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Social and Economical Factors Hindering Adoption of Improved Cassava Varieties in Kiganjo Location, Nyeri Municipality Division, Kenya

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Cassava (*Manihot esculenta* Crantz) is one of the most important root crops for food security in developing countries because it is tolerant to drought and low fertility, and it grows in a variety of climates. This study aimed to determine what factors led to the low adoption rate of improved cassava varieties by small-scale farmers in Kiganjo, Nyeri Municipality Division, Kenya. A survey of 80 farmers was carried out in January 2010 using a structured questionnaire to collect data. Thirty-two percent of respondent farmers did not grow cassava. The cassava adoption rate was higher for farmers with larger farms than for those with smaller farms. The adoption rate was closely related to farmer income. Farmers with income from cash crops and livestock adopted cassava cultivation at the rates of 82% and 73%, respectively, whereas the corresponding rates were 59% and 61% for farmers without income from these sources. The adoption rate for improved cassava varieties also was higher for farmers with income from cash crops and livestock than for farmers without such income. Farmers who were members of extension groups cultivated cassava and introduced improved varieties at higher rates than farmers who were not members. The adoption rate of improved varieties for farmers who cultivated cassava was 35% for extension group members compared to 18% for nonmembers. Farmer sex, educational level, age, and training on cassava did not significantly influence the rate of adoption of the cultivation of local or improved varieties of cassava. Extension agents need to find ways of more effectively reaching farmers with limited income and land resources because they are most vulnerable to food insecurity. Extension group members should accept the social responsibility of sharing planting materials with nonmembers to help them break the cycle of poverty.

Key words: Agricultural technology adoption, food security, drought tolerant crops, social and economic factors

Introduction

Food Security Situation

Food security is a global concern. Over 1 billion people experience the hardship that hunger imposes, a figure that continues to rise despite the economic development of most countries in the world. With increased population growth, economic instability, and climate change, food security has become a major challenge for national and global governance. The World Food Summit in 1996 stated "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2009). The first Millennium Development Goal (MDG) falls short of food security aspirations in seeking only to reduce by half the proportion of the world's population experiencing hunger by 2015. However, without achieving the first MDG on reducing hunger, it will be difficult for a country to achieve the other MDGs.

Sub-Saharan Africa is one of the regions's most

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affected by food insecurity. There are 15 countries in Africa where the incidence of hunger exceeds 35% of the population. Kenya periodically suffers from food insecurity as a result of climate change, population increase, and political issues, among others reasons. It is estimated that about 50% of the population is poor with 7.5 million living in extreme poverty. Over 10 million people suffer from chronic food insecurity and poor nutrition with an estimate of 1.8 million children (30%) being classified as chronically undernourished (Ministry of Agriculture, 2009). Out of a total population of over 33 million, some 2 million suffer continuously from food insecurity and depend on relief food. That figure usually rises to 5 million during droughts (Wambugu and Muthamia, 2009). Nyeri Municipality Division occasionally experiences food insecurity and has the second-highest poverty index (43%) among the divisions in Central Province (Ndenge *et al.,* 2005). This leads people to move from surrounding rural areas to Nyeri Town in search of employment, which contributes to problems associated with rural-urban migration, such as a high incidence of HIV/AIDS.

The Ministry of Agriculture's vision is to take the lead in ensuring food security for all Kenyans at all times. One ministry strategy is to encourage farmers to shift from an overreliance on maize to more drought resistant crops (Ministry of Agriculture, 2009). Cassava is one of the crops being promoted, especially in areas with unreliable rainfall and poor soils. The ministry has occasionally supplied farmers with planting material for cassava cultivation, but farmers' adoption of cassava cultivation has been slow. With the continued effects of climate change, it is important that farmers shift from traditional crops and farming methods and focus on growing crops that can cope with climatic changes.

Cassava Production and Utilization in Kenya

Cassava (*Manihot esculenta* Crantz) is one of the most important root crops for food security in developing countries because it is tolerant to drought and low fertility, and can adapt to a variety of climatic conditions. Cassava production in Kenya in 2009 was projected at 542,984 t from an area of 35,675 ha, down from 47,925 ha in 2008 (Ministry of Agriculture, 2010). Cassava production varied

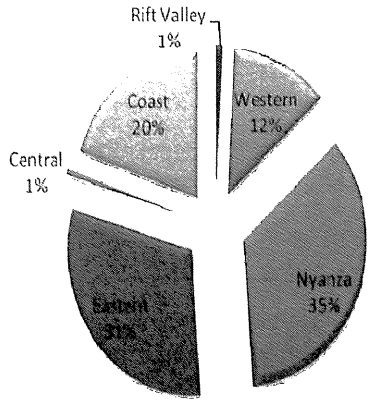

Fig. 1. Distribution of cassava production in Kenya by province in 2009. (Source: Ministry of Agriculture, Crop Production Division).

considerably by province in 2009 (Fig. 1), and production was affected by low rainfall. However, cassava breeding programs in research institutes—both local and international—have produced varieties that are being grown by farmers in various parts of the country. Improved mosaic resistant varieties of cassava from the Kenya Agricultural Research Institute (KARI) were bulked and widely planted with the expectation of increased yields. The lack of good planting material was a constraint, but improved varieties were introduced to replace low-yield, disease-susceptible local landraces. The improved varieties could yield as much as 30 t/ha as compared to 6 t/ha for landraces (Wambugu and Muthamia, 2009). The characteristics of improved cassava varieties differ in a number of ways from those of local landraces (Table 1).

