from Mombassa in the East to the Ugandan border in the West. Most seed was obtained in sealed tins. Each sample was allocated a unique identification number and the details recorded (). Where there was sufficient seed, samples were divided into sub-samples for testing.

Test method

Initially, testing of the collected seed was done at HRI-Wellesbourne by KEPHIS staff during the training visit and also by HRI staff. Subsequent testing was done in Kenya, in Nairobi or Lanet by KEPHIS staff, either as part of the training workshops or independently. The seed test method used was as described by (Roberts *et al.* 2004) and also (Roberts and Koenraadt 2003), and included the recommended centrifugation step. Briefly the steps were as follows: seed was suspended in sterile 0.85% saline plus 0.02% Tween 20 (approx. 10 ml per 1,000 seeds) in conical flasks and shaken for 2.5 h on an orbital shaker. After 5 min, two 1 ml samples were removed, centrifuged, re-suspended in 0.1 ml and then held in the refrigerator until plating (concentrated extract). After 2.5 h, two serial ten-fold dilutions were prepared and 0.1 ml of each dilution, the undiluted extract and the concentrated extract was spread onto plates of FS and mCS20ABN selective media. Plates were incubated at 30°C for 3-4 d and the number of suspect *Xcc* and other colonies recorded on each plate. If present, at least six suspect *Xcc* colonies were sub-cultured to sectored plates of YDC medium. Sectored plates were incubated for 24-48 h at 30°C and compared with positive control strains of *Xcc* growing on the same medium. Colonies that appeared to be similar to *Xcc* on YDC were then inoculated into seedlings of cabbage cv. Wirosa F_1 by stabbing the veins with a pin charged with bacterial growth. Plants were examined for the appearance of typical black rot symptoms after 7-10 d.

Data analysis

A sub-sample was considered positive for *Xcc* if at least one of the suspected colonies gave a positive result in the pathogenicity test. The estimated number of *Xcc* present in any sub-sample was adjusted to take account of the proportion of suspects that gave a positive pathogenicity test. The proportion of infested seed in the seedlots and their confidence limits was estimated by maximum likelihood, using *STpro* (Ridout and Roberts 1995; Roberts *et al.* 1993).

6.1.3. RESULTS

A total of 110 seed samples were tested, including 50 cabbage, 1 cauliflower, 2 Chinese cabbage, 26 collards, 30 kale and 1 rape. The results are summarised in Table 6.1. and. *Xcc* was detected in 23 samples representing each of the three major brassica types (cabbage, collards, kale); in both home-produced seed lots and seed lots imported from Denmark, France and the USA; and in seed obtained both from reputable suppliers and more dubious sources. In a number of cases multiple samples of seed labelled with the same seed lot number were obtained from different places and suppliers; assuming that in most cases the lot numbers were correct estimates of infection levels were derived from the combined results of all samples of the same seed lot.

Table 6.1. Summary of tests for *Xanthomonas campestris* pv. *campestris* on samples of brassica seed available to farmers in Kenya

Type	Tested	Positive	Countries of origin
Cabbage	50	3	Denmark, France, Unknown
Cauliflower	1	0	Unknown
Chinese cabbage	2	0	Unknown
Collards	26	7	Kenya, USA, Unknown
Kale	30	12	Denmark, France, Unknown
Rape	1	1	Unknown
Totals	110	23	

Table 6.2. Details of seed samples and results of seed tests for *Xanthomonas campestris* pv. *campestris*. Where appropriate the % infection is calculated from the combined results for particular lot number

Tested	Samp.	Type	Cultivar	Collection centre	Supplier	Lot No.	Origin	Treat	Packed	No tested	Xcc detected	% Inf.
Nov-04	112	Cabbage	Copenhagen Mkt	Kongowea	E A Seeds	03-698/307092	-	?	Jan-04	7,105	No	<0.042
Nov-04	92	Cabbage	Copenhagen Mkt	Matuu	E A Seeds	04-7427/407064	-	?	Sep-04	9,940	No	<0.030
Jun-Aug 04	39	Cabbage	Copenhagen Mkt	Busia	Amiran	102	France	TMTD		10,000	No	<0.010
Jan-05	86	Cabbage	Copenhagen Mkt	Nyahururu	Simlaw	102	France	TMTD			No	(comb)
Nov-04	117	Cabbage	Copenhagen Mkt	Malindi	Amiran Kenya Ltd	102	France	TMTD	Oct-03	11655	No	
Nov-04	94	Cabbage	Copenhagen Mkt	Machackos	Vet & Agron. Ltd (ex Griffaton)	172	France	TMTD	Nov-01	9,695	No	<0.030
Jun-Aug 04	14	Cabbage	Copenhagen Mkt	Migori	Kenya seed	311	-	-		10,000	No	<0.030
Jun-Aug 04	2	Cabbage	Copenhagen Mkt	Kericho	E A Seeds	32060	Denmark	Thiram		10,000	No	<0.030
Jun-Aug 04	16	Cabbage	Copenhagen Mkt	Kehencha	Simlaw	181400	Kenya	-		10,000	No	<0.030
Jun-Aug 04	48	Cabbage	Copenhagen Mkt	Mumias	E A Seeds	406064	-	?		10,000	No	<0.030
Jun-Aug 04	3	Cabbage	Copenhagen Mkt	Awendo	Royal Sluis	641187	Netherlands	Thiram		10,000	No	<0.015
Jun-Aug 04	35	Cabbage	Copenhagen Mkt	Baitany	Royal sluis	641187	Netherlands	Thiram		10,000	No	comb
Jan-05	62	Cabbage	Copenhagen Mkt	Nakuru	Griffaton	-	France	TMTD			No	
Aug-03	786	Cabbage	Copenhagen Mkt		E A Seeds	022922	USA	?		1 x 10,000, 2 x 4,400	No	<0.016
Jun-Aug 04	46	Cabbage	Copenhagen Mkt	Malaba	E A Seeds	03-698/307092	-	?		10,000	No	<0.030
Jun-Aug 04	33	Cabbage	Copenhagen Mkt	Sondu	E A Seeds	046165-1	-	?		10,000	No	<0.030
Jan-05	65	Cabbage	Copenhagen Mkt	Moi's Bridge	E A Seeds	04-7427/407064	-	?			No	
Aug-03	782	Cabbage	Copenhagen Mkt		Kenya Seeds	2003-4548	Kenya	?		1 x 10,000, 2 x 3,900	No	<0.017
Jan-05	84	Cabbage	Copenhagen Mkt	Nyahururu	Simlaw	2004-6140-1	-	?			Yes	
Jan-05	75	Cabbage	Copenhagen Mkt	Iten Nyahururu	Simlaw	2004-6140-2	Netherlands	?			No	
Jan-05	90	Cabbage	Copenhagen Mkt	Nyeri	Simlaw	2004-6140-2	Netherlands	?			No	
Nov-03	9	Cabbage	Copenhagen Mkt		Griffaton	345	France	Thiram		10,023	Yes	>0.005
Aug-03	792	Cabbage	Copenhagen Mkt		Jumbo Agrovet (ex Royal Sluis)	634463	Netherlands	Thiram		1 x 10,000, 2 x 5,100	No	<0.015
Aug-03	790	Cabbage	Copenhagen Mkt		Regina Seeds (Royal Sluis)	637509	Netherlands	Thiram		1 x 10,000, 2 x 4,800	No	<0.015
Jun-Aug 04	44	Cabbage	Drum Head	Homa bay	Royal Sluis	852815	Netherlands	Thiram		10,000	No	<0.030
Jun-Aug 04	34	Cabbage	Drum Head	Kisumu	Simlaw	2001-9691	-	?		10,000	No	<0.030
Jun-Aug 04	26	Cabbage	F1	Kiligoris	Simlaw	02A4A	-	-		10,000	No	<0.030
Jan-05	52	Cabbage	Gloria	Nakuru	Simlaw	62030	Denmark	Thiram			No	
Jun-Aug 04	19	Cabbage	Gloria	Bomet	Simlaw	102030	Denmark	Thiram		10,000	No	<0.030
Jun-Aug 04	24	Cabbage	Gloria	Mau-Narok	Kenya Seed	156455	Denmark	Thiram		10,000	No	<0.030

Table 6.2. Details of seed samples and results of seed tests for *Xanthomonas campestris* pv. *campestris*. Where appropriate the % infection is calculated from the combined results for particular lot number

Tested	Samp.	Type	Cultivar	Collection centre	Supplier	Lot No.	Origin	Treat	Packed	No tested	Xcc detected	% Inf.
Aug-03	783	Cabbage	Gloria		Kenya Seed	183960	Denmark	?		1 x 10,000, 2 x 3,000	No	<0.019
Jun-Aug 04	42	Cabbage	Gloria	Kitale	Simlaw	187505	Denmark	Thiram		10,000	No	<0.030
Aug-03	787	Cabbage	Gloria		E A Seeds	307079	Denmark	?		1 x 10,000, 2 x 3,100	No	<0.018
Jun-Aug 04	45	Cabbage	Golden acre	Iten	Simlaw	2003-645	Denmark	Thiram		10,000	No	<0.030
Jun-Aug 04	10	Cabbage	Kopkool	Migori	Kenya Seed	515001	-	-		10,000	No	<0.030
Jan-05	79	Cabbage	Prize Drumhead	Kabarnet	E A Seeds	8194	-				No	
Nov-04	96	Cabbage	Prize Drumhead	Wote	Simlaw	50211		?	Nov-02	8,330	No	<0.036
Nov-04	97	Cabbage	Pruktor F1	Kibwezi	Simlaw	167831	Denmark	Thiram	May-03	9905	No	<0.030
Nov-04	100	Cabbage	Riana F1	Athi	Simlaw	137796	Denmark	Thiram	?	9450	No	<0.032
Jan-05	82	Cabbage	Riana F1	Subukia	Simlaw	189231	Denmark	Thiram			No	
Nov-04	102	Cabbage	Romenco	TZ Border	Regina Seeds (Royal Sluis)	491265	Netherlands	?	May-01	10080	No	<0.030
Jan-05	60	Cabbage	Romenco	Nakuru	Regina	553703	Netherlands	?			No	
Jan-05	80	Cabbage	Romenco Glory	Solai	Regina	933898	Netherlands	Thiram			No	
Jun-Aug 04	15	Cabbage	Sugarloaf	Kehencha	Simlaw	502404	Kenya	-		10,000	No	<0.030
Nov-04	118	Cabbage	Sugarloaf	Malindi	E A Seeds	905648	-	?Thiram	Oct-02	12,285	No	<0.025
Jun-Aug 04	8	Cabbage	Sugarloaf	Migori	Kenya Seed	02-A44	-	TMTD		10,000	No	<0.030
Nov-04	106	Cabbage	Sugarloaf	Taveta	Simlaw	2004-7176-1	-	?	May-04	11,935	No	<0.025
Jan-05	83	Cabbage	Supermaster	Subukia	E A Seeds	185873	Denmark	Thiram			Yes	
Aug-03	791	Cabbage	Victoria (Gloria)		Regina Seeds (Royal Sluis)	728225	Netherlands	Thiram		1 x 10,000, 2 x 2,360	No	<0.020
Aug-03	793	Cabbage	Victoria (Gloria)		Jumbo Agrovet (ex Royal Sluis)	761474	Netherlands	Thiram		1 x 10,000, 2 x 4,500	No	<0.016
Jan-05	81	Cauliflower	Kibo Giant	Subukia	Simlaw	182301	Denmark	?			No	
Jan-05	51	Chinese cabb.	Chihili	Nakuru	E A Seeds	22990	Arusha, TZ	?			No	
Nov-04	105	Chinese cabb.	Michihili	Taveta	Simlaw	2003-645-1	-	?	Sep-04	13,090	No	<0.023
Nov-04	116	Collards	Georgia	Malindi	Bonanaza Seeds	151001-926.3	USA	Thiram	Dec-03	11,585	No	<0.026
Aug-03	795	Collards	Georgia (Sukuma Wiki)		Jumbo Agrovet (ex E A Seeds)	02-4289 (022989)	Kenya	?		1 x 10,000, 2 x 4,000, 3 x 1,000	No	0.003 comb
Aug-03	789	Collards	Georgia (Sukuma Wiki)		E A Seeds	02-4289 (022989)	Kenya	?		1 x 10,000, 2 x 3,300	Yes	
Jun-Aug 04	20	Collards	Georgia (Sukuma Wiki)	Gucha	Simlaw	03-4836	USA	-		10,000	Yes	0.01 comb
Jun-Aug 04	6	Collards	Georgia (Sukuma Wiki)	Kehancha	Simlaw	03-4836	USA	-		10,000	Yes	
Jun-Aug 04	32	Collards	Georgia (Sukuma Wiki)	Sondu	E A Seeds	03-4836-1	USA	?		10,000	Yes	

