

Seed-Production Mechanisms

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of a workshop
held in Singapore,
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Edited by
Neil Thomas and Nicolas Mateo

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SEED PRODUCTION AND DISTRIBUTION MECHANISMS

Case study of pigeonpea in Kenya

P.M. Kamani¹ and O.L.E. Mbatia²

¹Department of Crop Science and ²Agricultural Economics
University of Nairobi
P.O. Box 29053 Nairobi, Kenya

ABSTRACT

Five hundred pigeonpea farmers in Machakos, Embu and Kitui districts were interviewed in September and October, 1989 to determine the adoption of the improved early maturing pigeonpeas, the area planted, and to evaluate the alternative seed production and distribution mechanisms used by small scale farmers. Seventy five, 36.6 and 72.6 percent of the farmers in Machakos, Kitui and Embu, respectively were growing the improved short duration pigeonpea cultivar, NPP 670. About 51 percent of farmers first heard about the new cultivars through agricultural extension officers, 22.9 percent from their neighbours, 8.1% saw them on neighbours field, 3.6% in farmers training centres and 0.4% through radio broadcast. Seventy nine percent of the farmers practised intercropping. Average cropped land was 0.63 hectares. Maize occupied 20.7 percent of the cropped area, pigeonpea 19.6 percent, beans 18.7 percent and cowpeas 14.5 percent. Forty percent of the farmers first obtained seeds of improved pigeonpeas from agricultural officers, 31 percent from neighbours, 11 percent direct from pigeonpea project, 9.4 percent from local shops and 6.7 percent from local markets. In 1989, 37.3 percent of farmers planted their own seed, 12.5, 6.6 and 1.7 percent bought seeds from agricultural officers, neighbours and local markets, respectively. Pigeonpea seeds are produced by small scale farmers on contract, pilot seed multiplication project, Machakos Integrated Development Project (MIDP), pigeonpea project and to a lesser extent women groups. Farmers indicated that pests were the main constraint in growing pigeonpeas. Most farmers obtained as much seed as they required. Local seed companies do not multiply pigeonpea seed due to fluctuations in demand for seed. It is suggested that the Ministry of Agriculture contract seed companies and farmers to produce and distribute pigeonpea seeds. Organised marketing of pigeonpeas is required.

INTRODUCTION

Pigeonpea (*Cajanus cajan* (L.) Millsp) is one of the most important legume crops in Kenya because it is drought tolerant and is a multi-purpose crop. Its seeds are a major source of protein (17-28%) for resource-poor families, stems are used as fencing material and fuelwood, leaves, pods and damaged seeds as animal feed (Kimani, 1985). It is grown in semi-arid areas which have unreliable rainfall of less than 800 mm annually. The major growing areas in Kenya are in the Eastern region comprising Machakos, Kitui and Embu districts, and to a lesser extent in Central, Rift Valley and Coast Provinces. It is however found in retail markets and shops throughout the country. An estimated 115,000 hectares are under pigeonpea in Kenya. Kenya is the world's second largest producer of pigeonpea after India (Onim, 1981).

The yield of pigeonpea is low in Eastern Africa averaging 450 to 670 kg ha⁻¹. Research workers have projected that yield could be improved up to 1120 kg ha⁻¹. It has been shown that under research conditions, a yield of between 2637 to 4250 kg ha⁻¹ can be realized (Onim, 1983; Kimani, 1988). In Australia, yields as high as 7500 kg ha⁻¹ have been recorded under research conditions (Akinola and Whiteman, 1972).

The factors contributing to low yield in Kenya are inferior varieties, diseases and pests, moisture stress and drought, poor soil fertility and poor crop husbandry practices (Kimani, 1987). The socio-economic factors are poor prices, poor marketing and infrastructure (Mbatia and Kimani, 1987).

Research aimed at improving the production of pigeonpea started in 1976 at the Department of Crop Science, University of Nairobi, Kenya, partly as a consequence of some earlier work at Makerere University, Uganda. (The pigeonpea research at the University of Uganda was fully funded by the International Development Research Centre (IDRC), Ottawa, Canada.) The major objectives of the pigeonpea project are to :

- i) Develop new cultivars of pigeonpea that are high yielding and with acceptable pod and seed characteristics.
- ii) Develop cultivars that have resistance to Fusarium wilt, the most important pigeonpea disease in Kenya.
- iii) Develop suitable agronomic practices for the new cultivars.
- iv) Initiate a seed multiplication and distribution scheme. The project also has a training component for graduate students in agronomy, plant breeding and plant pathology.

Most of the above objectives have already been achieved. Through crossing and selection, the researchers have developed and released cultivar NPP 670 which matures in four and a half to five months compared to traditional pigeonpeas which mature between 10 and 12 months (Kimani, 1987). NPP 670 has a high yielding potential and two crops are harvested before traditional pigeonpeas mature. It is moderately resistant to Fusarium wilt. Other cultivars already developed include Kitui 1, NPP 673/3, Kioko and Munaa. The latter take 6 to 7 months to mature and have excellent seed characteristics and yield potential. Major evaluation of these cultivars started in 1983. Between 1983-89, 40 on station trials and over 140 farm trials were conducted. Average yields of the former reached 2400 kg ha⁻¹, compared with 1500 kg ha⁻¹ on farm.

Although resistance to Fusarium wilt has been found and incorporated into a new generation of early maturing cultivars, insect pests remain a major obstacle to higher productivity of pigeonpeas in farmers fields (Kimani, 1989, 1988, 1987; Okiror, 1986). Research work on control of pigeonpea pests is still going on. Mbatia and Kimani (1987) carried out a social-economic survey of pigeonpea farmers in Machakos, Embu and Kitui districts. A sample of 1500 farmers were interviewed. The study showed that the major problem farmers encountered with these new varieties were insect damage on pods and seeds and diseases to a lesser extent. Farmers liked the improved varieties because of their early maturity and high yields.

SEED MULTIPLICATION AND DISTRIBUTION

In Kenya, seed multiplication and distribution is primarily conducted through the private sector. The main seed companies include Kenya Seed Company which handles the largest volume of seed trade. It multiplies and distributes seeds of cereals such as maize, wheat, barley as well as vegetable seed (tomatoes, carrots, beans) and pasture seed. It has its main offices in Kitale, Rift Valley provinces with branches in Nairobi and other urban areas. The East African Seed Company located in Nairobi multiplies and distributes vegetable seeds, fertilizers and crop protection chemicals. Oil Seeds Development Company, a subsidiary of East Africa Industries mainly handles oil seeds especially sunflower and rape seed in collaboration with Kenya Seed Company. Also there are other small companies in seed trade. The large companies contract large-scale well-established farmers to multiply seed and offer premium prices for seed crop compared to the general commercial crop. Seed certification and quality control is carried out by the National Seed Quality Control Service (NCQS) based in Lanet, Nakuru district in collaboration with seed companies. NCQS performs crop inspection and issues certificates for quality seed in conformity with international seed regulation.

In Kenya new crop cultivars are mainly developed by breeders in the public sector, although the private companies maintain research departments which include breeders. Promising crop cultivars are usually entered in the national performance trials (NPT) for three years and the best performers are recommended for release through the National Variety Release Committee (NVRC) which draws its membership from government ministries, public institutions and private companies. After multiplication, sorting, packaging, seeds of new varieties are distributed through a network of co-operative stores, private shops and quasi-government farm input stores such as the Kenya Grain Growers Co-operative Union (KGGCU) throughout the country.