Cassava is prepared in a variety of ways in various parts of Kenya, but the boiling of fresh tubers is the most common method used. Home processing of cassava is done in Nyanza Province, Western Province, and in a few areas of Eastern Province. Processing involves chopping, drying, and milling the cassava into flour. Milled flour is easy to store and has a shelf life of up to 2 years. Milled flour may be used alone or mixed with wheat flour to make baked products. Dried cassava chips are also milled together with cereals such as maize and sorghum to make composite flours (Karuri *et al.,* 2001). Mixing cassava with cereals helps reduce the use of grains, such as maize, which are usually more expensive than cassava. The composite flours are usually mixed with boiling water to make por-

Table 1. Characteristics of improved cassava varieties grown in Kenya

Variety	Yield (t/ha)	Cultivation period (months)	Type	Other characteristics
Mucericeri	20-28	16	Sweet	Tolerant to cassava mosaic virus
KME1	20-28	16	Sweet	Tolerant to cassava mosaic virus and scales, and less fibrous when cooked
KME61	20-30	14	Bitter	Tolerant to cassava mosaic virus and scales, and more fibrous when cooked
Local landraces	6-8	20	Various	Susceptible to cassava mosaic virus and scales

Source; Karanja *et al,* (2006).

ridge (mainly for children) or thick blend called *ugali,* which is commonly consumed as a main dish with vegetables. KARI has created over 30 recipes in a bid to promote increased consumption of cassava (Karanja *et al.,* 2006). However, knowledge of the recipes and the associated skills needed for their preparation have not reached most farmers and consumers. Coupled with the lack of knowledge and skills in the use of cassava, rural communities are also constrained by the lack of appropriate tools and equipment, such as ovens, used to make a wide variety of baked products.

Cassava is most commonly marketed fresh and usually sold in heaps or in bags in local markets. Although it can be used as a raw material for a number of industrial products, including glue, starch, animal feeds, and beer, only one cassava processing factory exists in Kenya. The factory, located in Coast Province, specializes in the production of starch. No industrial processing of cassava products for human consumption is carried out in Kenya. Quality assurance and the continuity of supply of home-processed products is a major challenge in cassava use. With improvements in processed products and an increase in the number of organized markets, cassava has the potential to not only meet the food security needs of the rural population, but also to generate income for farmers (Kiura *et al.,* 2010).

Adoption of Agricultural Technology

Adoption of new agricultural technology plays a major role in raising incomes, improving living standards, and enhancing the food and nutritional security of rural households. Although agricultural research institutions have pursued scientific discoveries and the development of new technologies for farmers in poor countries, the adoption of promising innovations is in many cases gradual and incomplete. The potential of an innovation to improve livelihoods can only be realized after its diffusion and widespread adoption and use. Consequently, it is essential for governments and change agents to amplify the diffusion of innovations and improve the distribution of gains by mitigating factors that hamper their adoption. Governments also need to determine whether adoption of an innovation enhances equity among rural people in terms of resource access and distribution, thus leading to poverty reduction. The more users that adopt a productive new technology, the more it contributes to the well being of society (Hall and Khan, 2002).

Several adoption diffusion theories have been developed, but innovation diffusion generally progresses through five stages. The first is acquisition of knowledge of an innovation, when an individual is first exposed to an innovation and understands its operation, functions, and potential. The second stage is persuasion, when the individual forms a favorable or unfavorable attitude toward the innovation. The decision stage is third, when the individual engages in activities that lead to a choice as to adoption or rejection the innovation. The implementation stage, when the individual puts an innovation into use, is fourth, and the fifth stage is confirmation, when the individual decides to either continue or discontinue use of the innovation (Carr, 2010).

