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Participatory Rural Appraisal of Farmers' Criteria for Selection of Maize Varieties and Constraints to Maize Production in Moist-Midaltitude Zone of Western Kenya

A case study of Butere-Mumias, Busia and Homa Bay Districts

Odendo, Martins[1], De Groote, Hugo[2], Odongo, Omari[1] and Oucho Patrick

[1]Kenya Agricultural Research Institute, Regional Research Centre, P. O. Box 169, Kakamega
[2]International Maize and Wheat Improvement Centre (CIMMYT), P. O. Box 25171, Nairobi

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Summary
Maize is a staple food for most households in Kenya and is grown in almost all agro-ecological zones. In the moist mid-altitude zone of western Kenya, which is drought prone and *Striga* weed infested, on-farm maize yield is too low to keep up with the rate of population growth, leading to serious food insecurity and poverty. The low yield is associated with low adoption of productivity improving technologies such as improved seed, which many farmers believe is inappropriate. The objectives of this study were to determine maize varieties farmers grow, farmers' preferences in choice of the varieties and to evaluate farmers' perceptions of constraints to maize production, on which basis research strategies for improvement of maize production could be formulated. The study, which was conducted in the year 2000 in 5 villages sampled from 3 districts, involved 8 focus group discussions composed of 83 male and 60 female farmers and interviews of individual key informants using a checklist. Scoring and ranking techniques were used to assess farmers' preferences and constraints. Nearly 80% of the farmers predominantly grow local maize varieties, whose seed they recycle for many seasons, whilst about 20% grow improved varieties, often in addition to the local varieties. The key farmers' criteria for variety selection, in order of importance are high yield, early maturity, tolerance to *Striga*, low cost of seed, tolerance to diseases, the ability of a variety to perform reasonably without application of fertilizers and resistance to insect pests.

The most important constraints perceived by farmers are low soil fertility, lack of financial resources to purchase inputs, especially fertilizers and seed, and low technical know-how. Others are *Striga* and stem borer damages, vagaries of weather, and low quality seed on the market. *Striga* is considered the most important pest, followed by weevils and stem borer. For increased maize production, research scientists should take into consideration the farmers' circumstances and develop appropriate maize varieties and crop management packages in order to increase likelihood of the technology adoption. This study shows how an interdisciplinary team of KARI and CIMMYT scientists involved farmers not only as end-users of maize technologies, but also as essential contributors to formulation of maize breeding research agenda that address the farmers' preferences and conditions.

Introduction

The national food security in Kenya is often pegged to availability of adequate supplies of maize to meet domestic demands. Maize is a staple food for most households in Kenya and is grown in almost all agro-ecological zones, including marginal areas on both large and small-scale farms. Smallholder producers account for over 70% of the total production and above 80% of the total maize area. However, the large-scale farmers contribute a significant proportion of marketed maize (Karanja, 1993). Under farmers' conditions, the national average maize yield is about 2 tons ha^{-1}, while potential exists for increasing the yield to over 6 tons ha^{-1} through increased use of improved seeds, fertilizers and good crop husbandry (GoK, 1997a). Annual per capita maize consumption in Kenya is about 125 kg (GoK, 1983), which is among the highest in the world. Although most small-scale farmers do not obtain adequate maize production to meet their household needs, they still sell part of the produce to meet other domestic requirements.

Stem borer and *Striga* are the two major biotic constraints to increased cereal production Kenya (ICIPE, 2000). Farmers in Kenya estimate crop losses due to stem borer at 15% of their ultimate harvest, amounting to 400, 000 tons of maize valued at US $ 90 million (CIMMYT, 1999), whilst *Striga* infestation causes 30-100% loss in maize yield in eastern

Africa (Hassan, 1998). In the moist mid-altitude zone of western Kenya, which is drought prone and *Striga* weed infested, maize is an important crop grown by almost all households in at least one cropping season per year. However, on-farm maize yield is too low to keep up with the rate of population growth, leading to serious food insecurity and poverty. Hassan (1998) reported that about 42.6 % of the total maize area in Kenya falls in the moist midland zone. The total maize production in the zone is about 232,000 tons, whilst consumption is approximately 387,000 tons, indicating a deficit of 155,000 tons per year. A recent survey in Siaya District, in the moist mid altitude zone in western Kenya (Achieng et.al. 1999) reveals that maize yield in the area stands at 0.5 - 0.7 tons/ha, while on-farm trials indicate that 1.4 - 1.6 tons/ha can be achieved when improved maize varieties and fertilizers are applied. The low maize yield is associated with low adoption of productivity improving technologies such as improved maize seed and low or non application of fertilizers (Hassan, 1998; Achieng et.al, 1999).