The University of Nairobi had originally intended to turn over the seed of the new pigeonpea cultivars to the private sector, but the latter is more interested in more lucrative crops such as maize, wheat, barley, vegetable crop and pasture seeds. Companies found through study that demand for crops grown under semi-arid conditions, such as pigeonpeas, green grams and cowpeas, is very unstable. Since most of these are composites or open or self-pollinated cultivars, farmers produce their own seed and would only buy seed if previous year was dry. Demand was not firm.

Mechanisms of Seed Multiplication and Distribution

The pigeonpea project has pursued five multiplication mechanisms:

1. Directly by the project

Multiplication was started in 1983, land being leased in Machakos district. The project carried out land preparation, sowing, weeding, pest control, irrigation, harvesting, drying, sorting, and packaging of the seeds.

2. Machakos Integrated Development Project (MIDP)

MIDP is a rural development project funded by the European Economic Community (EEC) and the Kenya Government, and located in Machakos town. Among its objectives is to provide farm inputs and technologies to small scale-farmers in Machakos district. The University provided

foundation seed and field inspection of seed crops, while MIDP did all the remaining production, packaging and distribution of seed packets.

3. Small-scale farmers contracts

The project chose farmers who had already grown improved pigeonpeas for at least one season. Technical assistance and chemicals were provided since most of these farmers are very poor and cannot provide any funds. Farmers provided all the labour. Farms were visited three times during the cropping season for roguing. Even in the predominantly self-pollinated pigeonpeas, there is a large amount of outcrossing (Onim, 1981; Kimani 1987; Githiri and Kimani, 1988). Farmers were paid on spot at harvest (1988, Kshs 7.00 kg⁻¹; 1989, Kshs 8.00-9.00 kg⁻¹). However, market prices rose to Kshs 12.00 kg⁻¹ in 1988, and farmers demanded the project increase the price it paid.

4. District based pilot schemes

In order to ensure that adequate seed was produced close to the demand areas, pilot seed schemes were initiated with the support of the district agricultural officer. These were generally felt to be the basis of a self-sustaining system. Seed is multiplied in farmers training centres (FTC) and farmer's fields and purchased by the district agricultural offices, sorted, treated, packed and resold to farmers. It was initiated in 1984 in Kitui district with an initial sample of 20 kg of foundation seed and had increased to 6 t in 1988/89. The project provided foundation seed for multiplication which is renewed after every three years.

5. Women's groups

The project started working with women's groups in 1988/89 cropping year. Multiplication of pigeonpea seed by women's groups was co-ordinated through the women's bureau, Ministry of Culture and Social Services. In this arrangement the groups were to lease land, preparation, sowing, weeding, roguing (with project staff), harvesting and sorting. The project would provide seeds, chemicals and spraying instructions, inspection, purchase of seed, packaging and distribution.

In addition, the East African Seed Company was multiplying seed in Meru district. The company carried out all the operations including packaging, labelling and distribution of seed.

Improved pigeonpea seed is disseminated through :

1. Direct sales from the project - at Kshs 17.00 per kg. Seeds are sold either at project headquarters at Kabete, or through substations at Makueni, Machakos, Embu, Kitui.
2. Agricultural extension offices - at district, division or location levels.
3. Co-operative union stores in target areas.
4. Open air markets and shops. Seed mainly originates from farmers fields.
5. Farmer to farmer.

6. Private companies especially East African Seed Company. Their operations are mainly limited to Nairobi and Meru.

The distribution of seed through these channels is mainly by informal contracts. The recommended base price is Kshs 8.50 per a 500g polythene bag in which seeds are normally packed. However, prices at sale points vary between Kshs 8.50 to Kshs 15.00.

OBJECTIVES OF THE STUDY

The general purpose of this study, was to generate and disseminate information leading to the strengthening of systems for the production and dissemination of improved pigeonpea seeds. The specific objectives were :

1. To estimate the amount of improved pigeonpea seeds distributed, the number of growers using improved seeds and the area planted by the small scale farmers.
2. To describe and evaluate the alternative seed production and distribution mechanisms being used by small scale farmers.
3. To make policy recommendation on improved pigeonpea seed production and distribution mechanisms.
4. To make the results and conclusions of the study widely known.

METHODOLOGY

Sampling technique

The researchers visited the district agricultural officers (D.A.O's) at Machakos, Embu and Kitui to establish a working relationship and explain the purpose of the survey. The D.A.O's assured the investigators that they would inform all the field officers and request them to support the investigators and recruit the enumerators. It was agreed that the study was timely in that information would be gained on how farmers acquired improved pigeonpea seeds and on help they required in seed multiplication and distribution.

Questionnaire

The questionnaire was prepared in consultation with extension workers in the field, agricultural officers and social scientists. The questionnaire was structured and had 77 primary questions. The questions were mainly on improved pigeonpeas. The major variables in the questionnaire were those related to seed production and distribution mechanisms. The variables included labour inputs, area planted, sources of improved seeds, price paid on seeds, yields, methods of harvesting, marketing channels, and other related variables.

Enumerators

The enumerators were recruited and hired from each area where the study was to be conducted. Equal numbers of male and female enumerators were selected. They were conversant with the area and spoke the local language. They were trained for a total of 8 hours. Many of the enumerators had done similar work

elsewhere. All the variables in the questionnaire were translated to local vernacular. At the end of the training each enumerator was given 5 questionnaires to practise with. The researchers went through completed questionnaires with enumerators to discuss any problems which they might have encountered. A final questionnaire was drawn after pre-testing.

A total of 500 farmers was planned for interview. This included a random sample of 200 from Machakos, and 150 each from Embu and Kitui districts. In each district the area with a high concentration of farmers growing improved pigeonpeas was selected as a research area. In Machakos district, Masii and Makueni divisions were selected. It should be noted that on-farm testing of improved pigeonpea started in Makueni area and has the highest number of farmers growing the improved pigeonpeas. In Embu district, Karaba and Gachoka locations were selected. The two areas have been used for seed multiplication. Kitui Central and Mwingi divisions, in Kitui district were selected because of high concentration of farmers growing both traditional and improved pigeonpea.

The random sample of farmers to be interviewed was drawn from a list of farmers growing pigeonpeas in targeted areas. The list was provided by extension officers working in that area. The list was drawn at random. Each enumerator was given a list of farmers to be interviewed. The enumerator was assigned to interview two farmers per day. In case the farmer was not at home or unavailable for interview, a new farmer was substituted or interviewing time rescheduled.

The final interview included 472 farmers. Of these 212 were from Machakos district, 135 from Embu and 125 farmers from Kitui district. The whole interviewing exercise went on smoothly due to the good cooperation of the farmers and extension workers.

RESULTS OF EMPIRICAL ANALYSIS

The socio-economic aspects

In all three districts, 54 percent of the 472 farmers interviewed were males and 46 percent were females. During the interviewing it was found that where both husband and wife were present they consulted each other in answering the questions.