Table 6.2. Details of seed samples and results of seed tests for *Xanthomonas campestris* pv. *campestris*. Where appropriate the % infection is calculated from the combined results for particular lot number

Tested	Samp.	Type	Cultivar	Collection centre	Supplier	Lot No.	Origin	Treat	Packed	No tested	Xcc detected	% Inf.
Jun-Aug 04	36	Collards	Georgia (Sukuma Wiki)	Vihiga	E A Seeds	03-4836-1/303040	USA	?		10,000	No	
Nov-04	111	Collards	Georgia (Sukuma Wiki)	Kongawea	E A Seeds	03-4836-1/303040	USA	?Thiram	Jun-04	8,575	No	
Jan-05	66	Collards	Georgia (Sukuma Wiki)	Kapkoi/Marigat	E A Seeds	04-7430/406057	USA	?			No	<0.008
Nov-04	95	Collards	Georgia (Sukuma Wiki)	Machatos	E A Seeds	04-7430/406057	USA	?	Sep-04	9,450	No	comb
Jan-05	91	Collards	Georgia (Sukuma Wiki)	Nanyuki	E A Seeds	04-7430/406057	USA	?			No	
Nov-04	120	Collards	Georgia (Sukuma Wiki)	Mombassa	E A Seeds	04-7430/406057	USA	?	Jul-04	9,975	No	
Jun-Aug 04	41	Collards	Sukuma Wiki	Butere	E A Seeds	21299	USA	?		10,000	No	<0.030
Jan-05	55	Collards	Sukuma Wiki	Nakuru	Simlaw	22083	Kenya	?			No	
Jun-Aug 04	5	Collards	Sukuma Wiki	Isebania	E A Seeds	02-4283	USA	-		10,000	No	<0.015
Jun-Aug 04	11	Collards	Sukuma Wiki	Isebania	E A Seeds	02-4283	USA	-		10,000	No	comb
Aug-03	785	Collards	Sukuma Wiki		Kenya Seed	02-5025	Kenya	?		1 x 10,000, 2 x 4,000	No	<0.010 comb
Jun-Aug 04	17	Collards	Sukuma Wiki	Kehencha	Simlaw	02-5025	Kenya	-		10,000	No	
Jun-Aug 04	9	Collards	Sukuma Wiki	Migori	E A Seeds	04-5050	-	-		10,000	No	<0.030
Jun-Aug 04	4	Collards	Sukuma Wiki	Awendo	Simlaw	04-5051	Denmark	Thiram		10,000	No	0.009
Jan-05	64	Collards	Sukuma Wiki	Timborua/Iten	Simlaw	04-5051	-	?			Yes	comb
Jan-05	89	Collards	Sukuma Wiki	Naro-moru	Simlaw	04-5051	-	?			Yes	
Jan-05	115	Collards	Sukuma Wiki	Mtwapa	Simlaw	04-5051	-	?			Yes (2 sub-sample)	
Nov-04	115	Collards	Sukuma Wiki	Mtwapa	Simlaw	04-5051	-	?	Jun-04	8,225	No	
Nov-04	101	Collards	Sukuma Wiki	Kibwezi	Simlaw	04-5051	-	?	Feb-04	7,245	No	
Nov-04	93	Collards	Sukuma Wiki	?	Simlaw	04-5068	-	?Thiram	Sep-04	7,315	No	<0.041
Aug-03	797	Kale	Kinale	Wangigi	Market	none	Kenya	none		1 x 10,000, 2 x 4,400	No	<0.008
Jun-Aug 04	31	Kale	Kinale	Nakuru	Market	none	Kenya	-		10,000	No	<0.030
Aug-03	796	Kale	Komolo	Wangigi	Market	none	Kenya	none		1 x 10,000, 2 x 4,800	No	<0.008
Jun-Aug 04	43	Kale	Sukuma Wiki	Luanda	Farmer	none	Kenya	?		10,000	No	<0.030
Nov-03	13	Kale	Sukuma Wiki	Nakuru	Market	none	Kinale	-		9,906	No	<0.030
Jun-Aug 04	7	Kale	Th. Headed	Migori	Service Plus	3	France	TMTD		10,000	No	0.009
Jun-Aug 04	18	Kale	Th. Headed	Bomet	Griffaton	3	France	TMTD		10,000	No	comb
Jun-Aug 04	13	Kale	Th. Headed	Isebania	E A Seeds	3	-	-		10,000	Yes	
Jan-05	61	Kale	Th. Headed	Nakuru	Griffaton	3	France	TMTD			Yes	
Jan-05	88	Kale	Th. Headed	Karatina	Griffaton	3	France	TMTD			Yes	
Nov-04	110	Kale	Th. Headed	Kongowea	Vet & Agron. Ltd (ex Griffaton)	03	France	TMTD	Jun-03	10,150	No	

Table 6.2. Details of seed samples and results of seed tests for *Xanthomonas campestris* pv. *campestris*. Where appropriate the % infection is calculated from the combined results for particular lot number

Tested	Samp.	Type	Cultivar	Collection centre	Supplier	Lot No.	Origin	Treat	Packed	No tested	Xcc detected	% Inf.
Jun-Aug 04	21	Kale	Th. Headed	Narok	Griffaton	24	France	TMTD		10,000	No	<0.030
Jun-Aug 04	38	Kale	Th. Headed	Siaya	Simlaw	02-A5025	-	?		10,000	No	<0.030
Jun-Aug 04	23	Kale	Th. Headed	Narok	E A Seeds	03-4835	-	-		10,000	No	0.004
Jun-Aug 04	40	Kale	Th. Headed	Capenguria	E A Seeds	03-4835	-			10,000	No	comb
Jun-Aug 04	1	Kale	Th. Headed	Kericho	E A Seeds	03-4835	Denmark	Thiram		10,000	Yes	
Aug-03	788	Kale	Th. Headed		E A Seeds	03-4835 (303038)	USA	?		1 x 10,000, 2 x 4,770	No	
Aug-03	794	Kale	Th. Headed		Jumbo Agrovet (ex E.A. Seeds)	03-4835 (303038)	USA	?		1 x 10,000, 2 x 4,800	No	
Jan-05	77	Kale	Th. Headed	Muserechi	E A Seeds	03-4835 (303038)	-	?			Yes	
Aug-03	784	Kale	Th. Headed		Kenya Seed	2003-405	Denmark	?		1 x 10,000, 3 x 1,000	Yes	0.670
Nov-03	12	Kale	Th. Headed		Kenya Seed	2003-605	Denmark	Thiram		10,012	No	<0.030
Jan-05	87	Kale	Th. Headed	Olkalau	Simlaw	2004-6140-2	-	?			Yes	
Nov-04	121	Kale	Th. Headed	Mombassa	Simlaw	2004-6140-7	-	?	Sep-04	9,590	No	<0.030
Jun-Aug 04	27	Kale	Unknown	Migori	Farmer	none	-	-		10,000	No	<0.030
Jun-Aug 04	37	Kale	Unknown	Mumias	Farmer	none	Kenya	?		10,000	No	<0.030
Jun-Aug 04	28	Kale	Unknown	Kipisorwet	Farmer	none	Kenya	-		10,000	Yes	>0.005
Jun-Aug 04	29	Kale	Unknown	Keumbo	Market	none	Kenya	-		10,000	Yes	>0.005
Jan-05	50	Kale	Unknown	Nakuru	Market	none	Kenya	-			Yes	
Jan-05	67	Kale	Unknown	-	Market	none	Kenya	-			Yes	
Jun-Aug 04	30	Kale?	Unknown	Keumbo	Market	none	Kenya	-		10,000	Yes	>0.005
Nov-03	11	Rape seed	Unknown	Njoro	Market	none	-	-		9,729	Yes	>0.005

6.1.4 DISCUSSION/CONCLUSIONS

Based on these results, the presence of *Xcc* in vegetable brassica seed available to farmers in Kenya is widespread and should be a cause for considerable concern. The frequency of occurrence (in *ca*. 20% of the samples examined) is very much higher than in vegetable brassica seed sold in developed countries and much higher than would be expected if seed companies/suppliers were taking any precautions to avoid supplying infected seed. It should be noted that for many of the samples tested only a single sub-sample of 10,000 seeds was tested and implies a tolerance standard of 1 in 3,300 seeds, such a tolerance standard is generally considered inadequate for this disease, it is therefore quite possible that some seed samples/lots for which negative results were obtained could be infested at levels likely to result in the development of epidemics in the field.

The frequent occurrence of *Xcc* in samples of collards and kales imported from developed countries is a clear indication that these seeds are not being tested for *Xcc* in the countries of origin.

In many cases, the labelling of seed containers was not adequate to identify the country of origin of the seed or the precise chemical treatment: regardless of any legal or statutory obligations, the absence of such information should be considered to be bad practice. In addition, the lot numbers appearing on the containers of many samples did not appear to comply with official requirements, bringing into question other information on the labels and in the cases of imports, whether they had been imported legally. In one case the same seed lot number was given on labels for two different crop types (see sample numbers: 87, collards; 75 and 90; cabbage).

Nearly all of the seed examined appeared to have been treated with a fungicide, although (as indicated above) the chemical used was often not indicated on the container. Such fungicidal seed treatments will have little or no effect on *Xcc,* a bacterial pathogen, and as such may be giving importers, officials and growers a false sense of security with respect to the health status of brassica seed.

Chapter 6: Developing practical strategies for sustainable management of black rot in brassicas

Part 2: Isolation of *Xanthomonas campestris* pv. *campestris* from ware and seed crops

6.2.1. INTRODUCTION

This work was done in addition to that specified in the original project proposal. During visits to Kenya by Dr Roberts in November 2003 and November 2004, crops grown for ware and seed were visited and symptoms typical of bacterial infection with *Xcc* were often observed. In order to confirm that these symptoms were caused by *Xcc,* leaf samples were collected and isolations attempted.