Farmers' low adoption of technologies developed by research institutions show the need for client-orientation in research and development (KARI/ISNAR, 1996). The key factors that constrain farmers' adoption of technologies are inappropriateness of the technologies, unavailability of required inputs and farmers' socio-economic conditions (Rogers, 1983; KARI, 1996). Technologies that do not meet farmers' preferences, objectives and conditions are less likely to be adopted (Upton, 1987). Farmers are more likely to assess a technology with criteria and objectives that are different from criteria used by scientists. However, farmers' and scientistis' criteria for technology assessment are complementary and essential for effective research and technology development. Farmer evaluations help scientists to design, test and recommend new technologies in light of information about farmers' criteria for usefulness of the innovation (Ashby, 1991; KARI/ISNAR, 1996). In this context, participation is crucial. Participatory research allows incorporation of farmers' indigenous technical knowledge, identification of farmers' criteria and priorities and definition of research agenda. Participatory Rural Appraisal (PRA) tools were applied to capture farmers' perceptions and preferences. Some authors (e.g. KARI/ISNAR, 1996; De Groote and Bellon, 2000) emphasize that PRA, which involves local people in gathering and analyzing information, allows seeking of insights about local people and their actual conditions, and fosters dialogue between scientists and farmers. By integrating farmers' concerns and conditions into agricultural research, it is hoped that research would develop technologies that become widely adopted, resulting in more productive, stable, equitable and sustainable agricultural systems.

To address maize yield loss due to stem borer, the Insect Resistant Maize for Africa (IRMA) project was launched in 1999 by the International Maize and Wheat Improvement Center (CIMMYT) and the Kenya Agricultural Research Institute (KARI), with financial support from the Novartis Foundation for Sustainable Agriculture. The goal of the project is to increase maize production and food security through development and deployment of insect resistant maize varieties, thereby significantly reducing the crop losses. In order to estimate potential adoption of the new varieties and facilitate overall evaluation of potential benefits of developing the varieties, an assessment of attributes of maize varieties preferred by farmers and socio-economic environment under which the farmers operate is an important starting point. The objectives of this study were to determine maize varieties farmers grow, farmers' preferences in choice of the varieties and to evaluate farmers' perceptions of constraints to maize production, especially insect pests, in the context of other constraints farmers face. The study forms a basis for formulating research strategies for improvement of maize production.