Household composition

The information on household was gathered according to age, family size, number of children going to school and employment. The average ages in Machakos, Kitui and Embu were 49, 45 and 45 years respectively. Average age in all three districts was 47 years. The family size in the three districts was eight persons per household with an average of four children going to school. Some of the children lived at home with their parents but 50 percent of the parents stated that their children either were working elsewhere or going to school away from home.

Farm labour

The small scale farmers mainly use family labour and hired labour during planting, weeding, harvesting and land preparation. About 58 percent of the farmers indicated that they hired some labour for farm work and 42 percent did

not hire since the family labour was sufficient or could not afford to hire. The majority of farmers hired labour on a part-time basis. Thirteen percent of farmers hired one worker on full time and 7.4 percent hired two workers on full-time basis.

Table 1 shows that an average of two workers were hired for land preparation, 2.3 for planting, and 4 workers for weeding. Weeding required more workers than any other activity. Some farmers hired workers during harvesting time. The farmers also indicated that they also kept some livestock.

Table 1: Hired farm-labour activities, 1989.
Units: percentage of surveyed farmers

Activity	Machakos	District Kitui	Embu	Mean
Land preparation	31.2	39.2	23.7	31.1
Planting	21.7	34.4	44.4	32.6
Weeding	23.6	43.2	52.6	37.1
Domestic (household)	14.2	14.4	5.2	11.7
Looking after animals	17.5	22.4	19.3	19.2
Other work	3.3	0.8	3.0	2.5

On average they kept 7 head of cattle, 10 goats, 5 sheep and 21 chicken. It could be inferred that farmers kept livestock for selling to earn income and perhaps for manure.

Land

The four major factors of production are land, labour, capital and management. Although all of these are important in production, land is perhaps the most vital for the farmer. In the three districts, the estimated land per farmer was 7.5 ha. Of this, 3.1 ha were under cultivation. The rest was used for grazing, source of woodfuel or bush. In many cases in the semi-arid area, the land has yet to be surveyed and consolidated. The average land under cultivation and owned by the farmer should be regarded as estimates since no measurements were taken by enumerators.

Education

Nearly 70 percent of the farmers had gone to school or attended some educational training. About 62 percent had a primary school or secondary school education.

Decision making on the farm

In many cases it has been assumed that decisions on cash crops to be grown are made by men whereas that on food crops for domestic consumption is made by women. Table 2 shows that 56.3 percent of the farmers indicated that both husband and wife make decisions regarding crops to be grown.

Table 2. Who made decision on what crops to be grown in 1989 cropping season

Decision maker	Machakos	District Kitui %	Embu	All
Wife	34.8	11.3	10.5	22.1
Husband	23.8	26.6	15.0	21.6
Both	41.4	62.1	74.0	56.3

CROPPING SYSTEMS

The cropping system normally practised by small scale farmers is mainly intercropping. Mbatia and Kimani (1987) found that 81.4, 83.3 and 73 percent of farmers in Machakos, Embu and Kitui respectively practised intercropping. They intercrop maize, beans and pigeonpea. During the 1988/89 season. The estimated average area under crops was 0.65 ha. In Machakos, farmers had a bigger area of 0.85 ha under crops, followed by Kitui with 0.5 ha and Embu with 0.44 ha.

Table 3 shows the average crop area for various crops grown in the three districts. Maize had the highest crop area followed by cotton.

Table 3: Area in hectares under various crops in farmers fields in Machakos, Kitui and Embu districts in 1988/89.

Crop	Machakos	Kitui	Embu	Mean
Maize	1.30 (21.0)*	0.66 (20.6)	0.73 (20.4)	0.90 (20.7)
Beans	0.70 (19.5)	0.55 (18.7)	0.44 (17.5)	0.56 (18.7)
Pigeonpeas	1.01 (20.4)	0.60 (19.4)	0.30 (18.8)	0.64 (19.6)
Cowpeas	0.52 (15.3)	0.38 (16.9)	0.31 (11.3)	0.40 (14.5)
Cassava	0.35 (3.1)	0.24 (4.4)	0.21 (0.8)	0.27 (2.8)
Cotton	1.06 (6.0)	0.54 (0.5)	0.72 (8.8)	0.77 (5.4)
Millet(Finger)	0.44 (5.7)	0.39 (7.3)	0.29 (5.8)	0.37 (6.1)
Sorghum	0.41 (5.1)	0.44 (7.0)	0.19 (3.2)	0.35 (5.0)
Fruits	0.61 (1.4)	0.14 (0.9)	0.22 (0.5)	0.32 (1.0)
Bananas	0.13 (0.5)	0.13 (1.2)	0.17 (2.1)	0.14 (1.2)
Green grams	0.46 (1.1)	0.34 (1.7)	0.37 (5.5)	0.39 (2.5)
Coffee	0.81 (0.2)	0.20 (0.2)	0.20 (0.2)	0.40 (0.2)
Potatoes	0.25 (0.6)	0.18 (0.7)	0.18 (1.1)	0.20 (0.8)
Sunflower	0.40 (0.1)	-	0.51 (0.8)	0.13 (0.3)
Wheat	0.10 (0.1)	-	-	0.17 (0)
Vegetables	0.05 (0.1)	0.04 (0.3)	0.40 (0.2)	0.16 (0.2)
Dolichos	-	-	0.38 (3.0)	0.13 (0.9)
Tobacco	-	0.40 (0.2)	-	0.13
Mean (ha)	0.83	0.50	0.45	0.63

*proportion by percentage in parenthesis.

The area under pigeonpea was 1.0, 0.6 and 0.3 ha in Machakos, Kitui and Embu, respectively. Maize occupied 20.7 percent of cropped area, pigeonpea 19.6 percent, beans 18.7 percent and cowpeas 14.5 percent. No other crop occupied more than 10 percent of area under crops.

Table 3 indicates that the major crops in the three districts are maize, cotton, pigeonpeas, beans, coffee, sunflower and fruits. Although cowpeas are considered drought tolerant they are grown on a smaller area and possibly by few farmers. Finger millet and sorghum are important in Kitui. In this district, the area under finger millet was 7.3 percent whereas 7.0 percent was under sorghum. In Machakos, 5.7 percent is under finger millet and 5.1 percent under sorghum. Due to frequent droughts, few farmers grow vegetables and fruit. Dolichos are popular in Embu.

PIGEONPEA FARMING

Mbatia and Kimani (1987) found that 86, 92 and 91 percent of farmers in Machakos, Embu and Kitui districts, respectively, have heard and grown improved pigeonpea. The majority of farmers interviewed stated that they grew improved pigeonpea every year. Only 7 percent of farmers interviewed did not grow improved pigeonpea yearly.

Time of planting

The breeding program of pigeonpeas in Kenya started in 1976/77. The objective was to improve existing traditional pigeonpeas that farmers have been growing for years. The time of planting is one of the key determinants of yield. Since the rainy season is short in semi-arid areas and moisture is often limiting during the season, timely planting is crucial for good yields. However, early planted short duration pigeonpeas often suffer severe insect damage. Late planting often gives poor yields. The recommended time of planting is late September and the whole month of October, i.e. short rain season. The highest percentage (70%) of farmers indicated that they planted their seeds at this time. However, some farmers also plant during the long rain season in March and April.