Those in contact with change agents are positively related with more formal education, a higher socioeconomic status, as measured by such variables as income, wealth, and greater social participation. Those who adopt innovations are generally

characterized by a willingness to take risks, relative youth, a higher social and financial status, contact with sources of information about innovations, and past interaction with innovations. Early adopters of agricultural innovations often possess advanced education and larger farms,

Accessible sources of information about technological innovations are required for the adoption of innovations to take place. Social networks among farmers have been found to contribute greatly in better communication among farmers and accelerate the adoption of technology (Mazur and Onzere, 2009). Social networks are usually voluntary associations among people with similar interests and needs, or with shared challenges, such as marketing agricultural produce. Such associations can be formal or informal and can be established on the basis of friendship, membership in an extended family or religious group, or through voluntary membership. Farmers usually rely on social networks for support in terms of material resources such as farm tools, planting material, and financial assistance. Social networks also provide farmers information about farming activities, such as sources and application of farm inputs, and new marketing channels. Farmers' reliance on one another other extends to influencing their decisions about adopting new technologies. Depending on the type of technology and the environment, various factors can influence decisions on the adoption of technology. A better understanding of the relative influence of some of these factors on such decisions in different environments would be beneficial.

Study Objectives

With the aim of reducing food insecurity, the Ministry of Agriculture promoted the production of cassava (among other drought-tolerant crops) as a food security crop under the Central Kenya Dry Area Project (CKDAP) from July 2000 to December 2009. Kiganjo was selected as one of the focal areas of the project. Under the project, the government provided some initial planting material in form of cuttings of improved sweet cassava varieties that have low cyanide levels and high yields.

The objective of this study was to identify social and economic factors that constrained the adoption of the new cassava varieties in the Kiganjo community. An additional aim was to identify ways of increasing the adoption of cassava cultivation, thus improving food security in the area and in the nation as a whole.

Materials and Methods

Study Area

The target area of this study was Kiganjo in the Municipality Division of Nyeri South District. The municipality is one of five divisions of Nyeri South District and is situated between 36° and 38° east longitude and between the equator and 0°38′ south latitude. The division covers an area of 167 km^2 and has a population of 102,238 and a population density of 603 persons/km^2. Nyeri Town, which is the capital of Central Province and also has a high population density, is also located in the division. Municipality Division forms the Nyeri Town constituency, which has the second-highest incidence of poverty (43%) among the constituencies in Central Province (Ndenge *et al.,* 2005). An estimated 39,702 in the constituency live below the poverty line (US#1 per day). The division is divided administratively into two areas, Kiganjo and Mukaro. Agriculture is the principal opportunity for livelihood available to the rural poor in the area, and 90% of the community depends directly or indirectly on the agricultural sector. The area is served by a main tarmac road to Nairobi, but the serviceability of most interior roads is seasonal.

Compared to the rest of the division, the agricultural potential of Kiganjo is constrained by low precipitation and limited soil fertility. The population density is also lower, 355 persons/km^2, with a population of 11,868 in an area of 33.4 km^2. Kiganjo lies in the upper midland zone 3 agro-ecological zone. The climate is highland equatorial, characterized by two rainy seasons—a short one from October to December and a longer one from March to May—with annual precipitation ranging from 500 to 1300 mm (Fig. 2). The rainfall pattern is occasionally disrupted by abrupt and adverse changes, resulting in rainfall for less than 3 months, which is usually inadequate to raise crops such as maize that require 4 to 6 months to mature. Temperatures range from 13℃ in the coldest months (June-July) to 28℃ during the hottest months (January-February). The topography is characterized by steep ridges and valleys, making the soils vulnerable to soil erosion. Droughts are frequent,

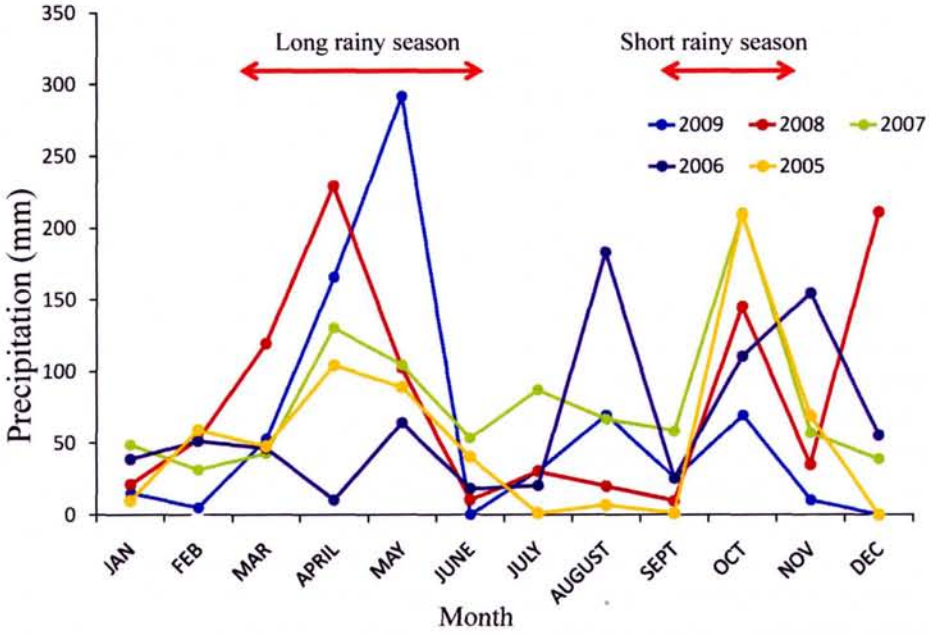

Fig. 2. Monthly precipitation in Kiganjo, 2005 to 2009.