Methodology

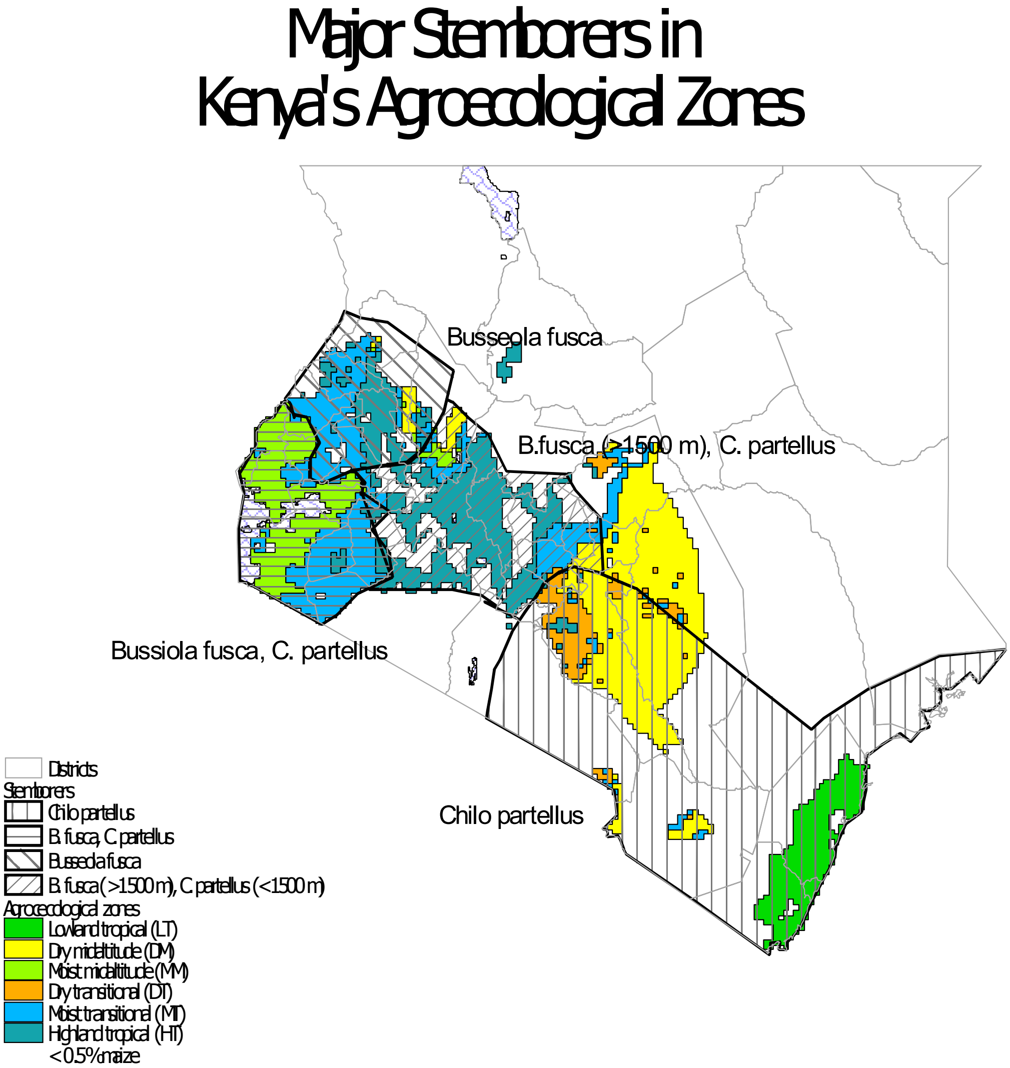
The Study Area

The study was carried out in Butere-Mumias and Busia districts in Western Province and Homa Bay District in Nyanza Province. Table 1 shows the selected study sites and the number of farmers who attended the meetings for focus group discussions, whilst the coordinates of the study villages are shown in appendix 1.

Table 1: Sampled study areas in moist mid-altitude zone of western Kenya

District	Division	Location	Village (s)	Male	Female	Total
Butere-Mumias	Butere	Shianda	Ebubala	17	23	40
Busia	Butula	Lugulu	Bulemia	17	20	37
	Matayos	Bukhayo West	Sirisia	24	3	27
Homa Bay	Ndhiwa	West Kanyamwa	Kayambo	12	10	22
	Rangwe	East Gem	Koyolo	13	4	17
TOTAL				83	60	143

The largest area of the two Provinces falls in the moist mid-altitude agroecological zone (Figure 1), which falls within *Striga* infested Lower Midland (LM) agro-ecological Zone (Jaetzold and Schimdt, 1983). The zone is sub-divided into LM_1 to LM_4 zones based on altitude, which ranges between 1100-1500 meters above sea level. Mean annual temperature is 12-24^{o}C. There are contrasts of rainfall, mainly due to local air circulation. Annual rainfall averages 700-1800mm and is bi-modal. The rainfall amount and pattern are modified by altitude, with higher elevation areas receiving relatively more rainfall than the lower elevations. First season in a year starts in February/March and second in August/September. At lower elevations, at the shore of Lake Victoria, the rainfall is less and the second season is less reliable. Most farming activities follow the rainfall pattern. Soils are varied, however, they are mainly clay-loam and sandy-loam and generally less fertile because there is very little volcanic or other young parent materials. In some areas such as Busia District the soils have laterite horizons (Jaetzold and Schimdt, 1983).



Agroecological zones: after Hassan (1998), stemborers after W. Overholt (pers. comm.)

Human Population

The population in the mid altitude zone is quite variable. According to the recent population census (GoK, 2000), the population of the study districts is shown in Table 2. Mumias-Butere is the most densely populated and Homa Bay the least. Whilst Butere-Mumias and Busia districts are predominantly occupied by different Luhya sub-tribes, Homa Bay is dominated by the Luo tribe.

TABLE 2. Population and density of the study Districts in western Kenya

DISTRICT	AREA (km^2)	MALES (000)	FEMALES(000)	TOTAL (000)	DENSITY Persons/ km^2
BUSIA	1262	174	197	371	294
BUTERE-MUMIAS	935	227	251	478	511
HOMA BAY	1156	137	154	291	252

Source: Adapted from the 1999 National Population Census (GoK,2000)

Road network and markets

Existence of well-developed socioeconomic infrastructure sets the base for improved agricultural productivity and industrialization. It hastens accessibility, reduces transport costs of inputs and outputs and lessens imbalances in resource distribution. Busia district has a fairly well distributed road network of 532.7 km but only 27 km, which is part of the national trunk road, is tarmacked. Thirty percent of the roads have gravel, leaving most of the district with seasonal roads. Butere-Mumias district, especially Mumias, Matungu and Butere divisions, which are in the sugarbelt have good gravelled roads which are maintained by Mumias sugar Company. There is a short railway extension between Butere and Kisumu. Homa Bay on the other hand has one main tamarcked road that cuts across the district. The rest are mainly earth roads, which are impassable in the rainy periods (GoK, 1997b; 1997c). All the districts generally have a large number of open markets, which meet at least twice a week.. Agricultural products form greatest proportion of the market transactions. However, marketing of the products is poorly organized.

Farming Systems

Mixed farming is the dominant farming system in the Moist Mid-altitude (MMA) agro-ecological zone in western Kenya. Despite the presence of livestock, mainly indigenous, crop husbandry dominates the agricultural activities. The main crops grown include, maize, sorghum, cassava, sweet potato, arrow roots, banana, bambara nuts, ground nuts, finger millet, beans, cow pea, green gram, sugarcane and cotton. The major cash crops are sugarcane, tobacco and cotton, although cotton and sugarcane productions have been adversely affected by poor marketing. Most of the other crops serve a dual purpose as cash and subsistence crops, but mainly subsistence. Livestock comprises mainly local breeds of cattle (zebus), chicken, sheep and goats (MoA, 1999; SDP, 2000).