Types and sources of pigeonpea planted

The farmers indicated that they planted either Katumani or NPP 670 seeds and traditional pigeonpea. The NPP 670 is commonly known by farmers as Katumani because it matures early like the composite maize variety known as Katumani. The distribution of NPP 670 seeds planted by farmers was 75.8 percent in Machakos, 36.6 percent in Kitui and 72.6 percent in Embu.

It was the interest of this study to explore how the farmers came to know about improved pigeonpeas (NPP 670). Table 4 shows that 50, 45.6 and 59.3 percent of farmers in Machakos, Kitui and Embu, respectively got information on NPP 670 from agricultural extension officers.

Table 4: How farmers first heard about improved pigeonpeas.

Source	Machakos	Kitui	Embu	All
		%		
Neighbour	25.9	17.6	23.0	22.9
Extension officer	50.0	45.6	59.0	51.5
Radio	0.5	0.8	-	0.4
Neighbours field	9.9	7.2	5.9	8.1
Farmers training centre	7.1	1.6	-	3.6
Other	1.4	2.4	2.2	1.9
NA*	4.2	24.8	9.6	11.7

*NA - Not applicable; i.e. those farmers who stated that they have not heard about the improved pigeonpeas.

The source of the first improved pigeonpea seed which the farmers planted is shown in Table 5.

Table 5. Sources of the first improved seeds planted by farmers. (1983-85) [see also Tables 9 and 16]

Source	Machakos	Kitui	Embu	All
Local market	6.1	13.8	5.3	8.4
Local shop	9.1	13.8	8.5	10.5
Neighbour	22.0	17.2	47.9	29.0
Agricultural officer	47.0	55.2	26.6	42.9
Farmers training centre	2.3	-	-	0.8
University researchers	12.9	-	11.7	8.2

In all three districts, 43 percent of the farmers got their seeds from agricultural officers, 29 percent of the farmers acquired their seeds from neighbours and about 8 percent obtained seed directly from researchers at the University of Nairobi. In Embu the majority of the farmers (47.9 percent) got their seeds from their neighbours. The local markets and shops ranked fourth as a first source of improved pigeonpea seeds.

Farmers were asked to state the reasons why they did not grow the new varieties of improved pigeonpea. Table 6 shows that 14 percent of farm stated that the improved pigeonpeas were not good. They argued that improved pigeonpea varieties required a lot of labour for spraying against diseases and insects, were too short and not good for firewood. Only 4 percent of farmers stated that the seeds were too expensive, and less than 2.0 percent had no money to buy the seeds. About 8 percent of farmers stated that seeds were not available. Mbatia and Kimani (1987) found that 40.7, 42.1 and 35.7 percent of farmers in Machakos, Embu, and Kitui respectively stated that seeds were not available.

Table 6: Reasons given by farmers for not growing improved pigeonpea

Reasons	Machakos	Kitui	Embu	All
		%		
Seeds not available	9.4	9.6	4.4	8.1
Seeds too expensive	4.7	4.0	3.0	4.0
Cash not available	1.4	2.4	1.5	1.7
Varieties not good	5.2	28.0	8.1	14.4
Other reasons	0.5	4.8	8.1	6.3
NA*	68.4	50.4	74.8	65.5

*NA - not applicable i.e. farmers who did not have any problems in getting seeds.

SOURCES OF IMPROVED PIGEONPEA SEEDS

The farmers obtained seeds for planting from various sources such as own seeds, buying seeds from neighbours or from the markets. Table 7 shows where the farmers obtained seeds during the period 1987-89. The major source of improved pigeonpea seeds were farmers own harvested seeds or from the extension officers. The extension officers were supplied with seeds by the researchers from the pigeonpea project, University of Nairobi. There is a steady increase from year to year of farmers who planted their own seed.

**Table 7: Sources of improved pigeonpea seeds
in Machakos, Kitui and Embu districts: 1987 to 1989.**

Source	1987	1988	1989
		percent	
Own seeds	20.3	33.1	37.3
Neighbours	7.6	8.1	6.6
Local market	5.7	3.8	1.7
Extension officers	16.7	12.3	12.5
Friends/relatives	0.8	0.4	-
Other	1.3	0.8	1.1
NA	47.3	41.5	40.9

The traditional pigeonpea seeds planted by the farmers were available at home, or purchased from markets and neighbouring farmers. Nearly all the farmers in the three districts where the survey was carried out indicated that they plant traditional pigeonpea every year. In 1987, 71.4 percent of the surveyed farmers planted seeds of their own traditional pigeonpeas. This increased to 74.8 percent in 1988 and to 78.2 percent in 1989. It is therefore, safe to say that for both improved and traditional pigeonpeas, the farmers used the seeds they harvested for planting. The buying of seeds from the market was insignificant in the three districts. The price charged for improved pigeonpea seeds for planting is Kshs. 17.00 per kg.

The farmers were asked whether they were able to buy as much improved seeds as they would have liked. Ninety one percent of the sampled farmers responded they were able to get as much seeds as they wanted. A very small number of the farmers, 2.3 percent, responded that the seeds were not available. Those who stated cash was a problem were 4.4 percent of the total surveyed. It should be concluded that the improved pigeonpea seeds were available and that the farmers were able to get seeds for planting.

PRODUCTION AND CONSUMPTION OF PIGEONPEA

In Machakos, Kitui and Embu districts, the majority of the farmers grow pigeonpeas either for home consumption or for sale in order to earn some income.

Table 8 : Production of improved pigeonpea seeds and number of farmers growing them, 1983 - 1989.

Year	Seed production* (t)	Number of farmers#
1983-84	3	5,000
1984-85	10	20,000
1985-86	11	30,000
1987-88	16	50,000
1988-89	20	over 55,000

* Based on seed packets sold to individual farmers by MIDP or pigeonpea project.

Ministry of Agriculture estimates.

Table 8 shows the amount of seeds of improved pigeonpea cultivars produced and sold to farmers and estimated number of growers. The figures indicate that amount of seed produced increased over sixfold while number of farmers increased tenfold during the seven year period. It should be noted that total amount of seed produced is likely to be much higher since the seed produced and sold by individual farmers or private seed companies was not included. Much of the seed produced by the project or MIDP was distributed through the extension officers, co-operative unions or sold directly to farmers. Data on Table 6 however indicated that 28 percent of seeds planted by farmers in 1987 came either from their own seed, local markets or from friends or relatives. In 1989, this figure rose to 45.6 percent. This is further supported by data on Table 5 which indicated of total seeds first planted by farmers, 48.7 percent originated from local markets, local shops or neighbours.

According to the Ministry of Agriculture report (1986) the area under pigeonpeas in Eastern province rose from 70,277 hectares in 1985 to 93,238 hectares in 1986, an increase of 32.7 percent. Production for the same period rose from 37,608 to 54,070 tonnes, an increase of 44 percent. This increase was attributed to rapid adoption of cultivar NPP 670 and favourable market conditions (Annual report, Ministry of Agriculture, 1986).

Over 85 percent of farmers in Machakos, Kitui and Embu stated that they did not purchase any pigeonpea for home consumption. In 1989, 11.7 and 12.6 percent of the farmers in Machakos and Embu, respectively bought less than 10 kg of pigeonpea for home consumption. There were relatively few farmers in Kitui who bought pigeonpeas for home consumption compared to the other districts.