6.2.2. MATERIALS AND METHODS

Leaf samples were collected from a number of locations (see Table 6.3) and isolations attempted in the KEPHIS laboratories in Nairobi (2003) or Lanet (2004). Small pieces (2 mm^2) of tissue were excised from the leading edges of lesions with a sterile scalpel and comminuted in a drop of sterile saline on a sterile glass microscope slide. After leaving to stand for approx. 5 min, the resulting suspensions were streaked out onto plates of YDC agar medium. Plates were incubated at 30°C for 2-3 d and examined for the presence of typical *Xcc* colonies. Suspect colonies were sub-cultured and inoculated into plants of cabbage cv. Wirosa to confirm their identity and pathogenicity. Some of the isolates were also race-typed in the UK by inoculation into a series of differential cultivars (Vicente *et al.* 2001)

6.2.3. RESULTS AND DISCUSSION

Results are summarised in Table 6.3. *Xcc* was isolated from nearly all attempts, and the results of race-typing indicated that they belonged to either Race 1 or Race 4, the two most common races found in vegetable brassicas. Of particular concern was the presence of typical black rot lesions and confirmed presence of *Xcc* in and near seed crops in both years. The presence of visible disease in a seed crop should result in rejection of that crop for seed.

Table 6.3 Isolations of *Xanthomonas campestris* pv. *campestris* from leaf samples collected in Kenya

Sample	Date	Location	Alt (m)	Type	Cv	Notes	Xcc isolated	
November 2003								
1	12/11/03	Whiteflower farm		Cabbage			Race 1	8414
2	12/11/03	Kereita (Nyutu's Farm)		Kale			Race 1	8415
3	12/11/03	Waburi's Farm		Kale			Race 4	8416
4	12/11/03	Uplands		Kale			Race 1	8417
5	13/11/03	Molo South	2650	Collards	Georgia	Seed crop	Race 4	8418
6	18/11/03	Kariguini		Kale		Nr reservoir	Race 1	8419
7	18/11/03	Kariguini		Cabbage	Gloria F1	Higher up from reservoir	Race 1	8420
8	18/11/03	Thika (KARI)		Cabbage	Gloria F1		Race 4	8421
9	18/11/03	Thika (KARI)		Kale		E A Seeds prodn. plots	Race 4	8422
10	18/11/03	Thika (KARI)		Cabbage		E A Seeds prodn. plots	Race 4	8423
November 2004								
0	23/11/04	Kinale, Farmer's trial site 3	2761	Cabbage	Victoria F1	ex Seed lot 893450	Yes	
1	25/11/04	Kiambirira (Molo)	2714	Cabbage	Copenhagen Mkt	Immature	Yes	
2	25/11/04	Kiambirira (Molo)	2714	Cabbage	Copenhagen Mkt	Mature crop 50 m from Sample 1	Yes	
3	25/11/04	Kiambirira (Molo)	2744	Kale	?	At edge of cabbage field	Yes	
4	25/11/04	Tomyeotta (Molo South)	2829	Kale	?	Personal prodn. near to Collards cv Georgia seed crop	Yes	
5	25/11/04	Tomyeotta (Molo South)	2829	Collards	Georgia	Seed crop (contract to EA seeds), pods beginning to mature	Yes	

Chapter 6: Developing practical strategies for sustainable management of black rot in brassicas

Part 3: The presence and survival of *Xanthomonas campestris* pv. *campestris* in brassica crop debris

6.3.1. INTRODUCTION

In addition to seed, another potential source of primary inoculum in intensively-cropped brassica production areas is the crop residues (debris) which remain in the fields after harvesting of an infected crop. However, there was no data on the potential for *Xcc* to be present or survive in such crop debris. Thus in order to gain an understanding of the importance of crop debris as a source of primary inoculum in seed production, a trial was undertaken to examine the survival of the pathogen in crop debris or in the soil over a period of up to one year.

6.3.2. MATERIALS AND METHODS

Sources of debris

Xcc-infested cabbage and kale crop debris was collected on 15 and 22 January 2004 from a smallholder's farm at Kariguini. It was applied to the plots/incorporated on 28 January 2004. A second sample of cabbage debris was collected on 3 February and incorporated into the soil on 9 February 2004.

Trial design/layout

A summary of the treatments in shown in Table 6.4. The trial consisted of five plots. Each plot was approx. 3 m x 2 m and was separated from the other plots by at least 10. Cabbage debris was applied to two plots and kale debris was applied to two plots, a mixture of cabbage and kale debris was applied to the fifth plot. In one cabbage plot and one kale plot, the debris was applied to the surface incorporated into the soil by hoeing. The remaining plots were covered with nets to prevent the debris on the surface from blowing away.

Table 6.4 Summary of treatments in trial to examine the survival of *Xanthomonas campestris* pv. *campestris* in crop debris.

Plot	Debris	Weight	Treatment
A	Cabbage	950 g	Debris incorporated into the soil
B	Cabbage	950 g	Debris spread on the surface and covered with netting
C	Kale	300 g	Debris spread on the surface and covered with netting
D	Kale	300 g	Debris incorporated into the soil
E	Cabbage + kale	850 g	Debris spread on the surface and covered with netting

Assessment of survival

Samples of the debris and/or soil were collected from each plot at intervals following initial set up and continuing until *Xcc* was not detected on three consecutive occasions. The presence of *Xcc* in the samples was determined using a protocol devised by S J Roberts, using the same selective media as used for seed health testing. Debris/soil samples were suspended in sterile saline plus Tween 20 (0.85% NaCl, 0.02% Tween 20; 10 ml per gram of debris/soil) in conical flasks. Samples were then allowed to soak for 1.5 h and shaken on an orbital shaker to mix. Four serial ten-fold dilutions were prepared, and 0.1 ml of each dilution and the un-diluted extract were spread onto the surface of plates of FS and mCS20ABN semi-selective media. Plates were incubated at 30°C for 3-4 d and the numbers of colonies of suspect *Xcc* and others recorded. The identity of suspect *Xcc* colonies was confirmed as in the seed tests.

Data Analysis

Data were summarised and standard errors obtained by fitting a generalised linear model with Poisson error distribution and log link function using Genstat (Payne *et al.* 2003)

6.3.3. RESULTS

Crop debris was visible and was collected from the plots up to 89 days from the start of the trial. After this time, debris was no longer visible and therefore only soil samples could be collected and tested. Large numbers (10^6 to 10^7 cfu/g) of *Xcc* were detected in the crop debris in all plots for 3 months after the start of the trial. Numbers then declined as identifiable debris became no longer visible in the plots, so that *Xcc* was not detected in any plots after 180 d (approx. 6 months) from the start of the trial, at which time there had been no visible debris for at least 2 months. *Xcc* was last detected at 152 d in the soil in two plots in which debris had been spread on the surface of the soil (B and C). The $\log_{10}$ of number of *Xcc* detected at each sampling date is shown graphically in Fig. 6.1. To avoid confusion, standard errors are not shown, but were generally less than 5%. The theoretical detection limit was 150 cfu/g of debris/soil ($\equiv$ 2.18 log units), thus samples in which *Xcc* was not detected are represented along the *x*-axis.

Weed samples were also collected at two sampling dates: 58 and 152 days after the start. Relatively low numbers of *Xcc* were detected in the weed samples only at 58 days, when much greater numbers were also present on the debris.

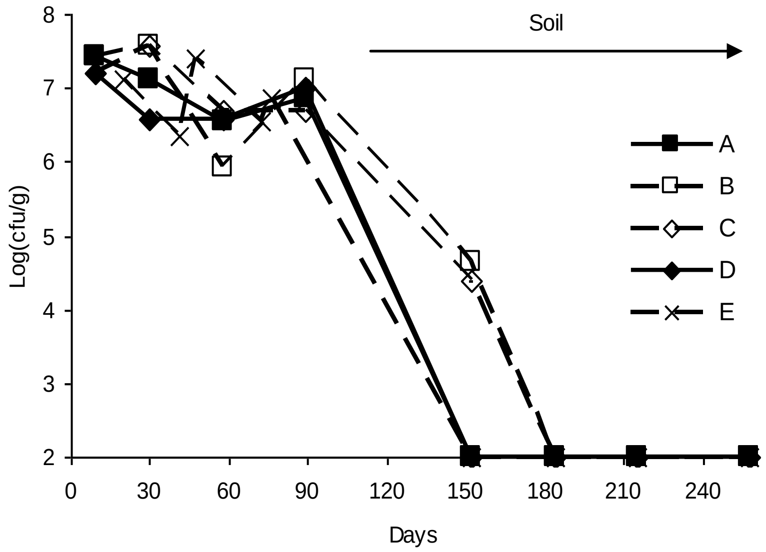


Fig. 6.1. Detection of *Xanthomonas campestris* pv. *campestris* in brassica crop debris and soil following surface application (A, D, E; broken lines) or incorporation of debris into the soil (B, C; solid lines).

6.3.4. DISCUSSION/CONCLUSIONS

These results clearly indicate that large numbers of *Xcc* may survive for several months in brassica crop debris, regardless of whether it is incorporated into the soil or left on the surface. However, once the debris degraded, the numbers of *Xcc* declined and became undetectable in the soil alone. The apparently longer survival time in two of plots in which the debris had been incorporated on the surface may have been the result of small, but indiscernible pieces of debris being contained in the final soil samples in which *Xcc* was detected.

The very large numbers of *Xcc* which were present in the debris suggest that debris from infected crops presents a very high risk to subsequent crops planted in or near it, so long as the debris remains discernable. *Xcc* appears to survive poorly in the soil itself and therefore once visible debris has been absent for several months there would appear to be little risk. Thus any actions which can be taken to increase the rate of breakdown of brassica debris would appear to be beneficial.

In terms of disease management, these results suggest, that if infected crop debris is left in the field, whether incorporated or not, that brassicas should not be planted into the same or nearby fields for at least 6 months. It is recognised that such an interval between crops would be virtually impossible to achieve for small peri-urban farmers, therefore alternative approaches to dealing with infected or potentially infected debris must be found.

At first sight, chopping the debris as small as possible and incorporating into the soil may encourage more rapid breakdown, but conversely this may increase the short term risks resulting from highly contaminated equipment and people, and the potential for raising infectious dust if the debris is dry, or aerosols if wet.

The most effective way of dealing with infected crop debris could be to remove from the field and then effective aerobic composting which achieves high temperatures and rapid breakdown of the material (Noble *et al.* 2004). Burning of dry debris may be another option.

Chapter 6: Developing practical strategies for sustainable management of black rot in brassicas

Part 4: Improvement of local seed testing capability for black rot and training provision for local personnel

6.4.1. INTRODUCTION

A key part of this project was to improve the local seed testing capability for black rot. This involved both purchase of equipment and consumables and training of staff via practical training visits to UK by KEPHIS staff and practical training workshops held in different laboratories in Kenya. The first training was held in the UK so that the individuals concerned could facilitate subsequent workshops in Kenya.

6.4.2. TRAINING VISIT TO UK

Supervisor: Dr. S.J. Roberts

Dates: from 18 Aug to 13 Sept 2003

Location: HRI-Wellesbourne

Trainees: Mrs. Elizabeth Lang'at; Mrs. Loise Kamuyu

The trainees spent four weeks working within the bacteriology group at HRI-Wellesbourne. Training was very much 'hands-on' and most of the time was spent working through the standard procedures for testing brassica seed for *Xcc*. Activities included: instruction in general aseptic and bacteriological techniques; use of automatic pipettes; preparation and sterilisation of media and antibiotics; preparation of glassware, reagents other materials; preparation of seed samples; incubation of seed samples, centrifugation, dilution and plating; recording of spread plates; sub-culturing and recording of sectored plates; pathogenicity testing; discussion of statistical interpretation of results. The trainees performed seed tests on some of the brassica seed lots which had been collected as part of this project and also on some other seedlots which were known to be positive or negative and with different background saprophyte populations. The trainees received instruction in, and worked through, closely related procedures for soil and debris testing. At all times emphasis was given to appropriate QA procedures, and critical control points to ensure results would stand up to external audit, in line with ISO-17025 and ISTA standards. In addition to the seed testing, the trainees received instruction in, and performed, pathotyping of *Xcc* isolates. Activities included: discussion of gene-for-gene relationships and the origin of and selection of the differential series; preparation of inoculum; inoculation methods; recording and interpreting of results. The results of the tests on particular seed lots are reported in Section 6.2.