Maize is grown in both long and short rain seasons. Farmers consider the long rain as the most important season for maize production due to relatively high reliability of weather in the season compared to the short rains. Relatively more land and other inputs are applied in the long rain season. According to Hassan (1998), the area under maize in the moist midaltitude zone during the long rain season is 47% more than that of the short rain season. Most farmers inter-crop maize with other crops. In Homa Bay, for instance, maize is intercropped with one or more of the following crops; sorghum, beans, groundnuts, cotton, sweet potato, cowpea, or soyabean. Cotton and sweet potato are relay-cropped in maize when maize is nearly ready for harvest. In Busia District, maize is intercropped mostly with cassava or beans or cowpeas, while in Butere - Mumias it is intercropped mainly with beans. However, in all the study sites, it is common to find a multiple intercrop such as maize, cassava, finger millet and sorghum. In all sites, livestock are mainly confined by tethering or semi-grazing systems and mostly fed on natural pastures, Napier grass and some waste crops (SDP, 2000; personal communication with MoARD staff in Busia, Butere-Mumias, and Homa Bay districts, 2000).

Recent studies in the moist mid-altitude zone show (e.g. KARI, 1994; MoA, 1999; Achieng et.al, 1999; SDP, 2000; MoRD staff, personal communication, 2000) that farmers have multiple objectives, which they strive to achieve mainly through farming. The first priority for majority of the households is to obtain adequate food supply, followed by generation of cash to meet other domestic requirements and for development. The third priority is to achieve prestige in the society, as a result of achievement of the first two objectives. In their bid to achieve these objectives, farmers face a myriad of constraints, especially inadequate financial resources to purchase farm inputs such as inorganic fertilizers and improved seeds. Whilst majority of the farmers appreciate the importance of inorganic fertilizers in maize production, most of them are resource-poor and cannot afford adequate or some fertilizer. Additionally, crop and livestock diseases and pests, and lack of technical know-how on agricultural practices, as a result of poor extension services, also constrain farmers. Others constraints are declining soil fertility, high *Striga* infestation, vagaries of weather (drought, unreliability, hailstones), poor infrastructure and poor marketing.

Data sources

Primary and secondary data sources were utilized. The primary data were generated through interview of male and female farmers as well as key informants using Participatory Rural Appraisal (PRA) approaches. Data were collected from 8 focus group discussions composed of 83 male and 60 female farmers (Table 1). The key informants included maize researchers, experienced farmers in the villages, local leaders and agricultural agents. Secondary data were obtained from the Kenya Government establishments and some relevant public as well as private institutions.

Sampling procedures

A multi-stage sampling techniques were applied to select the study sites that represent diverse ecological and socio-economic environment and varying maize production systems in the moist mid-altitude zone. The zone was stratified into three sub-zones to allow capturing of variability in the whole zone and one district purposively selected from each sub-zone. Two divisions were randomly selected from each district. The major criteria for stratification were relative importance of maize, severity of *Striga*, agroecological zones, ethnicity and presence or absence of sugarcane. It is believed that sugarcane acts as an alternate host for stem borer and thus reduces its incidence. Busia district was selected to represent *Striga* prone area, Butere-Mumias for sugarcane zone where maize is a very important crop and Homa Bay for *Striga*-and drought prone area where maize is a relatively less important crop. Two divisions were randomly selected from each district, except for Butere-Mumias where only one was selected.

A list of all locations in each of the selected divisions was obtained from respective divisional agricultural and administrative staff, from which one location was randomly selected and then a list of all sub-locations obtained, from which 1 or 2 sub-locations were sampled. One village[1] was then randomly selected using lists of villages as the sampling frames.

Data collection and analysis

The research team comprising an interdisciplinary team of KARI and CIMMYT researchers and Ministry of Agriculture staff visited the chosen villages, under guidance of frontline agricultural staff. This visit aimed at familiarizing the research team with the study sites, establish a good rapport with the local people and relevant Government agencies and have a feeling of the study areas. After some discussion, the local administrators and extension staff were asked to mobilize farmers, both male and female for focus group discussion on agreed dates, venue and time. Checklists were developed and used to guide discussions with farmer groups and individual key informants. The objectives of the project and contributions of various actors were explained and communication procedures established to ensure that farmers and researchers were at the same wavelength and discussing the same issue.

The farmers were encouraged to use a language they were most familiar with. A member of the research team most versed with the local dialect facilitated the group discussions. For ease of focusing the discussions and reaching a consensus, the farmers were asked to form discussion groups depending on the number of farmers who attended and their composition. Sex and age were the important criteria the farmers used in categorizing themselves into discussion groups. The farmers were asked to list maize varieties they grow, and the relative proportions of the varieties. They were also asked to list and rank the criteria they used in variety selection in terms of their relative importance and main constraints to maize production. The groups were given some flip charts and felt pens to allow them write results of their discussions. In almost all cases, each farmer group appointed a rapporteur. The role of the research team was to facilitate farmers' discussions, whilst the farmers took the lead of the meeting to allow free discussion. At the end of the exercise, whenever time allowed, there was a plenary session whereby each group was given a chance to present its results to the whole group of farmers who had attended the meeting for validation, verification and modification.