Cooking of pigeonpea

The amount of time food takes to cook depend on many variables such as firewood used and composition of grain being cooked. On the basis of their cooking experience, farmers were asked which pigeonpeas cooked faster, improved or traditional pigeonpeas. Table 9 shows the reaction of farmers to this question. Seventy percent of sampled farmers (mainly women) answered this question. Forty-five percent indicated that the improved variety cooked faster

than traditional one. An earlier study by Mbatia and Kimani (1987) found that improved pigeonpea took shorter time to cook than traditional one.

Table 9: Responses of surveyed farmers as to which cooks faster, traditional or improved pigeonpea varieties in percentage

Relative cookability	Machakos	Kitui	Embu	All
No Difference	33.3	40.7	23.7	31.4
Improved variety	27.6	53.7	68.9	44.9
Traditional variety	39.1	3.6	76.4	23.7

According to 70 percent of surveyed farmers who had cooked and tasted both varieties, 40 percent indicated that traditional pigeonpeas tasted better than improved variety. Thirty-four percent of farmers stated that the improved variety tasted better than the traditional one. The taste preferences of the farmers are shown on Table 10.

Table 10: Taste preference of surveyed farmers in percentage

Preferred variety	Machakos	Kitui	Embu	All
Improved variety	17.1	25.9	40.6	26.0
Traditional variety	56.0	11.1	27.4	39.7
Both are about the same	26.9	63.0	32.0	34.3

PURCHASE OF IMPROVED PIGEONPEA SEED FOR PLANTING

The improved pigeonpea seeds for planting by the farmers could be acquired from various sources such as farmers using their own seeds or purchasing. It was found that 66.6 percent of farmers purchase seeds, and that the rest used some of their own seeds from previous crops and bought some.

Table 11 shows the place where the farmers said they would purchase the improved pigeonpea seeds. About 53 percent of the farmers would buy the improved pigeonpea seeds from agricultural officers and 16 percent indicated that they did not know where to buy the improved pigeonpea seeds.

Table 11: Places where farmers said they would buy improved pigeonpea seeds for planting (in percentage)

Place of purchase	Machakos	Kitui	Embu
Local shop	3.9	2.2	-
Local market	8.3	6.4	3.7
Agricultural office	48.5	28.0	58.8
From neighbour	9.8	2.2	10.0
Co-operative store	12.3	1.6	-
Do not know	10.2	67.0	-
NA	-	-	8.15

In 1988, 97 percent of farmers planted pigeonpeas. The varieties of pigeonpeas planted by farmers are shown in Table 12. The traditional pigeonpeas were planted by 37.9 percent of sampled farmers. Those farmers who planted only improved varieties amounted to 6.4 percent. Both varieties were planted by 55.7 percent of the farmers.

Table 12: Type of pigeonpea planted by farmers in 1988 in percentage

Type	Machakos	Kitui	Embu	All
Traditional pigeonpea	29.6	66.1	26.3	37.9
Improved pigeonpea	1.4	4.3	16.7	6.4
Both varieties	69.0	29.6	57.1	55.7

Most of the farmers surveyed grew pure stands of the improved pigeonpeas but the traditional pigeonpeas were usually intercropped. The improved pigeonpeas were hardly intercropped with traditional pigeonpeas.

HARVESTING AND STORAGE OF PIGEONPEAS

Quantity of pigeonpea harvested

Table 13 shows the quantities of pigeonpea harvested in 1988 season. In all the areas, more than two thirds of the farmers harvested less than or up to 5 bags. On average farmers in Machakos harvested 4.7 bags, in Kitui 4.3 bags and 2.3 bags in Embu. Machakos is the leading producer of pigeonpeas, followed by Kitui and Embu. A bag of pigeonpeas weighs 120 to 130 kgs.

Table 13: Quantities of pigeonpeas harvested by farmers (in percentage) in 1988 in three districts

Bags	Machakos	Kitui	Embu	All
Upto 5	73.1	75.7	88.9	78.1
5.1 - 10	20.9	17.1	8.5	16.6
10.1 - 15	3.0	4.5	1.7	3.0
15.1 - 20	2.0	1.8	0.9	1.6
20.1 - 30	0.5	0.9	-	0.5
Over 30	0.5	-	-	0.2

Storage of Pigeonpeas

The method used in storing grain is very vital in reducing damages caused by rotting, insects and rodents. Table 14 shows the methods used by farmers. Ninety-five percent of farmers used bags in storing pigeonpeas. This is the most common method employed for storing produce by farmers.

Table 14: Methods used by farmers to store pigeonpeas after harvest (in percentage)

Storage method	Machakos	Kitui	Embu	All
In bags in store	97.2	88.3	96.0	94.5
In open in a store	2.8	11.7	0.8	4.6
Outside (house or store) But covered	-	-	0.8	2
Others	-	-	2.4	7

The surveyed farmers reported that they treated harvested pigeonpeas during or before storage. Ninety-six, 86 and 82 percent of farmers in Machakos, Kitui and Embu districts, respectively treated their produce before or during storage.

Forty-six percent of the surveyed farmers stated that their produce was damaged during storage in all three districts. The rest reported that their produce was not damaged. In all districts 87.6 percent of farmers stated that the major damage was due to insects. Forty-eight percent stated that the damage to the produce was very little. This indicates that about half of the farmers employed proper methods of storing produce.

MARKETING OF PIGEONPEAS

The primary objective of growing pigeonpeas or other crops by farmers could be either for home consumption or to sell in order to earn some income. The income is used for buying essential household goods such as food, and clothing and for services such as school fees, medical services, farm inputs and others. The surveyed farmers were asked if they had sold pigeonpea harvested in the 1988 season or they intended to sell in future. The farmers who responded positively to the question were 56.4 percent. About 54 percent of the farmers indicated that they had no intention of selling pigeonpeas in future.

The time for selling pigeonpea is very important. At harvesting time there is more pigeonpea in the market than there is demand. This causes the price to be low. In 1988 season, the price was Kshs 3.00 per kg. Table 15 shows the various times when the farmers put pigeonpea for sale. Thirty-four percent of farmers sold the pigeonpeas at the time of paying school fees. The demand for money is very high during this time since this is the only source of income for many farmers. At harvesting time 36.8 percent of farmers sold pigeonpeas. The majority of the farmers (86.2 percent) who had no intention of selling pigeonpeas stated that they only had enough to meet their domestic consumption. This confirmed an earlier observation that farmers do not buy pigeonpeas for their domestic consumption.

Table 15: Times when farmers normally sell pigeonpeas (in percentage)

Time	Machakos	Kitui	Embu	All
Harvesting time	26.4	65.6	30.2	36.8
Planting time	13.1	33.0	1.6	7.9
Paying school fees	35.7	19.7	42.9	33.6
Buying food	8.5	3.3	14.3	8.7
Others	16.3	8.1	11.0	13.0

Market outlets for pigeonpeas

Table 16 shows the various marketing outlets which farmers used to sell pigeonpeas. In Machakos and Kitui the major buyers were traders. The traders normally operate shops in nearby shopping centre where the farmers take their produce. In Embu 56.6 percent of farmers sold pigeonpeas at the markets. The buyers include many consumers who buy small amounts and also traders who buy and transport the produce for selling in urban centres such as Nairobi and Mombasa. The market days are normally twice per week.