one of the reasons the location was selected to benefit from CKDAP. Under the project, groups of farmers were trained in the cultivation of drought-resistant crops such as cassava. Due to the high cost and adulteration of key farm inputs in Kenya, adequate supplies of farm inputs were unaffordable for many farmers, resulting in low input application rates, declining soil fertility, and low crop yields. Kiganjo farmers apply fertilizer at average rate of 5 kg/ha of diammonium phosphate and 1 t/ha of manure, according to a unpublished survey carried out by the Ministry of Agriculture in 2007. Due to inadequate rainfall and poor soil during the survey period, farmers harvested little food and occasionally experienced crop failure. The result was reliance on government food relief (Ministry of Agriculture, unpublished report, 2009).

Data Collection and Analysis

The study survey was carried out in January 2010. A structured questionnaire was developed and the extension officers in municipality division were used to administer it. Data were collected from two regions, Kirichu and Gachika, which were chosen at random from the four regions in Kiganjo. Respondent farmers were selected at random from villages in the study area and included both member and nonmember farmers of extension groups used for training during implementation of CKDAP. A total of 80 farmers were interviewed.

The questionnaire was divided into four major categories. The first focused on background information about the respondent farmers, including age, sex, and level of education, as well as the roles of farm family members, farm size, and livelihood strategies (e.g., main sources of income). The second part concentrated on cassava production, including source of planting material, cultivars planted, diseases, and pests. The third part focused on extension and training, the type of training received, and participation in extension groups. The last section requested information about cassava utilization and perceptions of and attitudes toward cassava.

One of the 80 questionnaires administered was incomplete, so a total of 79 questionnaires were analyzed using the JMP Ver. 8.0 (SAS JAPAN, Tokyo) statistical package. Likelihood ratio tests were carried out.

Results and Discussion

Food Security

Of the farmers interviewed, 100% grew maize, 92% cultivated beans, 86% cultivated potatoes, and 68% grew cassava. Other crops cultivated were

bananas, sweet potatoes, and a few horticultural crops. In 2009, production per hectare for both maize and beans averaged 90 kg. All farmers used a mixed cropping farming system. About 25% of respondent farmers experienced crop failure and did not harvest anything, particularly annual crops.

Food insecurity was clearly a major issue. Only 25% of sampled farmers produced enough food for their families, due mainly to a prolonged period of low rainfall. As a result, 49% of the farmers received relief food from the government in 2009. Relief food included maize, beans, and cooking oil, but the majority of families received only maize rations. The largest amount of food received by a household in 2009 was 45 kg. Some households relied on the local market for food supplies. The largest amount of maize purchased in the year by one household was 6 bags (540 kg), but purchases varied by household size.

Cassava Production

Cassava can be planted anytime during the year in the study area provided soil moisture is adequate. In areas such as Kiganjo, where precipitation is unreliable, planting was best after the first well-defined rainfall to ensure that the plants were exposed to as many months of rain as possible and to reduce losses. Cassava was best planted at the beginning of both the short or long rainy season and harvested 12 to 16 months later, depending on the variety. Farmers reported cassava cultivation in the study area as early as 1958, but the area under cultivation had decreased in the past decade (Table 2). Reduced rainfall for 3 consecutive years —in 2006, 2007, and 2008—could have resulted in the large decline in the number of cassava plants between 2004 and 2008. The number of farmers cultivating improved varieties of cassava increased by 18% during the same period, whereas the number of farmers growing local varieties decreased by 21%. More farmers were interested in cultivating improved varieties of cassava, but some farmers opted to stop planting cassava. The study showed that 92% of farmers with improved varieties had received the materials from the government and 8% from neighbours. However, due to the distance of the study area from the research institutes where the planting material was distributed, government-supplied planting materials sometimes arrived late, after the onset of the rainy season, resulting in some of the materials drying out (Ministry of Agriculture, unpublished reports, 2008).

Table 2. Cassava production in Kiganjo

Year	Planted area (ha)	Number of cassava plants per farmer	
		Maximum	Average
2000	2.4	150	14
2004	2.4	110	14
2008	1.4	50	8

Cassava Preparation

All farmers in the study area used boiling as the main method of cassava preparation, followed by roasting (47% of farmers), stewing (46%), and chip making (4%), and baking (3%). In Nyanza and Western provinces, where the proportion of farmers cultivating cassava is high, cassava is consumed chiefly as processed flours mixed with other cereals such as maize and sorghum. Together with the provision of planting material, the communities need training in the preparation of new recipes to allow them to create a variety of cassava dishes. The link between researchers and farmers should be strengthened as stipulated in the Ministry of Agriculture Strategic Plan 2008-2012 (Ministry of Agriculture, 2009).