Results and Discussions

Maize varieties grown

Table 3 shows maize varieties grown in the moist mid-altitude zone of western Kenya. Farmers grow an assortment of maize varieties. Both local landraces, often referred to as local varieties and improved varieties are grown to meet farmers' multiple objectives in maize farming. About 80% of the respondents predominantly grow local varieties, whilst only 20% dominantly grow improved maize varieties, often in addition to the local varieties. In some instances, either the same local varieties are known by different names or different varieties known by the same names, depending on the area of reference and local dialects. The names of the local maize varieties are often descriptive, referring to certain key identifiable characteristics especially grain colour, appearance, growth habit and the perceived place of origin. The variety *Jowi Jamuomo*, for instance, refers to a charging buffalo, in apparent reference to high growth vigour of the variety. The variety is perceived to be able to survive despite the odds of harsh environment, including *Striga*, low soil fertility and drought. *Nyamula* and *Shipindi*, both yellow-grained landraces grown mostly in Nyanza and Western Provinces respectively, are reportedly tolerant to *Striga* and stem borer. The

[1] Kenya is administratively divided into provinces, districts, divisions , locations, sub-locations and villages. A village is the smallest administrative unit

variety *Nyar Maragoli* refers to origin of the variety, which is believed to be Maragoli area in Vihiga district in Western Province. In the same vein, the variety *Ke-Buganda* is an open pollinated variety (OPV) imported from Uganda.

TABLE 3. Maize varieties grown by site and gender

Names of varieties	% farmers indicating that they grow the variety					
	Butere – Mumias N=40		Busia n=64		Homa Bay n=39	Mean %
	Male=17	Female =23	Male=41	Female=23	Male=25 Female =14	
Shipindi/Sipindi	25	100	95	100	0	80
Ke-Buganda	0	0	93	100	0	39
H622	6	60	36	0	41	29
Samaria	45	100	0	0	0	29
Nyamula	0	0	0	0	100	25
H511	0	0	25	36	60	24
Pioneer 3253	12	10	100	0	0	24
H614	53	28	0	0	25	21
H513	12	0	64	0	0	15
Opapari	39	22	0	0	0	12
Katumani	0	5	10	0	24	8
Maseno double cobber	6	6	0	0	40	8
Nyar Maragoli	0	0	0	0	38	8
Pwani Hybrid 1(PH 1)	0	0	0	0	40	8
Imodi	0	0	0	36	0	7
H632	0	0	25	0	0	5
Jowi Jamuomo	0	0	0	0	20	4
H512	0	0	0	14	0	3
Pannar	0	0	13	0	0	3
Radier	0	10	0	0	0	2

Note: 1) Percentages are estimates based on opinions of the number of farmers who attended the Meetings and rounded to the nearest tenth.
2) 0 Indicates that the variety was not mentioned at the site

Some varieties are grown in both long and short rain seasons, whilst others are only planted in either of the seasons. In Homa Bay and Butere-Mumias Districts, for example, most households plant *Nyamula* and *Shipindi* respectively in both seasons, while hybrid H622 and PH 1, which are not drought tolerant are only grown in long rain season by a small proportion of farmers as a risk management strategy since the short rain season is more unreliable. In Butere-Mumias, however, *Samaria*, which is white-grained, early maturing and perceived to be drought tolerant, is grown by most households in both long and short rain seasons. Women in Butere-Mumias perceived that all households grow *Samaria* in both seasons. While men confirmed that the variety is grown in both seasons, they are conservative in their figures of the proportion of farmers growing it. Since women are more involved in farming they probably provide the most reliable figures. *Shipindi* is grown by relatively fewer farmers in both seasons, whilst Ke-Buganda is widely grown in Busia District, especially during the long rains.

Farmers indicated that they were willing to buy new varieties that are resistant to stem borer if availed as long as the price is equal to current market price of other commercial seed maize and utmost 25% higher. In addition, the farmers' willingness to buy such varieties was contingent to the new varieties having other desired attributes, especially high yielding, early maturing and resistance to *Striga*. Other considerations were field demonstration of the new varieties to show superiority of the varieties to the ones they currently grow and assurance that the seeds will be of high quality.