Table 16: Marketing outlets for pigeonpeas in percentage of farmer response

Outlet	Machakos	Kitui	Embu	All
Neighbours	8.9	1.2	21.7	10.6
Nearby shop (traders)	67.9	74.7	10.8	51.1
Local markets	16.8	19.3	56.6	30.9
People who come to buy (Merchants)	4.7	1.2	10.8	5.6
Pigeonpea project	1.6	3.6	-	2.6
Others	-	-	-	-

Table 16 also shows that only a small fraction of the pigeonpea grain is sold back to the project as seed.

Prices for pigeonpeas

The price for pigeonpea is not controlled by the government. Normally by word of mouth, farmers are aware of going price at farm gate, at the shopping centre and also at the market. The prices are low during harvesting time and high during planting time. The price of pigeonpeas, either improved or traditional, for home consumption is between Kshs 3.00 to Kshs 4.00 per kg. The price paid for improved pigeonpea seeds to farmers contracted by the pigeonpea project is Kshs 8.00 per kg.

The farmers were asked to react to the price they received i.e. whether it was good, poor or reasonable. The farmers' responses are shown in Table 17. About 23 percent of the farmers felt the price was good, and 31.8 percent of the farmers considered the price to be poor.

Farmers stated that they experienced problems such as transportation in getting their produce to the market. They noted that transportation was unavailable and when available it was too expensive. Over 50 percent of farmers in all three districts indicated that they had problems getting their pigeonpeas to the market.

Table 17: Reaction of farmers to prices paid for pigeonpea seeds (in percentage)

	Machakos	Kitui	Embu	All
Very good	4.4	8.7	1.1	4.4
Good	22.2	7.2	36.7	22.9
Fair	20.2	7.2	25.6	19.1
Poor	27.6	47.8	28.9	31.8
Very poor	25.6	8.7	7.8	21.8

EXTENSION

The farmers received information on new technology through radio broadcasts, extension workers, field days, through other farmers and during agricultural shows. They stated that they were aware of radio programs on farming. Although these radio programs on farming are in Swahili language, some of them are also broadcast in local languages. The extension workers communicate to the farmers in local languages during farm visits and on field days. Apparently there were no problems of communicating new technology to farmers. This has contributed to rapid adoption of the new early maturing pigeonpea.

DISCUSSION

Seed multiplication mechanisms

The project has pursued various mechanisms for seed multiplication with varying degrees of success. Multiplication of seed on leased land at Kibwezi was initiated by the project in 1983. All the operations were carried out by the project personnel and good quality seeds were obtained due to close supervision, suitability of land and availability of irrigation. However, the land rent became exorbitant which implied higher seed costs. This was considered undesirable since the aim of the project was to provide growers with good quality seed at a price they could afford. Besides seed production operations made heavy demand on limited project personnel. The Kibwezi area, Machakos district, is thinly settled and much of it being bush, wild animals often damaged the seed crop.

Multiplication of seed by MIDP worked well except for the frequent changes in personnel. Being an externally funded project, it had a limited life span and hence not a sustainable method of seed multiplication.

The small-scale farmer contracts worked best. Farmers were ready to produce as much seed as required so long as there was a good market for their produce and good prices. This, however, requires a revolving fund for purchase of chemicals, provision of foundation seed, gunny bags and on-the-spot payment. It also requires close supervision and functioning arrangements for marketing of the

seed. Loan of chemicals and foundation seed were easily recovered at the time of seed purchase preferably in the form of produce. For the farmers it was a crucial income generating enterprise. It has the greatest potential.

The district based pilot schemes operated along the same lines as farmers contracted by the project. This scheme proved workable as long as funds were available for the purchase of inputs or to repurchase the seed from farmers. The major drawback was that funds from seed sales were paid to the treasury and not ploughed back into the scheme, other than through the normal allocations for each district.

Although it was generally felt that multiplication of seeds by women's groups had great potential, this potential was not fully realised. The project provided about 240 kg of foundation seed in 1989, having jointly worked out a plan of operation with the women's bureau (Ministry of Culture and Social Services) which represented women's groups. However, the seeds were distributed to individual members. Although it is too early to make firm conclusions on this mechanism, proper management and co-ordination is essential.

As indicated earlier, private companies are principal multipliers and distributors of seed in Kenya. The results of this survey clearly supported their view that demand for seed is not firm. Data on Table 7 showed that the number of farmers using their own improved seed increased progressively from 1987 to 1989. This was also true of seeds of traditional pigeonpea varieties. The majority of the farmers do not buy pigeonpeas for their own consumption. This pattern is likely to persist so long as open or self-pollinated cultivars can be grown year after year without any serious deterioration in yield. Yet there is demand for seed of new varieties and especially after drought years. The survey results indicated that 66 percent of the farmers purchased seed of improved cultivars for planting. There is urgent need to quantify this demand and provide more market information.

It is in view of these constraints that the government-owned Kenya Agricultural Research Institute has agreed to contract private seed companies to produce seeds of semi-arid lands, pigeonpea included.

Dissemination mechanisms

The results indicated the largest proportion of the seeds of the improved varieties was disseminated initially through extension agricultural officers and farmer-to-farmer (Table 5). Most farmers also learnt about these cultivars through extension officers and their neighbours (Table 4). In subsequent years, the farmers used their own seeds for planting (Table 7). Direct purchases from the University accounted for only 8.2 percent of the seed distributed. This indicates clearly that agricultural extension officers and farmer-to-farmer sales were the most crucial mechanisms of disseminating the seed of the new cultivars. It may be inferred that farmers regard extension officers as their primary source of information on new technologies. This is further supported by data presented on Table 11. Asked where they would buy seeds of improved cultivars, 59 percent of the farmers said from extension officers and 10 percent from their neighbours.

The large number of responses indicating agricultural offices as sources of information or new technology could be attributed to the fact that there is at least one extension officer at grassroots or locational level. These officers are responsible for visiting farmers in their homes regularly or inviting them to field days or barazas (meetings) where farmers are informed of the latest information

relating to agriculture, and which also provide a forum where farmers can air their views. The project involved these officers in most of its field operations. This outlet should be exploited in future seed dissemination mechanisms.

Local shops and markets and co-operative stores can also be used effectively, for seed distribution, since they are to be found in the remotest of the places. It is the combined effect rather than any one single channel that contributed to the rapid dissemination of seeds of the new pigeonpea cultivars. These mechanisms should be utilised fully regardless of the institution multiplying and distributing the seed. Co-operative stores such as KGGCU which have branches in all major urban areas and distributes other farm inputs have a great potential in seed dissemination.

The demand for pigeonpea seeds has been high. Mbatia and Kimani (1987) showed that farmers had some difficulties in getting seeds. They reported that 40.7, 42.1, and 35.7 percent of farmers in Machakos, Embu, and Kitui, respectively stated that seeds were not available. However, in the present study, only 8 percent of the farmers stated that seeds were not available. Ninety-one percent of the sampled farmers responded that they were able to get as much seeds as they wanted. This confirmed that seed dissemination mechanisms were effective and farmers had access to seeds of the new pigeonpea cultivars. The project has received some requests for seeds of new varieties from Malawi, Tanzania, Uganda, Zimbabwe, Somalia, Pakistan, India and Sudan. Most of these requests have been met.