6.4.3. EQUIPMENT AND CONSUMABLES

During the training visit to HRI by KEPHIS staff, the opportunity was taken to identify essential equipment and consumable which were needed in order for KEPHIS to be able to undertake seed testing for *Xcc* in Kenya. Many of these items were acquired during the stay of the trainees, and were therefore shipped to Kenya as 'un-accompanied luggage' when the trainees returned. Remaining items were despatched subsequently or directly by the suppliers.

6.4.4. NAIROBI WORKSHOP, NOVEMBER 2003

Leader: Dr. S.J. Roberts

Local organisers: Dr. Esther Kimani (KEPHIS), Dr. Noah Phiri (CABI), Dr. G. Kibata (KARI)

Local technical support: Mrs. Elizabeth Lang'at (KEPHIS)

Dates: from 14 Nov to 20 Nov 2003

Location: KEPHIS Plant Health Clinic, Nairobi.

Attendees: Duncan Chacha (CABI), Lucy Karanja (CABI), Stephen Koech (KARI NARL), Boniface Mbevi (KARI NARL), Joseph Kinoti (KARI NARL), Stephen Ndirangu (KARI NARL), Miriam Otipa (KARI NARL), Jesica Mbaka (KARI THIKA), John Kamanga (KEPHIS NAKURU), Isaac Macharia (KEPHIS PQS), Lucy Thungu (KEPHIS PHC), Linnet Otieno (KEPHIS PHC)) (12)

The workshop followed a very practical format. Participants worked in groups of two or three and each group was allocated a number of seed samples to test for the presence of *Xcc.* Following some initial discussion and/or practical demonstration of each step by Dr. Roberts, the participants then performed the standard procedures for the seed test. This included: preparation of seed samples; incubation of samples; centrifugation; dilution and plating; recording of spread plates; sub-culturing and recording of sectored plates; pathogenicity testing. More general aspects of aseptic technique, use of equipment, and general laboratory procedures were also discussed informally during the workshop, as time permitted. Isolation of the pathogen from leaf material was demonstrated. Dr. Roberts also gave formal lectures on: *The biology and epidemiology of black rot*; *ISTA and the ISTA Method Validation Programme*; and *Statistics in Seed Health Testing.* The results of the tests on particular seed lots are reported in Section 6.2.

6.4.5. LANET WORKSHOP, NOVEMBER 2004

Leader: Dr. S.J. Roberts

Local support: Mrs. Elizabeth Lang'at

Dates: from 24 Nov to 30 Nov 2004

Location: KEPHIS National Seed Testing Laboratory, Lanet, Nakuru.

Attendees: John Kamanga, Jane Mumo, Isabella Ondabu, Michael Kiplagat (All KEPHIS).

The workshop followed a very similar format to the one held in 2003. Participants performed seed tests for *Xcc* on a number of seedlots. The smaller number of participants mean that each received much more direct tuition and practical experience and permitted much more discussion and interaction during the formal presentations by Dr. Roberts. The results of the tests on particular seed lots are reported in Section 6.2.

Chapter 7: Harvest of kale seed and dissemination to kale farmers

7.1 INTRODUCTION

The overall objective of this project has been the promotion of a sustainable system for farmer-led multiplication of kale seed for smallholder farmers in the Kinale region of peri-urban Kenya, in order to improve the quality, health and availability of kale seed to smallholder farmers. To this end, emphasis was on farmer-to-farmer distribution under the regulation of KARI, KEPHIS and in collaboration with NGOs, and the value of producing or purchasing good quality seed has also been promoted. As detailed in previous chapters of this report, one important achievement by farmers and researchers has been the selection of seven improved kale lines from a trial of 24 Kinale kale lines grown on the KARI station at Njabini. The lines are very impressive and will be in demand from farmers in the future.

In the initial phase of seed harvesting, the KARI-CABI team were able to gather an extremely large volume of seed. However, KEPHIS, who have been evaluating the lines with the research team throughout, could not support the idea of engaging a seed company for distributing the seed. The reason why KEPHIS does not accept distribution of seed through Certified Seed Companies is because seeds from the Kinale kale lines are yet to be certified. Thus, in order to progress to possible new varieties, seeds needed to be distributed to farmers for multilocational on-farm performance trials (see Chapter 3, Section 3.2.7.1 of this report), and farmers' feedback sought as to the respective strengths of the potential varieties they grew.

7.2 MATERIALS AND METHODS

Following the completed harvest of seed at Njabini research station, seed from open pollinated plants of the Kinale kale lines was disseminated to farmers as part of pilot trials in strict accordance with Kenyan rules and regulations governing the distribution of seed. Seeds were distributed, along with promotional posters as detailed in Chapter 4, to 359 kale farmers in most kale-producing peri-urban areas of Nairobi (Kinale, Nyathuna, Ruiru, Thika, Kiserian and Athi River) (See Table 4.1). The criteria used to select farmers were that they are kale farmers, have land and were willing to try our Kinale kale selections and give a feedback. Many of these farmers had worked with the project research team in previous phases of the programme. Details relating to how long the farmer has been growing kales, and what kale varieties s/he has been growing, was also collected, along with the following information:.How the farmer compares the Kinale kale selection with the varieties s/he has been growing in terms of growth characteristics, size of leaves, marketability of the harvested leaves if selling, palatability of the leaves from Kinale kale selections, how long s/he has been harvesting from Kinale kale selection plants before they flower, whether s/he would choose and buy seeds of Kinale kale selection if available on the market, whether s/he would recommend the selection to other farmers, and whether s/he has grown Kinale kale landraces for both leaf and seed production. Feedback obtained from farmers would help in disseminating this important output of the project to a wider area, because farmers who would have received and planted the seed will act as demonstration sites and surrounding farmers would easily get to know about the selections. In addition, this could create demand (awareness) for Kinale kale varieties and seed when released during ZA0663.

7.3 RESULTS: Farmers' feedback

Farmers planted seed in the long rains of 2005 (April/May), so feedback will be obtained during the current follow-on project (PM285), and reported in the corresponding FTR.

R8312 CROP PROTECTION PROGRAMME

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Appendix I

- PART 1: QUESTIONNAIRE ON FARMER PERCEPTIONS OF SEED PRODUCTION AND MARKETING
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Appendix I

Part 1: QUESTIONNAIRE ON FARMER PERCEPTIONS OF SEED PRODUCTION AND MARKETING

1. Location…………………………Village…….……………………Group……………
2. Farmer name……………………………..……sex…………Age…………..
3. Land size (acres)…………………Land under kale production (acres)…………

Kale production and the potential for seed production

4. Acreage under kale last year………….Amount of kale harvested last year (bags)…….. Income obtained from kale last year (Ksh)………………………….
5. How many times did you plant kale last year…………..Amount of seed used?………… (Specify units-gms, cups etc)
6. Source of seed a) farm saved b) purchased c) Neighbours/friends
7. If purchased what is the source a) other farmers b) shops (commercial varieties) c) shops (local varieties) d) Local market
8. If own farm saved seed, any special management on the kale for seed production? ……………………………………………………………………………………
9. Why the choice made on source of seed in 5 above? ……………………………………………………………………………………
10. Varieties commonly planted and proportion planted in % for those who plant more than one variety

Variety	Proportion (%)

11. How would you rate the availability of seed for each of the below sources a) own farm saved…………………………..b) other farmers………………… c) shops(commercial varieties)……………d)shops (local varieties)…..………

(1-High 2-medium 3-Low)

12. General constraints with respect to seed (rank in order of importance
    1,……………………2,…………………………3,…………………4,………………
13. Specific problems with own farm saved seed (rank in order of importance)
    1,……………………2,…………………………3,…………………4,……………..
14. Specific problems with seed purchased from other farmers (rank in order of importance)
    1,……………………2,…………………………3,…………………4,………………
15. Specific problems with commercial purchased seed (rank in order of importance)
    1,……………………2,…………………………3,…………………4,………………
16. Is farmer selling seed? …….…………….If yes, how much sold last year ……
17. Who farmer sells seed to a) other farmers /neighbours b) middlemen c) local market
18. What factors would influence you to purchase seed from other farmers as opposed to the shops?
    ………………………………………………………………………………………
19. What factors would influence you to grow your own seed rather than purchase from other farmers?
    ………………………………………………………………………………………
20. What criteria does farmer consider when purchasing seed from other farmers?
    ………………………………………………………………………………………
21. What criteria does farmer consider when purchasing commercial seed from shops?
    …………………………………………………………………….………………
22. What would be your ideal source of seed a) grow own seed b) purchase from other farmers c) purchase from shops
23. Would you consider growing kale specifically for kale seed for sale considering the reduced leaf harvest required?
    …………………………………………..…………………
24. What conditions would you consider necessary for you to go into kale production for seed? ………………………………………………………………………………………
25. Would you prefer to grow the kale seed a) individually b) as a group
26. What strategies for marketing would you propose for the kale seed
    ………………………………………………………………………………………

PART 2: KEPHIS DATABASE – AMOUNT OF SEED TRADED 2002-2004

AMOUNT OF BRASSICA SEEDS IN 2002

Merchant	Species	Amount in kgs
Amiran (K) Ltd		
	Broccoli	2.00
	Cabbage	639.22
	Kale	272.20
		913.42
EASCO		
	Broccoli	89.00
	Brussel Sprout	3.04
	Cabbage	15,908.80
	Collards	25,482.00
	Kale	2,200.00
	Turnip	1,598.00
		45,280.85
Farmchem Ltd		
	Cabbage	342.16
	Kale	87.00
		429.16
Hygrotech E.A L		
	Broccoli	0.39
	Cabbage	85.00
		85.39
Intra Farm Serv		
	Cabbage	42.50
	Cauliflower	10.50
		53.00
KHLSCO Co.		
	Broccoli	2.00
	Cabbage	82.75
	Cauliflower	11.30
	Kale	23.95
		120.00

KSC Simlaws		
	Cabbage	14,836.90
	Chinese Cabbage	275.00
	Collards	200.00
	Flower	0.10
	Kale	1,256.00
		16,568.00
Regina Seeds		
	Broccoli	9.00
	Brussel Sprout	0.15
	Cabbage	8,508.50
	Cauliflower	68.60
	Hyb.Cabbage	25.00
	Kale	179.00
		8,790.25
Vetagro E.A Ltd		
	Cabbage	3,970.00
	Cauliflower	25.00
	Kale	502.00
	Turnip	100.00
		4,597.00
Total		76,837.07

AMOUNT OF BRASSICA SEEDS IN 2003

Merchant	Species	Amount in kgs
Amiran (K) Ltd		
	Brusels Sprout	6.00
	Cabbage	1,755.50
	Cauliflower	69.08
	Collards	66.00
	Kale	2,219.00
	Red Cabbage	3.00
		4,118.58
EASCO		
	Broccoli	35.00
	Cabbage	14,876.30
	Cauliflower	331.50
	Chinese Cabbage	2,041.00
	Collards	28,740.00
	Kale	1,976.50
	Mustard	1,481.00