Farmers' choice of varieties

In all the study sites, farmers use complex combinations of criteria in selecting the maize varieties they grow. The main criteria farmers apply in choosing maize varieties they grow and the extent of contribution of each criterion are shown in Table 4. Farmers' perceptions and rating of the different criteria varied across the study sites. The most important criteria across the sites were high yield, early maturity and tolerance to *Striga*, low cost of seed, tolerance to diseases, the ability of a variety to perform reasonably without application of fertilizers and resistance to insect pests. Early maturity considered an important criterion for three main reasons. Early maturing varieties allow farmers to prepare land in order to plant the crop twice a year to fit the bimodal rainfall pattern. Other reasons are that early maturity allows the crop to escape drought and ensures early provision of food to the households to alleviate hunger. Taste was rated lowly in all sites because the farmers only considered taste as important when they have adequate maize output, however, most households often obtain less than they require for home consumption. Additionally, taste is considered somewhat important when a variety is grown mainly for farm household consumption. Although taste was mentioned in Ndhiwa and Butere, it was ranked among the least important criteria in both sites. Women in Butere ranked taste least important, whilst men did not rank it at all. Resistance to insects and other pests as a criterion for selection of maize varieties was considered useful in practice if the attribute is combined with the most important criteria farmers apply in variety selection, thus adding value to the varieties.

TABLE 4. Scoring of main criteria for maize variety selection

Criteria for Preference	Site Scores			
	Butere-Mumias	Busia	Homa Bay	Mean score
	Score	Score	Score	Score
High yield	3.0	3.0	3.0	3.0
Early maturity	2.5	3.0	3.0	2.8
Tolerant to *Striga*	2.5	2.7	3.0	2.7
Low cost of seed	2.5	2.5	2.0	2.3
Tolerant to diseases	2.0	3.0	2.0	2.3
Compact grain	2.0	2.5	2.0	2.2
Low external input demand	1.0	3.0	2.0	2.0
Resistant to field insects/ pests	2.0	2.0	2.0	2.0
Low lodging	2.0	0	0	2.0
Resistant to storage pests	1.0	2.0	0	1.9
Drought tolerant	0	2.3	2.5	1.6
Large grain size	0	3.0	0	1.0
High no. of rows/cob	3.0	0	0	1.0
Taste	1.0	1.3	1.0	1.0
Grain colour	1.0	1.0	1.0	1.0

Notes: 1) Scores: 1= of minor importance, 2= Moderate importance, 3= very important; and 0=criteria not mentioned

2) Mean scores are computed per site and for all sites

In Homa Bay, high yield, early maturity, *Striga* and drought tolerance were the key criteria for selecting maize varieties. *Nyamula* and *Ke-Buganda*, for instance, were preferred to hybrids due to their early maturity, tolerance to *Striga* and drought, as well as their ability to perform fairly under low soil fertility or no fertilizer application and their low vulnerability to diseases. Most of these attributes of the local varieties are perceived by farmers to lack in most improved varieties, thus partially explaining low adoption of improved maize varieties and high preference for local varieties. Also, most farmers lack resources to pay for improved seed on regular basis. In addition, negative attitude of farmers to the improved commercial maize seed mainly occasioned by previous experiences whereby farmers unknowingly purchased adulterated or fake seeds, which have low germination rates, are low yielding and not true-to-type also contribute to low usage. Under these circumstances, farmers resort to planting their own maize seed, which are cheap as the local varieties are open pollinated varieties (OPVs) and hence recycled without marked yield loss. For example, most farmers in Homa Bay grow local landraces, especially *Nyamula,* which they recycle for a long time to the extent that they cannot precisely remember the time period. Some farmers also recycle hybrid maize for the same reasons and also due to lack of knowledge. In Homa Bay sites, unlike Butere-Mumias and Busia, farmers recycle both local landraces and hybrids. To recycle, maize cobs are selected at the time of harvesting and separated from others by not removing husks. The main criteria used in selecting the cobs for seed across the study sites are large cobs, and free from diseases and pests. The belief is that maize seed from larger cobs produce high yield in subsequent generation. The selected cobs are either not shelled and hang at the fireplace till next planting season or shelled, sun-dried and treated with ash to control storage pests, especially weevils. The farmers, however, experienced yield decline, high incidence of diseases and pests and high crop variability upon recycling hybrid maize. The number of recycling is determined experientially.

Constraints to maize Production.

Farmers face several constraints in maize farming. Table 5 shows the main constraints to maize farming. Farmers' prioritization of the constraints was based on number of households affected, severity of the constraint, importance of the constraint in attainment of household objectives, frequency of occurrence of the constraint and the likelihood of a solution being provided by research team. The most important constraints perceived by farmers are low soil fertility, lack of financial resources to purchase inputs, especially fertilizers and seed, and low technical know-how. Others are *Striga* and stem borer damages, vagaries of weather, and low quality seed on the market.

The farmers highly ranked poor cash flows as a key constraint because they believed that alleviation of the constraint would lead to alleviation of many other constraints. Although, in some instances, farmers did not explicitly indicate that the cost of seed and low soil fertility are some of the constraints they face, their assertion that they lack cash to buy the inputs, implies that the constraints actually exist. Availability of low quality agricultural inputs in the market is the other constraint mentioned by farmers. Maize seeds, for instance, are often adulterated or not true to type. Marketing of maize grain is widely believed as a constraint to maize farming in Kenya, however, in the MMA zone of western Kenya, it was not mentioned as a constraint, probably because of small quantities of maize sold by producers in the zone.