The majority of respondent farmers (57%) considered cassava a main meal, and the rest considered it a snack. The method of preparation usually determined whether cassava was taken as a meal or a snack. Most of the men interviewed purchased roasted cassava in the market as a snack. Those who considered cassava a snack may not prioritize increasing and improving its cultivation and preparation, as compared to other crops.

Farmer Characteristics and Cassava Adoption Rates

Sex

Of the sampled farm households, 72% were headed by men and 28% by women (Table 3). Most female head of households were widows, but some were women whose husbands were working far from the farm. Among farm households headed by females, 13 (59%) cultivated cassava compared to 41 (72%) of farm households headed by males.

This gap was not significantly different based on the likelihood ratio test. Similarly, adoption of improved cassava varieties was not found to be dependent on the sex of the household head (38% for females and 29% for males).

Age

Farmers interviewed ranged in age from 29 to 70 years old, with 49 years old the average. Farmers 50 years old and younger accounted for 59% of those sampled. Of farmers over 50 years old, 72% cultivated cassava compared to 62% of farmers aged 50 years old or younger ($p=0.086$; Table 3).

The adoption rate of improved cassava varieties was not significantly different for farmers of different ages. Younger farmers may have been influenced by a combination of factors, such as having smaller farms and changing eating habits (resulting in their cultivation of crops to match their food preferences). The older generation may have recognized the value cassava has as a food security crop because it has assisted them in previous times of famine. In 1949, for example, a famine in Central Province was named after cassava (*ngaragu ya mianga*) because it was the only crop that survived the drought and available for food (Ministry of Agriculture, unpublished report, 2007).

Education

Among farmer respondents, 62% possessed a secondary education and 38% had a primary education (Table 3). In the group with a secondary education, 34 farmers (69%) cultivated cassava compared to 20 farmers (67%) with a primary education. The same proportion of cassava-cultivating farmers introduced improved cassava varieties among those with a secondary education and those with a primary education. Formal education did not seem influence decisions about cassava production or adoption of new varieties. This may have been because cassava cultivation does not require special management skills.

Membership in Extension Groups

Of the farmers interviewed, 76% were members of extension groups while 24% were not (Table 3). Farmers joining an extension group were thought to be more social, in that such membership offered more opportunity for interaction with extension agents and other farmers. Access to information about innovations was another benefit. Sampled farmers joined extension groups that focused on their concerns, such as crop farming (maize, beans, and pigeon pea—33% of farmers), dairy goats (28%), merry-go-round activities involving purchasing of household equipments for members in turns (19%), beekeeping (14%), tree nursery (5%), tissue culture (4%), cassava (3%), and horticulture (2%). The number of farmers that joined group activities related to cassava was clearly low. More groups dealing with cassava need to be formed by extension officers, and promotions of improved cassava varieties through other enterprise groups need further development.

Of the 54 farmers cultivating cassava, 43(80%) were members of an extension group. Among extension group members, 72% cultivated cassava, which was significantly higher than the proportion of cassava-cultivating farmers who were not members of an extension group (58%, Table 3).

The proportion of extension group members (88%) was far higher than that of nonmembers (12%) for farmers cultivating improved varieties of cassava. The proportion of extension group members (76%) was also larger than that of nonmembers (24%) for farmers cultivating only local varieties. Among cassava-cultivating farmers who cultivated improved varieties, 35% were in an extension group, which is significantly higher than the proportion of nonmembers (18%, Table 3). Extension group members may have had greater access to planting material for improved cassava varieties because the materials were primarily distributed through extension groups, as was the provision of training. The few nonmembers who cultivated improved varieties may have obtained planting materials from their neighbors. These findings are compatible with Githaiga's (2007) earlier findings in Kenya that the number of extension service providers accessible to extension group members was significantly higher than the number accessible to nonmembers.

Members of extension groups had higher incomes than nonmembers in most cases (Table 4). In addition to agricultural training, most groups pursued activities catering to those with higher incomes—saving and loan activities were common, as were welfare activities such as the planning of weddings and funerals. The groups were also used to source funds from government organizations. The multi-

Table 3. Distribution of farmers according to selected socioeconomic characteristics