	Turnip	1,272.40
		50,753.70
Farmchem Ltd		
	Cabbage	170.80
	Kale	132.50
		303.30
Homegrown (K) Ltd		
	Cabbage	35.00
	Chinese Cabbage	25.00
	Pack Choi	50.00
	Turnip	20.00
	Vegetable	25.00
		155.00
Hortitec (K) Ltd		
	Cabbage	260.00
		260.00
Hygrotech E.A.Ltd		
	Cabbage	150.00
	Cauliflower	10.00
		160.00
KHLSCO		
	Broccoli	2.00
	Cabbage	79.95
	Cauliflower	19.50
	Kale	44.80
	Vegetable	8.13
		154.38
KSC Simlaws		
	Broccoli	50.00
	Brussel Sprout	0.02
	Cabbage	11,036.85
	Cauliflower	58.80
	Chinese Cabbage	100.00
	Collards	9,729.00
	Kale	709.30
		21,683.97
Regina Seeds		
	Broccoli	7.80
	Cabbage	8,080.50
	Cauliflower	108.20
	Hybrid Cabbage	5.00
	Mustard	50.00
		8,251.50

Merchant	Species	Amount
Vegpro Ltd		
	Cabbage	3.00
		3.00
Vetagro E.A. Ltd		
	Cabbage	2,784.75
	Cauliflower	33.80
	Kale	1,011.50
	Turnip	134.00
		3,964.05
Vitacress (K) Ltd		
	Herb	40.00
		40.00
Total		89,847.48

AMOUNT OF BRASSICA SEEDS IN 2004

Merchant	Species	Amount in kgs
Albhai Shariff & Sons		
	Cabbage	0.500
		0.500
Amiran (K) Ltd		
	Cabbage	309.080
	Cauliflower	31.950
	Kale	223.250
		564.280
East African Seed Co.		
	Cabbage	1.500
	Mustard	1,012.000
	Cabbage	340.500
	Cabbage	11,360.225
	Cauliflower	167.900
	Collards	53,754.000
	Kale	11,218.500
	Turnip	88.000
	Chinese Cabbage	40.000
		77,982.625

Farmchem Ltd		
	Cabbage	198.250
	Kale	123.050
		321.300
Homegrown Co		
	Brassica rapa	75.000
		75.000
Hygrotech E.A Ltd		
	Chinese Cabbage	50.000
	Mustard	10.000
	Cabbage	141.000
	Cabbage	14.000
	Cauliflower	31.000
	Vegetable	30.000
	Chinese.Cabbage	50.000
		326.000
Kenya Highlands Ltd		
	Pack Choi	85.000
	Mustard	20.000
	Broccoli	3.500
	Cabbage	38.000
	Cauliflower	8.900
	Japanese Greens	40.000
	Pack Choi	10.000
	Tatsoi	10.000
	Brassica rapa	20.000
		215.400
KSC Simlaw		
	Broccoli	24.515
	Brussel Sprout	0.385
	Cabbage	8,020.200
	Collards	7,065.000
	Kale	1,117.000
		16,227.100

KSC Simlaws		
	Kale	10,000.000
		10,000.000
Regina Seed Co		
	Brassica oleracea	20.000
	Cabbage	3,442.430
	Cauliflower	461.550
	Collards	2.290
	Kale	6.020
		3,932.290
Vegpro (k) Ltd		
	Turnip	21.000
		21.000
Vetagro E.A Ltd		
	Cabbage	1,661.000
	Kale	575.000
	Turnip	74.000
		2,310.000
Vitacress (K) Ltd		
	Brassica juncea	188.000
	Brassica oleracea	50.000
	Brassica rapa	10.000
		248.000
Grand		112,223.490

PART 3: SMALL PACK SEED PRICELIST 011003

Kenya Seed Market Price Calculator
Exchange rate Ksh/US$ - 80

HYGROTECH EAST AFRICA LTD.

CROP	Variety	HEA Retail price effective 1/10/2003 Ksh
CABBAGE	Copenhagen Market	40
		55
		90
		150
		330
		640
		1240
CABBAGE	Green boy F1 (Gloria)	370
		900
		1600
		3100
		7600
		15000
		30000
CABBAGE	Riama F1	400
		950
		1650
		3200
		7600
		15000
		30000
CABBAGE	Marcanta F1	350
		900
		1600
		3000
		7300
		14500
		28800
CABBAGE	Cape Spitz / Sugar Loaf	30
		40
		50
		100
		180
		320
		630
CAULIFLOWER	Snowball	70
		150
		240

		500
		950
		1750
		3500
CHINESE CABBAGE	**Michihili**	30
		40
		60
		90
		190
		360
		680
SUKUMA WIKI	**1000 Headed Kale**	45
	(Chou Moullier)	72
		110
		180
		400
		780
		1500
COLLARDS	**Georgia**	35
		45
		70
		100
		240
		460
		880
SWISS CHARD	**Ford Hook Giant**	30
		40
		60
		95
		200
		360
		700

PART 4: SURVEY OF KINALE KALE

SURVEY OF KINALE KALE "VARIETY"

DISTRICT______________________ DIVISION______________________________

NAME OF PERSON COLLECTING INFORMATION________________________

DATE RECORDED__________________

KALE VARIETY	PRESENT OR ABSENT IN THE DISTRICT/DIVISION	ESTIMATED AREA (ha) GROWN TO VARIETY	SOURCE OF SEED FOR THE VARIETY
KINALE (MATHARU)			
THOUSAND HEADED			
COLLARDS			
OTHER KALE VARIETIES (if any)			

ANY COMMENTS

____

____

____

____

____

____

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PART 5: KALE PROJECT BY CABI AND LAGROTECH SEED COMPANY

PROMOTION OF QUALITY SEED PROJECT IN KENYA BY CABI. (The CABI Kinale Kale Seed Development Project).

By
Moses Onim, Lagrotech Seed Company.

1. THE ROLE OF LAGROTECH SEED COMPANY IN THE CABI QUALITY KALE SEED PROJECT.

1.1. The main roles of Lagrotech Seed Company in the CABI Kale project include:

- Providing plant breeder role in the development, and possible release of a kale variety or varieties to the farmers in Kenya, East African region, or elsewhere where the varieties will be suitable.

- Dr. Moses Onim (PhD in Genetics and Plant Breeding), the Managing Director of Lagrotech Seed Company, and Mr. Joseph Mito (MSc in Genetics and Plant Breeding), the Head of Research and Product Development of Lagrotech Seed Company, will collaborate on this project to play the above role.

- Lagrotech will closely work with the other collaborators to select the seed growers, and register them with KEPHIS.

PLANS TO BE PUT IN PLACE FOR SUSTAINABILITY WHEN THE PROJECT STOPS IN MARCH, 2005.

There are two major options that could lead to sustainability of the excellent activities of kale seed research, development and proposed production.

a). Formation of Kinale Kale Seed Growers' Farmers Group or Co-operative for specific purpose of certified seed production. The Seed Growers' Group or Co-operative should then be registered with KEPHIS as a Seed Company.

b). The current Kale farmers be encouraged to form a Kale Seed Producer Group or Co-operative as shown above, then the seed producers are attached to a Seed Company, like Lagrotech. The Kale Seed Growers will then become seed growers like is the case with seed companies operating in Kenya.

Lagrotech Seed Company has valuable experience in this area where it closely works with KEPHIS and KARI to develop12 farmer groups in Western and Eastern Kenya (6 districts in each region), to grow certified seeds of various varieties of maize, sorghum, cowpeas and bean. These seeds are now marketed in the whole country.

In such arrangement, a number of things must be put in place for both parties to operate well. These include:

- The responsibilities of the seed growers, and those of the Seed Company for which the farmers produce the seed, should be well documented.
- The Seed Company (Lagrotech) will draw seed growers' contracts with them; clearly spelling out the terms of seed growing and what is expected of them to produce certified kale seeds. The price to be paid to the seed growers per specified unit of seed will be clearly spelt out in the contract before the farmers undertake seed growing.
- The seed growing farmers will need to be trained on other technologies that will empower them to benefit best in the area of seed production. The Seed Company, KEPHIS, KARI will conduct such courses, if need be, together with Agricultural inputs companies, or in any combinations of the above, as may be necessary to assure the best results.
- The Seed Company (Lagrotech), will take the responsibility of advertising and marketing the Kinale Kale Seed all over the country and beyond. This will be after the seed growers will have produced kale seed that will have met all the field KEPHIS certification standards. The seed will then be bought by the Seed Company, have all post harvest KEPHIS viability and other quality tests done and met. The seed will then be processed, dressed, packaged as required by seed laws, and marketed within Kenya and beyond.
- It will be the responsibility of the the Seed Company (Lagrotech), to market and widely make the Kinale Kale seed known through many forms of advertising eg by posters, brochures, radio, on-farm demonstrations, and agricultural shows.
- Lagrotech Seed Company already works with over 400 seed stockists all over the country, including marketing through the Kenya Farmers' Association (KFA) that has branches all over the country. Kinale Kale seeds will be marketed to farmers through these outlets.

These options will be discussed with project managers and collaborators so that the best one is followed. However, for sustainability of this project after funding stops, a Seed Company working with the seed producers to make these very promising lines available in the market as soon as possible, and assuring farmers of higher income from their kale vegetable and seed production should be a better choice. This step would make these good lines being developed into varieties be more widely available to farmers, other than only to farmers around Lari Division (Limuru, Kinale and Njabini) and its neighborhoods. A survey to determine how far seed of these kale varieties have spread has been done and a report should be available.

2. SUGGESTED STEPS TO MAKE THE PROMOTION OF QUALITY SEED PROJECT ACHIEVE ITS GOAL AND OBJECTIVES.

I attended two previous project meetings held in KARI-NAL Campus in 2003 and 2004. These meetings were convened by CABI and attended by collaborating institutions, which included KARI-NAL, KARI-Horticultural Research Station, Thika, KEPHIS, Nicola Spence and Lagrotech Seed Company. In these meetings it was suggested that the team, including CABI scientists, KEPHIS, KARI and Lagrotech seed Company, suggests how the improved kale lines selected from land races among Kinale kale farmers and its environments could be developed into commercial varieties. Two options, as have been highlighted above, viz. (a) kale seed farmers working towards developing a commercial seed-growing farmers' group (Company); or (b) the seed growers work through a seed company. Whichever one is preferred, the following steps are recommended to enable the seed of selected lines to be developed into varieties and their commercial seed is released for the market.

i. The Project works with several farmers that grow the Kinale type kales and determine production practices for leafy vegetables and seed production. Kinale kale farmers were already practicing both, and were selling their kale seed actively within the area.

ii. A Socio-economic study of production of Kinale leafy kale vegetable and seed production should be conducted to determine the importance of Kinale kales in the farming activities of these farmers.

iii. The project research team and collaborators should work closely with KEPHIS to determine the best way forward towards getting the Kinale kales land races, or selections from these land races developed into commercial varieties.

iv. Several good and healthy kale plants be selected within farmers' fields and tagged with collaboration of kale growing farmers in these areas. During flowering, part of the branches of selected flowering plants be selfed by covering them with muslin bags or brown paper bags to keep out insect pollinators, and the other part to be left for open insect pollination.

v. Pods from self-pollinated flowers be carefully dried, threshed and seeds cleaned, still maintaining identity of each selected single plants.

vi. The self-pollinated seeds should be planted into progeny rows to enable the research team and KEPHIS to characterize the lines. This step was carried out, however, it was observed that the selfed pods formed only a few very poor shriveled seeds. The open-pollinated pods formed many healthy seeds, except bird damage of the pods was extremely high as birds ate young maturing seeds.

vii. Single plant progeny rows were therefore grown from the open-pollinated pods. The progeny rows should be covered to avoid insect cross-pollination between the lines. The cover used should protect the plants from both insects and birds that damage flowers and pods.

viii. The seeds harvested from the insects-birds protected plots should be divided into three portions. The first part should be given to KEPHIS for planting to test the lines for Distinctiveness Uniformity and Stability (DUS). This is an important step towards release of a new variety where the descriptor for each line that was developed in the characterization phase is verified. The descriptors for each variety must be given to KEPHIS for filing for their seed inspectors to use during variety field inspection for seed production by seed growing farmers. A fee is paid to KEPHIS for DUS test.

ix. The second portion of selfed seeds should be submitted to KEPHIS in March of 2005 when KEPHIS convenes the National Variety Release Committee that is made up of all seed companies and organizations that intend to enter their various crop varieties to be tested in the National Performance Trial (NPT). These trials are conducted at several locations across the country where the varieties are tested against many other similar varieties entered for NPT by other seed companies and organizations. These varieties are also tested against about five commercial checks already released and are being marketed.