TABLE 5. Farmers' perception and ranking of major constraints to maize farming.

	Scores by site			
Constraints	Butere-Mumias	Busia	Homa Bay	Mean score
Low soil fertility	5.0	2.0	5.0	3.5
Liquidity problems	5.0	4.0	1.0	3.3
Poor extension service	1.0	4.0	1.0	3.0
Striga weed	1.0	2.3	2.5	1.9

Unreliable rainfall	2.5	2.3	1	1.9
Stemborer	4.0	1.0	0	1.7
Field Insect pests	2.5	1.0	1.0	1.5
Low quality seed	0	1.0	2.0	1.5
Rats and moles	2.0	1.0	0	1.0
Theft	1.0	1.0	1.0	1.0
Termites	1.0	1.0	1.0	1.0
Head smut	1.0	1.0	0	0.7
Maize streak	1.0	1.0	0	0.6
High price of seed	1.0	0	0	0.3

Note: Criteria ranked on 1-5 scale . If a group ranked a criteria 1st, received 5 scores; 2nd, received 4 scores; 3rd; 3,scores; 4th, 2; 5and above, 1 score; and when a criteria not mentioned, 0 score.
(2) Mean scores were computed per site

Maize pests and farmers' coping Strategies

The major maize pests are *Striga***,** stem borer, weevils, termites and moles (Table 6). *Striga* is considered the most important pest in Homa Bay District and it was ranked first in both Ndhiwa and Rangwe divisions, and it was a lesser constraint in Butere, where it was ranked fifth. The ranking was majorly based on the incidence and severity of the pest. *Striga* was closely associated with low soil fertility, drought and unavailability of effective control measures. Low soil fertility was in turn associated with continuous cultivation without crop rotation or nutrient replenishment.and high population density.

TABLE 6. Farmers' rating of maize pests

Pests	Butere-Mumias	Busia	Homa Bay	Mean score
Striga	4.5	3.6	5.0	4.4
Stemborer	2.5	4.0	3.5	3.3
Weevils	4.5	3.0	**2.0**	3.2
Termites	2.0	2.7	3.0	2.6
Moles and Rats	1.5	1.3	2.0	1.6
Head smut	1.0	2.0	0.0	1.5
Army worms	1.0	1.0	00	1.0
Couch grass	1.0	1.0	0.0	1.0
Wild animals	0.0	1.0	1.0	0.6
Domesticated animals	0.0	0.0	1.0	0.3
Beetles	0.0	1.0	0.0	0.3
Quelea birds	0.0	1.0	0.0	0.3
Maize streak	0.0	2.0	2.5	1.5
Ear rot	0.0	1.0	1.0	0.6

Note: 1) Each group that ranked the criteria as first (1), received 5 scores; second rank, received 4; third, 3; fourth, 2; and for5and above, 1 score and 0 when the pest is not mentioned

Stemborer, known as k*undi* in Luo language and *tsingetsa* in in some Luhya dialects, was considered as either the second or third most important maize pest in all sites. The symptoms of stemborer are not as conspicuously observed by farmers compared to symptoms and effect of Striga and this could explains why it is lowly rated. The fact that farmers have local names for stemborer proves existence of the pest and farmers' awareness that it affects maize yields.

Factors affecting incidence and severity of stem borer

Farmers perceive that there are certain factors that influence occurrence and severity of stem borers such as presence of leftover maize stover, late planting, lack of rotation and drought. Table 7 shows the key factor farmers perceive to be responsible for occurrence of stem borers. Drought and late planting, are however, perceived by majority of the farmers as the key factors that influence severity of stem borer.

TABLE 7. Factors influencing incidence and severity of stem borer

Factor	% of sites where the factor was mentioned n=5
Late planting	50
Leaving stover on farm (not burning)	40
Drought	80
Lack of rotation	20

Maize yield losses due to stem borer

Farmers estimated that roughly 25% and 80-90% of the area under maize is affected by stemborer in Butere-Mumias and Busia respectively. Whilst farmers in Butere-Mumias and Busia estimated yield loss due to stem borer to be 30% and 20% respectively, farmers in Homa Bay were unable to estimate (Table 8).

TABLE 8. Farmers' perception of maize yield loss due to stem borer

Site	% maize loss due to stemborer
Butere-Mumias	30
Busia	20
Homa Bay	-

Farmers are aware of some stemborer control measures, although very few farmers deliberately control it. Though most farmers are aware of chemical control measures, they cannot afford the chemicals such as bulldock, which are effective against stemborer. The use of resistant varieties to address the problem has highest adoption potential, especially among the smallholder and resource poor farmers. In Ndhiwa site, some farmers are aware of existence of some pesticides, which can be applied to control stemborer, however, they do not apply due to lack of cash. Although farmers know that burning of maize stover minimizes incidence of stemborer, this control measure conflicts with agricultural extension staff recommendations. Another control method known and practised by farmers is rotation, but this is not done primarily for stemborer control, but mainly as soil fertility management strategy. A majority of the farmers in Rangwe, however, were not aware of stemborer control measures, despite their full knowledge of existence of stemborer on their farms. In all the sites, farmers are well versed with some control measures for *Striga* weed, including application of manure, hand pulling, application of fertilizers and planting of tolerant varieties.