Category of Farmers	No. of farmers cultivating local variety[a]	No. of farmers cultivating improved varieties[a]	Total no. of cassava cultivating farmers[b]	No. of farmers not cultivating cassava[b]	Total no. of farmers[c]
Sex of household head					
Male	29 (51) [71]	12 (21) [29]	41 (72)	16 (28)	57 (72)
Female	8 (36) [62]	5 (23) [38]	13 (59)	9 (41)	22 (28)
Total	37 (47) [69]	17 (22) [31]	54 (68)	25 (32)	79 (100)
Age of household head					
50 years and below	19 (40) [66]	10 (21) [34]	29 (62#)	18 (38#)	47 (59)
Above 50 years	18 (56) [86]	7 (22) [24]	25 (78#)	7 (22#)	32 (41)
Total	37 (47) [69]	17 (22) [31]	54 (68)	25 (32)	79 (100)
Educational level of household head					
Primary	14 (47) [70]	6 (20) [30]	20 (67)	10 (33)	30 (38)
Secondary	23 (47) [68]	11 (22) [32]	34 (69)	15 (31)	49 (62)
Total	37 (47) [69]	17 (22) [31]	54 (68)	25 (32)	79 (100)
Membership in extension groups					
Nonmembers	9 (47) [82*]	2 (11) [18*]	11 (58*)	8 (42*)	19 (24)
Members	28 (47) [65*]	15 (25) [35*]	43 (72*)	17 (28*)	60 (76)
Total	37 (47) [69]	17 (22) [31]	54 (68)	25 (32)	79 (100)
Received training on cassava					
Received training	21 (51) [70]	9 (22) [30]	30 (73)	11 (27)	41 (52)
No training	16 (42) [67]	8 (21) [33]	24 (63)	14 (37)	38 (48)
Total	37 (47) [69]	17 (22) [31]	54 (68)	25 (32)	79 (100)
Farm size					
≤0.8 ha	21 (48) [72]	8 (17) [28]	29 (62*)	18 (38*)	47 (59)
>0.8 ha	16 (50) [64]	9 (28) [36]	25 (78*)	7 (22*)	32 (41)
Total	37 (47) [69]	17 (22) [31]	54 (68)	25 (32)	79 (100)
Income from cash crops					
Without income	20 (43) [74]	7 (15) [26]	27 (59*)	19 (41*)	46 (58)
With income	17 (52) [63]	10 (30) [37]	27 (82*)	6 (18*)	33 (42)
Total	37 (47) [69]	17 (22) [31]	54 (68)	25 (32)	79 (100)
Income from livestock					
No income	16 (52) [84*]	3 (10) [16*]	19 (61#)	12 (39#)	31 (39)
With income	21 (44) [60*]	14 (29) [40*]	35 (73#)	13 (27#)	48 (61)
Total	37 (47) [69]	17 (22) [31]	54 (68)	25 (32)	79 (100)

[a]: Figures in parenthesis indicate the percentage of the total number of farmers in the given category. Figures in brackets indicate the percentage of the total farmers in the given category that cultivate cassava.
[b]: Figures in parenthesis indicate the percentage of the total number of farmers in the given category.
[c]: Figures in parenthesis indicate the percentage of the total number of farmers.
*: $p<0.05$ between two categories by the likelihood ratio test; #: $p<0.10$ between two categories by the likelihood ratio test.

Table 4. Average income and farm size for farmers according to membership or non membership in extension groups

Category of farmers	No. of farmers	Average income from cash crops (KES)[a]	Average income from livestock (KES)	Average farm size (ha)
Group member	60	12,467	38,891	1.1
Non-member	19	2,647	30,766	0.9

[a] KES80 ≈ US$1.

ple roles of many groups necessitated occasional membership contributions, effectively discouraging the membership of low-income farmers.

Training in Cassava Cultivation

Among farmers interviewed, 52% received training related to cassava (Table 3). For farmers cultivating the local varieties, 57% received such training while 43% did not. Of the 17 farmers cultivating improved varieties, 53% were trained while 47% were not, and the 9 who received training and grew improved varieties comprised 30%. Among farmers who received training of some kind, 27% did not grow cassava. Training did not significantly influence adoption of cassava cultivation. This may reflect the innovation adoption process, where the proportion of those aware of or having knowledge of an innovation is generally higher than the rate of adoption.

Farm Characteristics and Cassava Adoption Rates

Farm Size

All farmers interviewed were small-scale farmers, defined as farmers with less than 10 ha (Ministry of Agriculture, 2009). The largest farm holding was 2.8 ha, the smallest was 0.1 ha, and the average was 1.0 ha. About 59% of farmers had 0.8 ha or less, while the remainder owned more than 0.8 ha (Table 3). The proportion of farmers with more than 0.8 ha who cultivated cassava (78%) was significantly higher than that of farmers with 0.8 ha or less (62%), but the adoption rates of improved varieties were not significantly different for farmers with different farm sizes (Table 3). This suggests that, due to the scarcity of land, farmers with small holdings did not attach a high priority to cassava cultivation. Farmers with smaller farms were also usually below 40 years of age, with land apportioned by their parents.

Labor Availability

Farm labor in the study area was in most cases expensive and in limited supply, and it contributed much to farm production costs. The adoption rate of an agricultural technology can be greatly influenced by whether it raises or lowers requirements for labor inputs. Farmers will favor and more rapidly adopt technologies that reduce labor inputs, and tend to be reluctant to adopt a technology that increases labor inputs (Feder *et al.,* 1982).