Adoption of improved pigeonpeas

The improved pigeonpea varieties have been widely adopted by farmers in Machakos, Kitui and semi-arid areas of Embu district. Mbatia and Kimani (1987) found that 86, 92 and 91 percent of farmers in Machakos, Embu and Kitui districts, respectively, have heard and/or grown improved pigeonpeas. In the present study, over 88 percent of sampled farmers have heard about improved pigeonpea mainly through extension officers and neighbouring farmers. Sixty-four percent of surveyed farmers have grown the improved cultivar NPP670 and about 54 percent of them grow it yearly. The rapid adoption of the new cultivars is, in part, attributable to their desirable traits, availability of seeds, reasonable prices and rapid dissemination of information by extension officers. Information on the new technology was relayed to farmers through agricultural extension officer, FTC's and from farmer-to-farmer. Radio played a relatively small role in disseminating information on the improved cultivars.

Asked what they liked about the improved cultivars, 52 percent of the farmers cited its early maturity, 20.1 percent high yields when sprayed, 9.1 percent stated that it can be harvested twice per year, 10.8 percent, better taste, and 3.4 percent better market prices. Other reasons that were cited include faster cooking (1.5 percent), short stature hence easy to spray (1.4 percent), and big seeds (1.1 percent). Among the dislikes were : insect susceptibility (30.4 percent), need to spray heavily (33.1 percent), diseases (15.1 percent), heavy labour demand (8.1 percent), expensive seeds (4.7 percent) and low yields (5.1 percent).

Seed marketing

In 1988/89 56 percent of the farmers indicated that they intended to sell part of their pigeonpea produce. Over 50 percent of the farmers indicated that they had problems getting their pigeonpeas to the market. The most serious problem was transportation. Either the transport was not available or if available was too

expensive. Others cited long distances to the markets. Perhaps the most potential solution to this problem is to organise a growers association so that the produce can be collected at several points and delivered to markets. Such associations exist for vegetable, coffee and tea growers. They assist the farmers in locating demand areas and negotiating better prices for their produce. Little market information is available on pigeonpea domestic or export markets. The future of increased pigeonpea production in Kenya lies in quest for market information, organised marketing and its linkage to production.

EXPERIENCES IN DRYLAND SEED PRODUCTION AND DISTRIBUTION

Although the pigeonpea project has made efforts to supply seed to farmers in collaboration with MIDP, several problems have been experienced. Seed production is an expensive and time consuming activity. Seed fields require full time staff to manage the fields and carry out all operations, ranging from land preparation to harvesting, cleaning, dressing, packaging, storage and distribution of seed to the farmers. Facilities for these operations are necessary since hired equipment from private companies means that seeds have to be sold at high prices to break even. This is complicated by the need to guard the crop from wild animals and theft, land leases and use of costly chemicals to ensure seed of high quality is delivered to farmers. Resource poor farmers in semi-arid lands cannot afford costly seed and this forces some to use unimproved seeds. Fortunately, unlike hybrid seeds, pigeonpea seed derived from open pollinated cultivars can be replanted for a few years without serious decline in yields. Rough terrain and impassable roads make it difficult to deliver seeds closer to farmers in the more remote areas. Seeds have to be sold at subsidized prices to ensure that new varieties are adopted by as many farmers as possible.

Dryland Seed Production and Distribution Committee

This committee was formed to assist in developing strategies for multiplication and distribution of seeds of dry land areas. It arose out of the realization that commercial companies were hesitant to multiply and distribute seeds for semi-arid lands except for maize, beans and sorghum which is carried out by Kenya Seed Company. The committee met at the National Dryland Farming Research Centre, Katumani on November 11, 1984. The purpose of the meeting was to work out a strategy for seed production and distribution for the semi-arid areas. Among the institutions represented were government agricultural research stations, district agricultural officers of Embu, Kirinyaga, Kitui, Machakos, Baringo, Kenya Freedom from Hunger Campaign, National Seed Quality Control Service (NSQCS), Kenya Seed Company, East African Seed Company, MIDP and the University of Nairobi. The main points made during that meeting were:

1. There is a critical need to provide good quality seeds to farmers and to ensure a supply of seed after bad cropping season.
2. Although official regulations require that varieties have to pass the National variety performance trials for three years before official release, under the present circumstances, good material from breeders should be multiplied to provide the farmers with seed, to create awareness and get a feedback to perfect the research work.

3. Although the Kenya Seed Company was willing to multiply seeds for dryland crops, the exercise must be profitable. The company's experience with multiplying GLP beans was unpleasant due to uncertain demand. The majority of the farmers bought certified seed only after bad seasons. The East African Seed Company would multiply the seed only if they were sure the demand would be high enough.

It was suggested that :

- i) seed prices should be subsidized to ensure farmers buy every season and the company could produce large quantities regularly.
 - ii) The National Cereals and Produce Board give premium prices for pure varieties. This would encourage farmers to buy more seed to produce pure varieties. It was concluded that this was a policy matter that needed further discussion at the ministerial level.
4. It was suggested that farmers should be given small quantities of seed to start them off and educate them that most of the dryland crop seed can be grown for more seasons and that after 2-3 seasons they will have to buy new seed. However, in bad seasons, farmers still need seeds to buy.
 5. Commercial seed companies were not interested in vegetatively propagated crops such as potatoes and cassava. Multiplication of these should be left to breeders, extension services, farmers or institutions.
 6. No institution appeared to have resources to multiply and organize seed distribution for arid lands. Apparently the only viable solution then was for each district to multiply and distribute seed to their farmers. The seeds unit at the National Dryland Farming Research Centre, Katumani had run out of resources to multiply seed and any new cultivars were given to MIDP.
 7. General rules for seed multiplication for cowpeas, green grams and pigeonpea were discussed. The commercial growers as well as DAO offices/projects were free to apply to grow the seeds, but applicants should have seed multiplication facilities.

Since demand for seed in marginal areas fluctuates seasonally with amount and distribution of rainfall, organized seed production and distribution was difficult to carry out. This activity would have to be done at the institutional level. The project researchers proposed small seed production pilot projects based at the district level. In this scheme small quantities of seed is sold to farmers who are encouraged to reserve some of the harvested seed for next planting and sale to neighbours. A few farmers are also contracted to produce seed to be purchased using a revolving fund. This seed is offered for sale through district agricultural offices and local shops to those farmers unable to produce enough seed in a previous season. The pigeonpea project will ensure that emergency seed stocks are available for each of the cultivars. In the long run, when a sufficient demand has been created commercial companies may be attracted. Seed production rules and regulations would be followed. It was generally felt that the Ministry headquarters should get more involved in seed multiplication and distribution for crops of semi-arid lands. Breeders should spend more of their time in cultivar development and research and less in seed production activities.