If the entered lines or land races, on the average, significantly do better than the checks across trial sites over a period of three years (seasons), then they are released for commercial production and marketing. However, if the entered lines or land races are exceptionally better than the checks in yield, or some other attributes, like disease or pest resistance, or earliness, then the entries may be pre-released after only one or two NPT trials, if the organization that entered the lines fight for pre-release. A fee is also paid to KEPHIS for every line (land race) entered for NPT every year (season).

x. The third portion of the selfed seed should also be entered for multiplications trials by the research team so that the team obtains performance data on these lines which may be used while defending the lines during the KEPHIS variety release committee meeting for March, 2006.

xi. Although KEPHIS usually only allows for seed increase of varieties or lines that have either been recommended for release or pre-release by the National Variety Release Committee, it is usually advisable to start seed increase earlier since once a variety is officially released, the amount of seed required by the market is usually very big.

3. CHALLENGES.

There are several challenges that need to be addressed for successful Kinale Kale Seed Project.

a). Kale, *Brassica oleracea* (Acephala Group), like other Brassicas, is largely open-pollinated by insects, mainly bees. Some Kale lines are even self-incompatible, which means that self-pollination is impossible. This means that selfing plants will quickly result in inbreeding depression, whereby seed production will be very poor and plants grown from such seeds are weak and unproductive.

b). Covering Kale plants like is being done now to keep out insect pollinators from cross-pollinating Kale lines from different selections can only be done under experimental management. Otherwise for commercial seed production, seed Kale fields will need to be grown away from other kale fields, at least an isolation distance of approximately one kilometer. Bees should be encouraged to forage in such seed fields to assure good seed setting. This can be done in suitable areas in the Kenya highlands, like what is done in Molo for Kale seed production.

c). Kale flowers and pods suffer extensive bird damage in Kinale area, where without covering the pods, as farmers do to be able to harvest any seeds, no or very little seed may be harvested. The birds causing damage are of the weaver family. This makes Kinale area appear to be unsuitable for Kale seed production. Other locations, like Molo, and other highland areas in Kenya may be better for kale seed production.

d). Bee keeping in Kenya is fairly advanced and therefore placing a number of bee hives around kale seed fields is feasible. Dr. Noah Phiri and I have already visited ICIPE in Nairobi for provision of bees for pollination under the fleece in Njabini.

e). It is hoped that Kinale kales will be adapted in lower elevations like other varieties eg. Collards and a thousand headed. This will be essential for Kinale kale seeds to find markets in more parts of the country to make its seed production profitable.

PART 6: PLANTS AND THEIR CHARACTERISTICS

Peter Thiongo

Plant Characteristics:

1. Plant height: 2M
2. Length of stem before Florescence
3. Length of internodes – 3-4cm
4. Color of fully developed leaf – Dark olive green
5. Intensity of color of leaf
6. Leaf blade color
7. Leaf blade height
8. Width of leave
9. Shape
10. Leaf blade curvature – noted
11. Leaf blade curling
12. Petiole attitude from stem- horizontal
13. Petiole number of lobes – 3

Flowers:

Flower color – yellow
Number of Flowers 50-80/ florescence
Florescence attachment angle – semi erect
Anthocynin coloration of inflorescence- stock medium purple
Coloration on midrib – weak medium
Number of petiole – 4
Number of anthers – 6
Sepals mature is deep yellow (gold)
Number of sepals – 4
Sepals when young or just before opening – green
yellow
Stem diameter - 4.5 cm
Age - over 1 year
5 plants

Kimani 3

Plant height – 180cm
Length of internodes – 3-4cm
Color of leaves – dark olivegreen
Intensity of leaf
Leaf curvature of leaves – strong
Leaf blade curling – weak medium
Leaf blade attitude – horizontal
Petiole number of lobes – 0-3(0)

Flower color – yellow
No of flowers/florescence – 50-80
Attitude of florescence - semi erect
Attitude of flower stalk – horizontal
Anthocynin of inflorescence ` - weak medium
Midrib anthocyanin coloration – weak
Petals – 4
Anthers – 6
Sepals – 4
Mature – gold
Younger – green yellow
Stem Diameter – 2.7cm
Age 1 year

3 NYUTU -2

Height – 2m
Length of internode 2cm
Colour of leaf – dark olive green
Leaf blade curling - medium
Petiole attitude - horizontal
Petiole number of lobes - 0-3 lobes
Flower color - yellow
Petiole – 4
Florescence attitude – semi erect
Attitude of flower stalk - semi erect
Width 4.6cm
Anthocyanin of florescence – weak
Midrib anthocyanin – absent
Petals number – 4
Anthers – 6
Sepals – 4
Sepal color – gold –mature
Green yellow -young
Pods length 9.7, 9-10, 9.0, 9.5(9-9.7)
Stock length 3.5, 3.5, 3.5
Stock semi erect
Pod – vertical/upright
Pod orientation excluding stock
Pod shape – slightly curved to elongate
Glucousity of pods – medium
Flower stock, inflorescence stalk also on leaves and stems
Attitude: 2469 m asl
S 0^0 58.033’
E 36^0 37.794’

Peter Karanja 2

Height 180 cm (1yr or over)
Internode length 2-3 cm
Leaf color – dark green olive
Leaf blade curling – weak/medium
Petiole attitude-Horizontal
No. of robes-2

Flower no. per infloresence -50-60
Floresence attachment to main stem -semi erect
Attitude of flower stalk -Horizontal
Anthocynin coloration
Midrib coloration –Absent to very week
No. of petioles –4
No. of anthers –6
No. of sepals –4 (green to gold)
Stem diameter –3.4
Glaucosity (waxiness) – week to medium on leaves young stem, flower stalk

Mutua Samuel

10 months old

Plant No.Mutua 3

1) Height –170 cm
2) Internode length –2.5 –3
3) Color of leaves – Dark olive green
4) Leaf blade curling – week
5) Petiole attitude –Horizontal to semi erect
6) No. lobes –zero (oldest leaves/left)
7) Flower colour –Yellow
Flower no. per infloresence –50-80
-Floresence attachment to main stem -semi erect
-Attitude of flower stalk -Horizontal
Anthocynin coloration
–Very week – infloresense stalk
- Leaf
- Midrib
Petals –4
Anthers –6
Sepal colour- Green to gold
Diameter –2.5
Glaucos/waxiness -Medium

Salome Njeri 2

1) Height –25 cm
2) Internode length – 2-3
3) Leaf color –Dark olive green
4) Petiole-
5) No. of lobes
6) Flower colour –Yellow
7) Flower
8) Floresence attachment to main stem -semi erect
9) Attitude of flower stalk -Horizontal
10) Anthocynin coloration-
    -Infloresence stalk-weak
    -Mid rib-weak
11) Petals –4
    Anthers –6
    Sepals-4
    Sepal colour- Green to gold
    Diameter –3
    Glaucos/waxiness –weak-medium

Mr. Mwaura

Plant no. Mwaura 2

Plant height –1.8m
Leaf color –Darkolivaceousgreen
Leaf blade curling-weak
Petiole attitude-Horizontal
No. of lobes-Absent(1 leaf)
Flower color –yellow
No. of flowers- 50-80
Floresent attachment to main stem-semi erect
Attitude of flower stalk-Horizontal
Anthocynin-infloresence-weak
    -Mid rib-very weak
Petals – 4
Anthers – 6
Sepals- 4
Sepal color- Green to gold
Diameter – 3
Glaucos/waxiness – Stem-weak
Stem diameter-2.9
Internode- 3-5 cm
Age of plant -12 months

Samuel Wamburi

Wamburi 2

Height –1.8
Internode length - 4-5
Color of leaf –Dark olive green
Leaf blade curling –weak
Petiole attitude -------
No. of lobes------
Flower color –Yellow
Flower no. per infloresence –50-80
Floresent attachment to main stem-semi erect
Attitude of flower stalk-Horizontal
Anthocynin-weak –flower stalk
Midrib-Absent
Petals – 4
Anthers – 6
Sepals - 4
Diameter – 3
waxiness – Medium
Stem diameter - 2.9
Internode- 3-5 cm
Age of plant -1 year

PART 7: SEEDS COLLECTED FROM TAGGED PLANTS – KINALE KALES – JANUARY 2004

(Lines in red were planted and evaluated evaluated at Njabini)

Kinale Kale Line no.	Source Of Line (Farmer Name)	Plant Number During Selection	Open or Selfed	*Numbering For Harvesting Trial*
1	David Mwaura	01	O	
2	David Mwaura	01	O	
3	David Mwaura	01	S	
4	David Mwaura	01	O	
5	Grace Nduta	02	S	
6	Grace Nduta	02	S	1H
7	Joseph Mukuwa	03	O	
8	Joseph Mukuwa	03	S	
9	Kimani Muhia	04	O	
10	Kimani Muhia	04	S	
11	Kimani Muhia	04	O	
12	Kimani Muhia	04	O	2H
13	Kimani Muhia	04	O	
14	Kimani Muhia	04	S	
15	Mbuthia Gitithia	05	O	
16	Mbuthia Gitithia	05	S	
17	Mbuthia Gitithia	05	S	
18	Mr. Nyutu	06	O	
19	Mr. Nyutu	06	S	
20	Mr. Nyutu	06	O	3H
21	Mr. Nyutu	06	S	
22	Mr. Nyutu	06	S	
23	Nyotu	07	O	
24	Nyotu	07	O	
25	Philomena Nduta	08	O	
26	Phyllis Karoga	09	O	
27	Phyllis Karoga	09	S	
28	Phyllis Karoga	09	S	
29	Salome Njeri	10	O	4H
30	Salome Njeri	10	S	
31	Salome Njeri	10	O	
32	Salome Njeri	10	O	
33	Salome Njeri	10	S	
34	Samuel Mutia	10	O	
35	Samuel Waburi	11	O	

36	Samuel Waburi	11	S	
37	Samuel Waburi	11	S	
38	Samuel Waburi	1	O	5H
39	Samuel Waburi	2	O	
40	Kimani Muhia		O	
41	Kimani Muhia		O	6H
42	Samuel Mutia		O	
43	David Mwaura		O	7H