Cassava in the study area was mainly intercropped with other crops such as maize and beans, with only three of the interviewed farmers cultivating pure stand. Consequently, it was not possible to segregate labor devoted to cassava cultivation. However, cultivation practices for improved cassava varieties are not different from those for local varieties. When queried about setting up the cultivation of cassava, 82% of the farmers interviewed said it was easy and the remaining 18% said it was difficult. Labor constraints were thus not a likely constraint in the adoption of improved cassava varieties.

Cash Crop Income

The main cash crop in the study area was coffee, cultivated by 61% of respondent farmers but only 42% earned income from the crop. This was due mainly to the collapse of cooperatives, which led to farmers incurring significant losses in the coffee sector and discouraged farmer investment in coffee.

The highest annual cash crop income in 2000 for the interviewed farmers was US#563 (Kenya shilling [KES] 45,000), but this dropped in 2004 to US #488 and to US#250 in 2008 because of a decline in precipitation. Maximum income was approximately US#2 per day, not enough to support family needs, especially if farm food production was inadequate. Further, income from coffee was paid in two or three installments per year, and payment

was not reliable. Among farmers with income from cash crops, 27 (82%) cultivated cassava, a significantly higher ratio than that of farmers without income (59%; Table 3). Of the farmers who had income from cash crops and cultivated cassava, 37% cultivated improved varieties. Although this proportion was larger than that of farmers without income (26%), the difference was not significant. The results show that farmers with higher incomes do cultivate cassava and may contradict the perception that cassava is a crop for the poor. However, cash crop income may also have been directly related to farm size.

Income from Livestock

The sale of livestock and livestock products was the main source of income in the community and was based on the sale of milk, dairy cows, dairy goats, and poultry. The average annual income from the livestock for the sample farmers was US #215 (KES17, 164), ranging from US#25 (KES 2000) to US#1,725 (KES138, 000).

Of the farmers interviewed, 61% had income from livestock while 39% did not (Table 3). Thirty-five (73%) farmers with income from livestock cultivated cassava. A smaller proportion (61%) of farmers cultivated cassava among those without income from livestock. Fourteen (40%) farmers with income who cultivated cassava had introduced improved varieties, a significantly larger proportion than among corresponding farmers without income from livestock (16%). The level of livestock income apparently influenced farmer decisions to adopt improved cassava varieties. Income from livestock was usually paid in monthly installments, which is superior to cash crop payments for supporting the frequent daily expenses common on farms. Livestock income also was more reliable than cash crop income. Farmers with frequent and reliable income were usually able to participate in social groups requiring monthly contributions, unlike farmers without regular income. The high rate of adoption of improved cassava varieties may thus be linked to membership in extension groups where members received planting material of improved varieties from the government.

Average cash crop and livestock income of farmers varied considerably according to membership or non membership in extension groups (Table 4). Farmers without livestock were usually poor with small farms. Low-income farmers also rarely joined extension groups, thus they lack access to information about innovations from change agents.

Farmer Perceptions and Attitudes

Farmer access to accurate information can influence their attitudes toward technologies. A thorough investigation is required to reliably determine such attitudes and perceptions (Rahim, 1963). Among farmers interviewed, 87% did not refer to cassava as a poor man's crop, and 92% thought cassava could be served to visitors (Table 5). These responses showed that farmers did not have a negative attitude toward cassava. Fifty-seven percent of respondent farmers did not seem to be aware of the presence of poison (cyanide) in cassava, and 28% did not know that the level of cyanide content varied according to cassava variety. Some respondents were thus not aware of the advantages of improved cassava varieties with low cyanide levels.

Questioned about the market for cassava, 92% of farmers interviewed said there was a market for cassava (Table 5). A few farmers occasionally sold cassava at the local market, but the majority waited for middlemen and women who move from farm to farm buying cassava—especially during the dry season. Cassava purchased by middlemen and women was destined primarily for local markets and local town centers, where it was usually roasted and sold as snacks. The farm gate price of one cassava root weighing approximately 1 kg averaged US$0.125 (KES10). A comparison of the yields and market prices of cassava and other crops in the area, such as maize, indicated that cassava would produce more income per hectare. For example, a conservative estimate of 6 t/ha of cassava in 1 year would yield income of US$375 (KES30, 000), while a 900 kg (10-bag-per-season) yield of maize on 1 ha in the study area would generate US$300 (KES24, 000) in 1 year. In addition, maize also requires a higher level of inputs, such as fertilizer, compared to cassava. However, extension officers have not sufficiently promoted cassava as a cash crop, as demonstrated by its absence from the District Farm Management Guidelines for 2009. From the responses given in table 5 and table 6 on marketing lack of market does not seem to be a major constraint to cassava production or to the adoption of improved varieties. It appears that