Conclusions and Recommendations

This study identifies maize varieties farmers grow, criteria for choice of the varieties and constraints the farmers face in maize farming in the moist midaltitude zone of western Kenya, thus providing the basis for formulation of farmer-oriented maize research programme. Farmers grow a wide range of improved and local maize varieties, often without application of fertilizers and pesticides. About 80% of the farmers predominantly grow local varieties, whilst only 20% dominantly grow improved maize varieties. In some instances, same local varieties are known by different names and different varieties known by the same names, depending on the area of reference or language under consideration. In most instances farmers grow more than one maize variety to meet their multiple objectives. Different local varieties are known by different names. Conversely same varieties are known by different names, depending on the area under reference or language under consideration. The names of the local maize varieties are often descriptive, referring to certain key identifiable characteristics especially grain colour, appearance, growth habit and the perceived place of origin. Farmers have diverse perceptions and complex combinations of criteria they use in selecting maize varieties. The key criteria include high yields, early maturity, tolerance to *Striga*, drought and insect pests, low costs of acquiring seed maize, and ability of a variety to give reasonable yield without application of external inputs, especially fertilizers and pesticides.

Maize production in the moist mid-altitude zone is constrained by a myriad of related factors, the extent of contribution of the factors vary across the sites. The most important constraints perceived by farmers are low soil fertility, lack of financial resources to purchase inputs, especially fertilizers and seed, and low technical know-how. Others are *Striga* and stem borer damages, vagaries of weather, and low quality seed on the market. To cope with cash constraints, farmers recycle the varieties for long period of time, especially the local varieties and do not apply or apply low rates of fertilizers and pesticides in maize fields.

To increase maize production, research should take into consideration the farmers' circumstances and preferences and develop maize varieties and crop management packages meet farmers demands. Incorporation of farmers' preferences in selection of maize varieties in breeding process would increase likelihood of adoption of the varieties. Whereas maize breeding cannot incorporate all the desired attributes, the key attributes should be included in particular varieties and many varieties should be bred focusing the demands of different groups of farmers. Considering that farmers prefer recycling seeds of maize local varieties as a strategy for coping with cash flow constraints, effort should be made to breed composites or open pollinated varieties (OPVs) that are resistant to insect pests. Such varieties are likely to be highly adopted by smallholder farmers, especially when the other key criteria they apply in maize variety selection are also incorporated.

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APPENDIX *1:Coordinates of the study villages in moist mid-altitude zone of western Kenya*

District	**Division**	**Location**	**Village (s)**	**Coordinates***
Butere-Mumias	Butere	Shianda	Ebubala	34.482140.388889
Busia	Butula	Lugulu	Bulemia	34.330360.351852
	Matayos	Bukhayo West	Sirisia	34.178570.462963
Homa Bay	Ndhiwa	West Kanyamwa	Kayambo	34.522010.45234
	Rangwe	East Gem	Koyolo	34.491070.55556

**Coordinates taken by Geographical Positioning System (GPS)*

APPENDIX 2: Description of maize varieties grown

Variety	**Origin**	**Grain Colour**	**Texture (flint/dent)**	**Height**	**Maturity Type**	**Yield Potential tons/ha**	**Year released**
Samaria	Local, OPV	White	Heavy	Moderate	Early	Moderate	
Shipindi	Local, OPV	Yellow	Heavy	Moderate	Early	Moderate	
Opapari	OPV	White	Heavy	Moderate	Early	Moderate	
Maseno Double cobbler	Improved, OPV	White	Heavy	Moderate	Medium	Moderate	
Radier	OPV	White	Heavy	Moderate	Medium	High; 2 cobs/plant	
Nyamula	OPV	Light to dark yellow	Heavy	Moderate	Early	Moderate	
Jowi Jamuomo	OPV	White purple helium	Heavy	Moderate	Early	Moderate	
Nyar Maragoli	OPV	White	Heavy	Moderate	Early	Moderate	Year released
H614D	Hybrid	White	Heavy	Moderate	Late	6.8	1986
H511	Hybrid	White	Heavy	Moderate	Medium	3.6	1968
H622	Hybrid	White	Heavy	Moderate	Medium	5.2	1965
Pioneer 3253	Hybrid	White	Heavy	Moderate	Medium	-	
PH1	Hybrid	White	Heavy	Moderate	Early	3.8	1989
Katumani	Composite	White	Heavy	Moderate	Early	2.0	1963

* Commercial varieties are not described. Descriptors of the released maize varieties are available at the Kenya Plant Health Service (KEPHIS), NAIROBI