PART 8: THRESHED KINALE SEED – 2003F1

		THRESHED KINALE SEED		
		TAGGED		
		Date of threshing 7-9/7/2004		
	Farmer	**Plant**	**Weight (g)**	**Remarks**
1	Grace Nduta	3	7.27	
2	Grace Nduta	1	1.19	
3	Mbuthia Gitithia	3	3.1	
4	Mbuthia Gitithia	2	3.72	
5	Phyllis Karoga	3	0.41	
6	Phyllis Karoga	4	2.97	
7	Mr. Nyutu	3	0.58	
12	Mr. Nyutu	1	1.54	
8	Samuel Waburi	4	0.15	
9	Samuel Waburi	3	0.24	
10	Kimani	1	0.26	
14	Kimani	5	0.45	
11	Joseph Mukuwa	1	0.12	
13	Mr. Nyutu	2	1.53	
15	Salome Njeri	3	0.06	
16	David Mwaura	2	0.79	
		UNTAGGED		
1	Mr. Nyutu	1	2.14	
2	Phyllis Karoga	3	1.31	
3	Mr. Nyutu	2	9.97	
4	Mbuthia Gitithia	1	5.3	

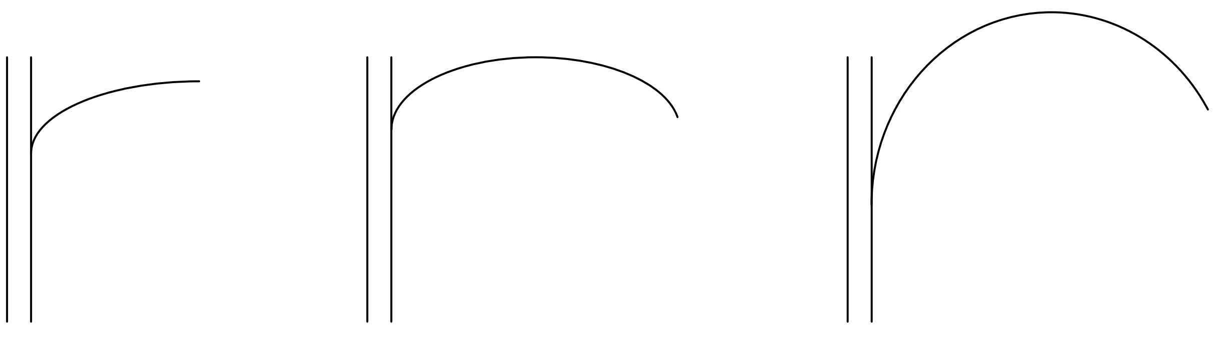
PART 9: CHARACTERISATION FORM

Farmer name: _______________ Plant Number: __________________
Plant age: ___________________ Date of recording: _______________
Mother plant or seedling: ______________________

Plant part	Characteristic	Example of characteristic	Recorded characteristic
1. Seeedling	**1. Colour of cotyledons**	Light green, medium green, dark green	
2. Plant	**2. Height**	Short, medium, tall	
	3. Width/diameter	Narrow, medium, broad	
	4. Length of stem	Short, medium, long	
	5. Length of internodes	Short, medium, long	
3. Leaf blade	**6. Colour of young leaf**	Yellow green, green, grey green, blue green	
	7. Intensity of colour of young leaf	Light, medium, dark,	
	8. Colour of a fully developed leaf	Yellow green, green, grey green, blue green	
	9. Intensity of colour of a fully developed leaf	Light, medium, dark	
	10. Leaf blade shape	Very narrow elliptic, very narrow elliptic to narrow elliptic, narrow elliptic to elliptic, elliptic	
	11. Leaf blade length	Short, medium, long	
	12. Leaf blade width	Narrow, medium broad	
	13. Leaf blade curvature (see diagram)	Weak, medium, strong	
	14. Leaf blade curling	Weak, medium, strong	
	14. Leaf blade cupping in cross section	Weak, medium, strong	
	15. Petiole attitude	Erect, semi-erect, horizontal	
	16. Petiole length	Short, medium long	
	17. Petiole width	Narrow, medium, broad	
	18. Petiole number of lobes	Absent or very few, few, medium, may, very many	
Flower	**19. Colour**	yellow	
	20. Number of flowers per	50-80	

	florescence		
	21. Florescence attachment to main stem	Erect, semi-erect, horizontal	
	22. Attitude of flower stalk	Horizontal,	
	23. Number of petals	4	
	24. Number of sepals	4	
	25. Number of anthers	6	
	26. Sepal colour when young	Yellow green	
	27. Sepal colour when mature/old	Gold	
Anthocyanin	**28. Anthocyanin on inflorescence**	Weak	
	29. Anthocyanin on midrib	Weak	
Glaucosis/waxiness	**30. Inflorescence**	Weak	
	31. Stem	Medium	
	32. Flower stalk	Weak	
Pod	**33. Length**		
	34. Pod stalk length		
	35. Pod stalk attitude	Semi-erect	
	36. Pod attitude/oriatation (excluding stalk	Vertical/upright	
More characters			

Leaf blade curvature:



Weak **Medium** **Strong**

PART 10: THE NETSCAPE "NAMED" COLOUR PALETTE

aliceblue #F0F8FF R: 240 G: 248 B: 255	aqua #00FFFF R: 000 G: 255 B: 255	antiquewhite #FAEBD7 R: 250 G: 235 B: 215	aquamarine #7FFFD4 R: 127 G: 255 B: 212
[redacted]	beige #F5F5DC R: 245 G: 245 B: 220	bisque #FFE4C4 R: 255 G: 228 B: 196	black #000000 R: 000 G: 000 B: 000
blanchedalmond #FFEBCD R: 255 G: 235 B: 205	blue #0000FF R: 000 G: 000 B: 255	blueviolet #8A2BE2 R: 138 G: 043 B: 226	brown #A52A2A R: 165 G: 042 B: 042
burlywood #DEB887 R: 222 G: 184 B: 135	cadetblue #5F9EA0 R: 095 G: 158 B: 160	chartreuse #7FFF00 R: 127 G: 255 B: 000	chocolate #D2691E R: 210 G: 105 B: 030
coral #FF7F50 R: 255 G: 127 B: 080	cornflowerblue #6495ED R: 100 G: 149 B: 237	cornsilk #FFF8DC R: 255 G: 248 B: 220	crimson #DC143C R: 220 G: 020 B: 060
cyan #00FFFF R: 000 G: 255 B: 255	darkblue #00008B R: 000 G: 000 B: 139	darkcyan #008B8B R: 000 G: 139 B: 139	darkgoldenrod #B8860B R: 184 G: 134 B: 011
darkgray #A9A9A9 R: 169 G: 169 B: 169	darkgreen #006400 R: 000 G: 100 B: 000	darkkhaki #BDB76B R: 189 G: 183 B: 107	darkmagenta #8B008B R: 139 G: 000 B: 139
darkolivegreen	darkorange	darkorchid	darkred

#556B2F R: 085 G: 107 B: 047	#FF8C00 R: 255 G: 140 B: 000	#9932CC R: 153 G: 050 B: 204	#8B0000 R: 139 G: 000 B: 000
darksalmon #E9967A R: 233 G: 150 B: 122	darkseagreen #8FBC8F R: 143 G: 188 B: 143	darkslateblue #483D8B R: 072 G: 061 B: 139	darkslategray #2F4F4F R: 047 G: 079 B: 079
darkturquoise #00CED1 R: 000 G: 206 B: 209	darkviolet #9400D3 R: 148 G: 000 B: 211	deeppink #FF1493 R: 255 G: 020 B: 147	deepskyblue #00BFBF R: 000 G: 191 B: 191
dimgray #696969 R: 105 G: 105 B: 105	dodgerblue #1E90FF R: 030 G: 144 B: 255	firebrick #B22222 R: 178 G: 034 B: 034	floralwhite #FFFAF0 R: 255 G: 250 B: 240
forestgreen #228B22 R: 034 G: 139 B: 034	fuchsia #FF00FF R: 255 G: 000 B: 255	ghostwhite #F8F8FF R: 248 G: 248 B: 255	gainsboro #DCDCDC R: 220 G: 220 B: 220
gold #FFD700 R: 255 G: 215 B: 000	goldenrod #DAA520 R: 218 G: 165 B: 032	gray #808080 R: 128 G: 128 B: 128	green #008000 R: 000 G: 128 B: 000
greenyellow #ADFF2F R: 173 G: 255 B: 047	honeydew #F0FFF0 R: 240 G: 255 B: 240	hotpink #FF69B4 R: 255 G: 105 B: 180	indianred #CD5C5C R: 205 G: 092 B: 092
indigo #4B0082 R: 075 G: 000 B: 130	ivory #FFFFF0 R: 255 G: 255 B: 240	khaki #F0E68C R: 240 G: 230 B: 140	lavender #E6E6FA R: 230 G: 230 B: 250
lavenderblush #FFF0F5 R: 255	lawngreen #7CFC00 R: 124	lemonchiffon #FFFACD R: 255	lightblue #ADD8E6 R: 173

G: 240 B: 245	G: 252 B: 000	G: 250 B: 205	G: 216 B: 230
lightcoral #F08080 R: 240 G: 128 B: 128	lightcyan #E0FFFF R: 255 G: 255 B: 224	lightgoldenrodyellow #FAFAD2 R: 250 G: 250 B: 210	lightgreen #90EE90 R: 144 G: 238 B: 144
lightgrey #D3D3D3 R: 211 G: 211 B: 211	lightpink #FFB6C1 R: 255 G: 182 B: 193	lightsalmon #FFA07A R: 255 G: 160 B: 122	lightseagreen #20B2AA R: 032 G: 178 B: 170
lightskyblue #87CEFA R: 135 G: 206 B: 250	lightslategray #778899 R: 119 G: 136 B: 153	lightsteelblue #B0C4DE R: 176 G: 196 B: 222	lightyellow #FFFFB0 R: 255 G: 255 B: 176
lime #00FF00 R: 000 G: 255 B: 000	limegreen #32CD32 R: 050 G: 205 B: 050	linen #FAF0E6 R: 250 G: 240 B: 230	magenta #FF00FF R: 255 G: 000 B: 255
maroon #800000 R: 128 G: 000 B: 000	mediumaquamarine #66CDAA R: 102 G: 205 B: 170	mediumblue #0000CD R: 000 G: 000 B: 205	mediumorchid #BA55D3 R: 186 G: 085 B: 211
mediumpurple #9370DB R: 147 G: 112 B: 219	mediumseagreen #3CB371 R: 060 G: 179 B: 113	mediumslateblue #7B68EE R: 123 G: 104 B: 238	mediumspringgreen #00FA9A R: 000 G: 250 B: 154
mediumturquoise #48D1CC R: 072 G: 209 B: 204	mediumvioletred #C71585 R: 199 G: 021 B: 133	midnightblue #191970 R: 025 G: 025 B: 112	mintcream #F5FFFA R: 245 G: 255 B: 250
mistyrose #FFE4E1 R: 255 G: 228 B: 225	moccasin #FFE4B5 R: 255 G: 228 B: 181	navajowhite #FFDEAD R: 255 G: 222 B: 173	navy #000080 R: 000 G: 000 B: 128