Table 5. Summary of farmer attitudes and perceptions concerning cassava

Question	Yes[a]	No
Is cassava food for the poor?	9 (11)	70 (89)
Can cassava be given to visitors?	6 (8)	73 (92)
Is cassava cooked or eaten as a last resort?	5 (6)	74 (94)
Is cassava eaten in developed countries like the USA?	30 (38)	49 (62)
Does cassava contain poison?	34 (43)	45 (57)
Is cassava poison level the same in any part of the plant?	9 (11)	70 (89)
Is amount of poison the same in all cultivars?	22 (28)	57 (72)
Is there market for cassava?	6 (8)	73 (92)
Should planting material be free?	22 (28)	57 (72)
Are cassava leaves edible?	40 (51)	39 (49)

[a] Figures in parentheses indicate the percentage of the total number of farmers.

farmers did not exploit marketing opportunities for cassava and did not consider cassava a cash crop. The market for cassava should be exploited to demonstrate its potential to contribute positively to the economic performance of farms. Such performance has been found to be a major factor influencing the adoption of agricultural technology (Rahim, 1963).

Reasons Why Farmers did not Cultivate Cassava

When queried about the principal reasons for the low rate of adoption of new cassava varieties, most farmers interviewed (58%) cited the lack of planting material (Table 6). This was in agreement with Feder *et al.* (1982), who cited supply constraints as a major factor limiting adoption of high-yield varieties, and reported that most farmers would not adopt these varieties unless seeds and some complementary inputs (such as fertilizer) were made available. Though most respondent farmers did not use fertilizer in cassava cultivation, easy access to planting material was necessary for an increased rate of adoption. Mammalian pests (e.g., moles, porcupines, and wild swine) were also cited by 31% of farmers as a major factor discouraging cultivation of cassava. This finding was in agreement with the results of Karanja *et al.* (2006). When no other crop but cassava was left on farms—particularly during seasons of drought, pests were left with only the cassava to feed on. This problem could be reduced if farmers learned simple processing technologies. All cassava could then be harvested at maturity and dried and stored, thus reducing the amount destroyed. The Ministry of Agriculture Crop Protection Division and stakeholders should investigate means of minimizing the pest problem. Farmers should also adopt indigenous methods for trapping pests such as moles.

Table 6. Farmers' reasons for not growing improved varieties of cassava

Reason	No. of farmers[a]
Lack of planting material	34 (58)
Mammalian pests	18 (31)
Cassava is poisonous	3 (5)
No market for cassava	1 (2)
Bad weather	3 (5)

[a] Figures in parentheses indicate the percentage of the total number of farmers who did not grow improved varieties.

Conclusions and Recommendations

Farmers poor in resources—particularly land and income—formed the largest group among those sampled who did not adopt the new varieties of cassava. Farmers who were members of extension groups showed the highest percentage of farmers adopting these varieties. This finding was in agreement with earlier studies revealing that farmers who were members of extension groups had more access to agricultural extension services and received more social and economic benefits than marginalized groups (Githaiga, 2007). Expanded efforts and improved approaches are needed to

more effectively reach resource-poor farmers, who are more vulnerable to food insecurity. Younger farmers also should be targeted in the promotion of cassava cultivation.

The lack of planting material emerged as a major challenge to expansion of cassava cultivation. Although the Ministry of Agriculture supplied planting material through the orphan crop program, it appeared that the needs of farmers for material were far from being met. In addition to planting material, farmers could be assisted with establishment of cassava bulking sites in local areas in collaboration with the research institutes. This would create a reliable source of planting material within the reach of farmers. The supply of planting material of newly released cassava varieties boosted cassava adoption in Thailand according to a report on the cassava industry in Thailand by Dr. Charanza of Kasesart University (unpublished report, 2008).

Destruction of cassava by mammalian pests—e.g., porcupines, wild swine, and moles— was a major factor discouraging farmers from its cultivation. Farmers and other concerned stakeholders need to find means of mitigating the destructive effects of wildlife if the cultivation of root crops such as cassava is to be successful. The community should minimize the effects of mole infestation by using both indigenous and other technologies for trapping moles.

Agro-processing technology should be promoted among farmers in line with the Kenya Vision 2030 and the Ministry of Agriculture Strategic Plan 2008–2012. Such technology could include home or village-level processing, involving peeling, drying, and milling of cassava into flour, which is easier to store and prepare as various products and could reduce reliance on wheat, which is mainly imported. This strategy would enable farmers to stop the piecemeal harvesting of cassava and the storage of cassava roots in farms. Stored roots are vulnerable to destruction by porcupines and moles. Farmers could instead harvest all their cassava at maturity, process it, and store the processed product. Agro-processing also could generate new marketing opportunities by reducing product perishability and permitting use of a wide range of recipes. Both of these benefits of agro-processing would enhance food security.

Farmers who are members of extension groups could be persuaded to accept additional social responsibility and consent to being trained to effectively share with poor farmers the knowledge and materials they have received through extension groups. Poor farmers rarely join the groups and may suffer from low self-esteem. Such sharing could help reduce the gap between rich and poor.

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