POLICY IMPLICATIONS AND RECOMMENDATIONS

The growing of improved and traditional pigeonpea is being carried out by small-scale resource poor farmers in semi-arid areas. This study has shown that the surveyed farmers have accepted growing improved pigeonpeas which are early maturing and of higher yielding capacity compared to that of traditional varieties. The farmers have experienced prevalent problems of insects and diseases as well as marketing. To help farmers overcome some of the constraints to increased production the following recommendations are suggested :

1. Research on breeding should continue - the farmers need cultivars which are resistant to diseases and insects. This requires more money, and, above all, team work of researchers with different scientific backgrounds such as entomologists, pathologists, among others (the project already has entomology, pathology, agronomy and breeding graduate students doing some work on these aspects).
2. The Ministry of Agriculture should take up the work of seed production and distribution. The pigeonpea project should concentrate on breeding, agronomy, socio-economics, entomology and pathology of pigeonpeas only.
3. Agents could be appointed by the government through the Ministry of Agriculture to carry out seed production and distribution. Some cost sharing mechanism should be worked out between farmers, agents and government so that seeds are produced at reasonable prices.
4. Extension workers should be educated regarding problems relating to improved pigeonpea and how farmers could select good seeds for planting.
5. In absence of seed agents good farmers in the area should be trained to produce seeds for planting. These farmers could be contracted to produce quality seeds.
6. A distribution system should be instituted to ensure that improved seeds reach farmers. Seeds could be distributed through agricultural offices, local shops, co-operative stores such as the Kenya Grain Grower Co-operative Union (KGGCU) chain stores, private seed companies and markets.
7. Agro-chemicals especially insecticides and spraying pumps should be made available to farmers at reasonable cost. The current prices for these are too high for most farmers. This issue needs urgent attention.
8. The marketing of pigeonpeas should be improved. Efforts should be made to organise farmers into groups so that costs of transportation and marketing their produce can be reduced. Better markets should be sought.
9. The Ministry of Agriculture should promote improved pigeonpea as one of the most drought resistant crop in the semi-arid areas.
10. The germplasm of improved pigeonpea varieties should be kept in national seed bank and be registered.

These policy recommendations are aimed at improving and increasing production of improved pigeonpea in semi-arid areas as the pigeonpea will continue to be a major crop in semi-arid areas. Therefore a joint effort between farmers, scientists, extension workers, politicians and policy makers is required to ensure sustainable production in agriculture. Good quality seeds must be provided to farmers to ensure sustainability.

CONCLUSIONS

1. The adoption of new varieties of pigeonpea has taken off very well in Machakos, Kitui and Embu districts. Over 88 percent of sampled farmers have heard about improved pigeonpea mainly through extension officers and neighbouring farmers. Sixty-four percent of surveyed farmers have grown the improved variety of pigeonpea i.e. NPP 670. Approximately 54 percent of sampled farmers grow improved pigeonpea yearly.

The farmers got the first seeds for planting from the agricultural officers (41 percent) and 31 percent of farmers got seeds from neighbouring farmers. In Kitui district much of the seed sold to farmers by the agricultural officers originated from the pilot seed multiplication project with small amounts supplied direct by the project headquarters at the Department of Crop Science, University of Nairobi. In Machakos district seeds were jointly multiplied and distributed by Machakos Integrated Development Project (MIDP) and the pigeonpea project. In Embu district the seeds were supplied to agricultural officers by the project from project nurseries and contract farmers. In 1988, 33.1 percent of surveyed farmers planted their own seeds, 12.3 percent bought seeds from agricultural offices, and 8.1 percent of farmers purchased seeds from neighbouring farmers.

2. The improved pigeonpea seeds were available to the farmers. Of the farmers who were growing traditional pigeonpea, 78.2 percent planted their own seeds. The rest of the farmers purchased traditional pigeonpea seeds at the market.
3. The prevalent problems experienced by farmers growing pigeonpea were insects and diseases. The farmers also indicated that the price paid on pigeonpea was poor. The farmers had problem in taking the produce to the market. They stated that transportation was expensive and unavailable.

The improved pigeonpea seeds are sold at Kshs 17.00 per kg. Seeds are packed in half kg packages. It is most likely that the improved seed bought from neighbouring farmers cost less than Kshs 16.00 per kg. In Karaba market, in Embu, improved pigeonpeas were selling at Kshs 12.50 per kg in 1988. Other donor agencies working in the semi-arid areas sold pigeonpea seeds at Kshs 8.00 per kilogramme.

4. Forty-five percent of sampled farmers reported that improved pigeonpeas cooked faster than traditional pigeonpea. About 40 percent of surveyed farmers responded that traditional pigeonpeas tasted better than improved pigeonpea. Other advantages cited by farmers about improved pigeonpeas include early maturity and that they harvest two crops per year. The traditional pigeonpeas are admired by farmers because of lower insect infestation and disease problems and also are a good source of firewood and fencing material.

5. The common method for harvesting pigeonpeas was cutting of entire crop and threshing by beating with a stick. This method was used by 61 percent of the surveyed farmers. Pigeonpea was stored in bags by 95 percent of farmers. The farmers also treated stored produce with agrochemicals.
6. The improved seeds for planting were supplied to agricultural offices by the Pigeonpea Project of the University of Nairobi funded by the International Development Research Centre (IDRC) Ottawa, Canada. The seed multiplication and distribution was carried out mainly by contracted small-scale farmers and the Pigeonpea Project. The seeds from contract farmers are purchased by the project, for sorting, dressing and packaging. Seeds are distributed through agricultural offices, local markets and shops and directly from project offices. Contract farmers also sell their seeds to their neighbours and in local markets. The amount of improved seed that has been produced and sold is difficult to quantify. A lot of seed is sold among farmers and from farmers to traders that is not recorded. The amount of seed produced by the project, MIDP and the pilot seed scheme in Kitui district increased from 3 tonnes in 1983/84 to over 20 tonnes in 1988/89. In the same period the number of collaborating farmers who received and planted this seed increased from 5,000 in 1983/84 to over 50,000 farmers in 1988/89. From this survey and 1987 socio-economic survey, it was estimated that over 64 percent of the farmers had grown the improved pigeonpea varieties. The population of three districts is estimated to be over 2 million people and an average household size of 5.3 persons i.e. 377,358 households (Jaetzold and Schmidt, 1979). It can be estimated that about 241,509 households (or farmers) have grown the improved pigeonpea cultivars (64 percent) which is about five times the recorded estimate.

The area under pigeonpeas in Eastern Province (Machakos, Embu, Kitui, Marsabit and Meru districts) increased from 70,277 hectares in 1985 to 93,238 hectares in 1986 (an increase of 32.7 percent) according to the Ministry of Agriculture report (1986). Production in the province which accounts for 90 percent of Kenya's pigeonpea crop, rose from 37,608 tonnes in 1985 to 54,070 tonnes in 1986, an increase of 44 percent. The increase in hectareage and production was attributed to a good market and improved pigeonpea varieties.

7. The multiplication and distribution of pigeonpeas requires a lot of investment both human and capital. It is suggested that a division of labour is required, where the Pigeonpea Project of the University of Nairobi should concentrate on breeding and agronomic research while the Ministry of Agriculture should concentrate on seed multiplication and distribution. For instance the Ministry of Agriculture could contract private seed companies to multiply the seed. The seed would then be distributed through the Agricultural Extension Officer, Co-operative union stores and shops among other channels. This appears to be a logical and efficient way of supplying farmers with the required improved pigeonpea varieties and other crops of semi-arid areas.

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