oldlace #FDF5E6 R: 253 G: 245 B: 230	olive #808000 R: 128 G: 128 B: 000	olivedrab #6B8E23 R: 107 G: 142 B: 035	orange #FFA500 R: 255 G: 165 B: 000
orangered #FF4500 R: 255 G: 069 B: 000	orchid #DA70D6 R: 218 G: 112 B: 214	palegoldenrod #EEE8AA R: 238 G: 232 B: 170	palegreen #98FB98 R: 152 G: 251 B: 152
paleturquoise #AFEEEE R: 175 G: 238 B: 238	palevioletred #DB7093 R: 219 G: 112 B: 147	papayawhip #FFEFD5 R: 255 G: 239 B: 213	peachpuff #FFDAB9 R: 255 G: 218 B: 185
peru #CD853F R: 205 G: 133 B: 063	pink #FFC0CB R: 255 G: 192 B: 203	plum #DDA0DD R: 221 G: 160 B: 221	powderblue #B0E0E6 R: 176 G: 224 B: 230
purple #800080 R: 128 G: 000 B: 128	red #FF0000 R: 255 G: 000 B: 000	rosybrown #BC8F8F R: 188 G: 143 B: 143	royalblue #4169E1 R: 065 G: 105 B: 225
saddlebrown #8B4513 R: 139 G: 069 B: 019	salmon #FA8072 R: 250 G: 128 B: 114	sandybrown #F4A460 R: 244 G: 164 B: 096	seagreen #2E8B57 R: 046 G: 139 B: 087
seashell #FFF5EE R: 255 G: 245 B: 238	sienna #A0522D R: 160 G: 082 B: 045	silver #C0C0C0 R: 192 G: 192 B: 192	skyblue #87CEEB R: 135 G: 206 B: 235
slateblue #6A5ACD R: 106 G: 090 B: 205	slategray #708090 R: 112 G: 128 B: 144	snow #FFFEE1 R: 255 G: 254 B: 225	springgreen #00FF7F R: 000 G: 255 B: 127
steelblue #4682B4	tan #D2B48C	teal #008080	thistle #D8BFD8

R: 070 G: 130 B: 180	R: 210 G: 130 B: 140	R: 000 G: 128 B: 128	R: 216 G: 191 B: 216
tomato #FF6347 R: 255 G: 099 B: 071	turquoise #40E0D0 R: 064 G: 224 B: 208	violet #EE82EE R: 238 G: 130 B: 238	wheat #F5DEB3 R: 245 G: 222 B: 179
white #FFFFFF R: 255 G: 255 B: 255	whitesmoke #F5F5F5 R: 245 G: 245 B: 245	yellow #FFFF00 R: 255 G: 255 B: 000	yellowgreen #9ACD32 R: 154 G: 205 B: 050

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PART 11: SELECTION OF CONTACT FARMERS FOR ON-FARM TRIALS

MEETING WITH KINALE FARMERS - 17.02.04

1. Joseph Macharia
2. Simon Kuria Ngure
3. John Githaiga
4. Patrick Mburu
5. Francis Ndungu
6. Mary Wanjiku
7. Lucy Wangui
8. French Wangechi
9. Esther Wambui
10. Hannah Wangari
11. Rev. Samuel N. Njoroge
12. Paul N. Gikuri
13. Daniel Mwangi

LIST OF ATTENDANCE GITITHIA MEETING OF 18.02.04 (AFTERNOON)

MEN = 11, WOMEN = 10

1. MICHAEL MBURU RARIUKI
2. JOSEPH KARARI
3. JAMES KIGERA
4. PATRICK KINYANJUI
5. PETER KANG'ETHE
6. RUTH NJAMBI
7. GRACE WAIRIMU
8. MARTHA NJERI
9. MARY NYAMBURA
10. ELEZABETH WAITHIRA
11. LEAH NYARUIRU NJOROGE
12. SALOME WANGECHI MBURU
13. MINEH WANJIRU
14. RUTH MUHAKI NGURE
15. TABITHA MUMBI MBUTHIA
16. PETER GAKUHA
17. SHEM GITHINJI
18. JAMES NJENGA
19. SAMUEL KAMAU
20. ISAAC NJOROGE
21. KAMAU NDEGWA

GITITHIA FORUM - For provision of planting plot the following were proposed:

1.	Joseph Rarari	--- 0	vote
2.	Tabitha Mumbi	-- 16	vote
3.	Elizabeth Waithira	-- 0	vote

Mrs Tabitha Mumbi was selected for this purpose.
She is the wife to JOHN MBUTHIA

CARBACID (BATHI) MEETING OF 18.02.04 -LIST OF ATTENDANCE

Farmers Name

1. ELIZABETH WANJIRU
2. BEATRICE NJAMBI
3. NAHASON MBUKI
4. MUHIA NJOROGE
5. SAMWEL NGUGI KURIA
6. SAMWEL NDERI KIMUCHU
7. JOHN KAMAU KARANJA
8. JAMES NDUNGU
9. SAMWEL NJOROGE NJUGUNA
10. GEORGE KARIUKI
11. NJOROGE MUHIA
12. PETER MUIRURI MUNYUA
13. JAMES NG'ETHE MUNGURIU
14. JAMES MIRINGU

Proposed for provision of planting plots:

1. Ndungu Mwangi
2. Muhia Njoroge Peter
3. Johana Mangorio

ELECTED: PETER MUHIA NJOROGE

ATTENDANCE IN KINALE (TRANSPLANTING DAY) 26/03/04

1. Rev. Ndirangu Njoroge
2. Francis N Waweru
3. Joseph K Mwangi
4. Rev Wilson Mwangi Thuo
5. John Njoroge Ndirangu
6. Bernard Kariuki Mwaura
7. Lucy Wangui Ndirangu
8. Furesia Wacheke
9. Tracia Wamatha
10. Peter Kimani Thuo
11. Jane Waithera Ndungu
12. Joseph Macharia Gitau

Spraying done on 26/3/04 against cutworms
Next spraying to be done after 14 days.

PART 12: DATA COLLECTION GUIDE FOR COST BENEFIT ANALYSES

Project: Promotion of Quality Vegetable Seed in Kenya (P1413)

<u>IDENTIFICATION OF A SUITABLE MODEL FOR KALE SEED MULTIPLICATION</u> (ACTIVITY 3.3)

This requires a comparison of kale production for seed with kale production for leaf; using cost benefit analysis. The effect of leaf harvesting on the quality and quantity of seed produced will be investigated. A split plot design having three treatments will be used. Our goal is to systematically compare and analyze farmers' perceptions of the three technological options. An assessment of the relative importance of key characteristics and the extent to which each of the technologies provides the requisite characteristics will be done.

The three treatments being evaluated in this regard are:

1. Full harvesting (for about 16 weeks)
2. Harvesting for half the way (8 weeks only)
3. No leaf harvesting

The requisite data for the identification will include the following: input requirements, costs, labour demands, productivity (yield), weeding regime, income, seed cost, value of seed, consumers' (buyers') preference, shelf life, size of leaves, price of leaves and seeds per unit, quantity of seeds and leaves, leaf colour, seed colour, seed size and willingness to wait for seed production.

Data collection Guide

Input/Cost Collection Sheet (for all treatments)

Input	Quantity (Kg or man hours)	Unit Price	Total Cost
Labour: land preparation			
Sowing			
Transplanting			
Weeding			
Pesticide application			
Harvesting			
Water collection			
Seeds			
Fertilizer			
Pesticides			

Output of leaves for treatment B (8 weeks harvesting)
(Harvesting will be done after every fortnight)

Characteristics	First Harvest	Second Harvest	Third Harvest	Fourth Harvest
Yield (quantity) (Kg)				
Price per unit				
Value of leaves				
Shelf life				
Leaf size				
Leaf colour				
Buyers(s)' preference				
Farmer perception of quality				
Other perceptions				

Output of leaves for treatment C (16 weeks harvesting)
(Harvesting will be done after every fortnight)

Charact-eristics	First Harvest	Second Harvest	Third Harvest	Fourth Harvest	Fifth Harvest	Sixth Harvest	Seventh Harvest	Eighth Harvest
Yield (quantity) (Kg)								
Price per unit								
Value of leaves								
Shelf life								
Leaf size								
Leaf colour								
Buyers(s)' preference								
Farmer perception of quality								
Other perceptions								

Key: leaf/seed size – small, medium, large
Buyer's preference – high, medium, low
Farmer perception – very good, good, bad
Other perceptions (specify) -------------------

Output of seeds for all treatments (A, B, C)

Characteristics	**Treatment A**		**Treatment B**		**Treatment C**	
	First Harvest	Second Harvest	First Harvest	Second Harvest	First Harvest	Second Harvest
Yield (quantity) (Kg)						
Price per unit						
Value of seeds						
Shelf life						
Seed size						
Seed colour						
Buyers(s)' preference						
Farmer perception of quality						
Other perceptions						

Overall technology evaluation (for all treatments)

Technology (Treatment)	Input required	Extra Input	Output Obtained	Extra Output	Surplus after paying for inputs
A					
B					
C					

Farmers' willingness to wait for seed production:
1. willing ----------------------
2. Not willing ----------------------
3. Undecided ----------------------

Appendix II

LIST OF DISSEMINATIONS:

- PART 1. Publications

- PART 2. Internal Reports
  Back to Office Reports
  Project Progress Reports
  Annual Reports

- PART 3. Other Dissemination of Results
  PRA Reports
  Forms/questionnaires
  Fact sheets
  Presentations
  Other

- PART 4. Key datasets generated

APPENDIX II

PART 1. Publications:

Anon (2003) Virus in the veggies - a short summary of results of the "Vegetable Virus Project". CABI in Africa issue 2003, page 5.

Onim, M (2004) Seed market development for rural farmers. *Proceedings of the US-Africa Agribusiness Conference, November 7-10, 2004, Marriott Conference Center, Monterey, California, USA.*

N. A. Phiri, N. Spence, S. Hughes, A. Mwaniki, S. Simons, G. Oduor, D. Chacha, A. Kuria, S. Ndirangu, S. (2004) Identification of beet mosaic virus (BtMV), and its effect on the yield of Swiss chard in Kenya. *Proceedings of the 9th Biennial Scientific Conference and Agricultural Research Forum 9-12 Nov. 2004, KARI Kenya.*

Anon (2004) Cleaning up the seedy business - a short summary of the current "Promotion of Quality Vegetable Seed Project". CABI in Africa issue 2004, page 2.

Phiri, NA, Hughes, SL, Njuki, J. Mwaniki, A. Simons, S, Oduor, G, Chacha, D, Kuria, A, Ndirangu, S. & Spence, NJ (2005). Identification of *Beet mosaic virus* (BtMV), and its effect on the yield of Swiss chard in Kenya. *In preparation for submission to Plant Pathology.*

Phiri, NA, Hughes, SL, Njuki, J, Mwaniki, A. Simons, S, Oduor, G, Chacha, D, Kuria, A, Ndirangu, S. & Spence, NJ (2005). Characterisation of *Turnip mosaic virus* (TuMV) and *Cauliflower mosaic virus* (CaMV) isolates from Kenya and their economic impact on cabbage and kale production. *In preparation for submission to Plant Pathology*.

Spence, N. J., Lenne, J.M., Pink, D.A.C., Njuki, J., Wanyonyi C. & Kimani, P.M. (2005). Opportunities and constraints for future economic development of sustainable vegetable seed business in Eastern and Southern Africa. *Abstract. International Conference on Agricultural Research for Development: European Responses to Changing Global Needs*. 27th-29th April 2005. Swiss Federal Institute of Technology Zurich. Switzerland. p121.

PART 2. Internal Reports:

Technical Reports

Anon (2003) Kinale kale plants: description of plant characteristics.

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