Wheat Farmers' Seed Management and Varietal Adoption in **Kenya**

Paul Gamba

Caroline Ngugi

Hugo Verkuijl

Wilfred Mwangi

Frank Kiriswa

November 2003

KARI

CIMMYT[MR]
International Maize and Wheat Improvement Center

Funded by the European Union

Egerton University

Wheat Farmers' Seed Management and Varietal Adoption in **Kenya**

Paul Gamba

Caroline Ngugi

Hugo Verkuijl

Wilfred Mwangi

Frank Kiriswa*

November 2003

* Paul Gamba is with Egerton University's Department of Agricultural Economics and Business Management, Njoro, Kenya. At the time of this report, Caroline Ngugi and Frank Kiriswa were with the Kenya Agricultural Research Institute, National Plant Breeding Research Centre, Njoro, Kenya. Wilfred Mwangi is with the Economics Programme of the International Maize and Wheat improvement Centre (CIMMYT), Addis Ababa, Ethiopia. Hugo Verkuijl is an Agricultural Economist with the Royal Tropical Institute (KIT) in the Netherlands, and previously worked with the CIMMYT Economics Program in Addis Ababa.

CIMMYT® (www.cimmyt.org) is an internationally funded, nonprofit, scientific research and training organization. Headquartered in Mexico, CIMMYT works with agricultural research institutions worldwide to improve the productivity, profitability, and sustainability of maize and wheat systems for poor farmers in developing countries. It is one of 16 food and environmental organizations known as the Future Harvest Centers. Located around the world, the Future Harvest Centers conduct research in partnership with farmers, scientists, and policymakers to help alleviate poverty and increase food security while protecting natural resources. The centers are supported by the Consultative Group on International Agricultural Research (CGIAR) (www.cgiar.org), whose members include nearly 60 countries, private foundations, and regional and international organizations. Financial support for CIMMYT's research agenda also comes from many other sources, including foundations, development banks, and public and private agencies.

Future Harvest® builds awareness and support for food and environmental research for a world with less poverty, a healthier human family, well-nourished children, and a better environment. It supports research, promotes partnerships, and sponsors projects that bring the results of research to rural communities, farmers, and families in Africa, Asia, and Latin America (www.futureharvest.org).

Correct citation: Gamba, P., C. Ngugi, H. Verkuijl, W. Mwangi, F. Kiriswa. 2002. Wheat farmers' seed management and varietal adoption in Kenya. Mexico, D.F.: CIMMYT, Egerton University, Njoro, Kenya, and KARI, Nairobi.

Abstract: Wheat is the second most important crop in Kenya after maize and is becoming an important source of food both for humans and livestock. Despite increasing wheat production, only 50% of domestic consumption requirements are being met. While the National Plant Breeding Research Centre at the Kenya Agricultural Research Institute has released more than 100 wheat varieties since it began operations in 1927, adoption has been slow in spite of better performance of new varieties. This study examined factors that influence farmers' adoption of new varieties in the Narok, Nakuru, and Uasin Gishu Districts that account for 80% of Kenya's domestic wheat production. The study found that most farmers in these Districts neither knew nor grew new wheat varieties, reflecting lack of seed and knowledge of these new varieties. Wheat varieties were also often not adopted in agroecological zones for which they were targeted. This should be an issue of concern to wheat breeders since varieties are currently bred specifically for agroecological zones. The main sources of wheat seed (old and new) for both smallscale and largescale farmers were other farmers. The adoption of new wheat varieties was significantly higher among largescale farmers in the high potential zone in Uasin Gishu District than among smallscale farmers in the low potential zone in Nakuru and Narok Districts. The logit model showed that experience in wheat farming had a positive impact on adoption of new wheat varieties. These factors will need to be taken into account by researchers, extension specialists, and policy makers.

ISBN: 970-648-098-6
AGROVOC descriptors: Triticum; Wheat; Varieties; Seeds; Management; Food production; Food consumption; Innovation adoption; Plant breeding; Breeding methods; Livestock; Small farms; Research institutions; Agroclimatic zones; Kenya
AGRIS category codes: F01 Crop Husbandry
E14 Development Economics and Policies
Dewey decimal classification: 633.116762

Printed in Mexico.

Contents

Tables

Acknowledgments

The authors are indebted to their respective institutions, Egerton University, Njoro, Kenya, the International Maize and Wheat Improvement Center, and the Kenya Agricultural Research Institute, Njoro, Kenya, for the support provided to them. The financial support of the European Union through the Strengthening of the National Agricultural Research Systems project enabled the completion of this study and is greatly appreciated.

Thanks also goes to Satwant Kaur and Sarah Fennell for editorial support and to Eliot Sánchez Pineda for the design and production of this report.

Wheat Farmers' Seed Management and Varietal Adoption in Kenya

Paul Gamba, Caroline Ngugi, Hugo Verkuijl, Wilfred Mwangi, and Frank Kiriswa

Introduction

Wheat is the second most important cereal crop after maize in Kenya (KARI 1989) and is becoming an important source of food for both humans and livestock. Demand for wheat and wheat products is growing at 7% per annum, and even though production is increasing, only about 50% of domestic consumption requirements are being met (Hassan et al. 1993). Increasing population, rapid urbanization, rising income levels, and changing tastes and preferences are major factors contributing towards this demand.

Wheat production started at the beginning of the century in Kenya, but it was not until 1927 that a formal wheat breeding research program was initiated at the Kenya Agricultural Research Institute's (KARI) National Plant Breeding Research Centre (NPBRC) in Njoro, Kenya. Since this program began, over 100 wheat varieties have been released (NPBRC 1974, 1984, 1987, 1989). Despite better performance of these new varieties in terms of yield, disease resistance, and other desirable characteristics (Hassan et al. 1993), the rate of adoption has been slow, implying that new varieties have either not reached farmers or have not been adopted for various reasons.

This study examines factors that influence farmers' adoption of improved wheat varieties and analyzes wheat farmers' socioeconomic characteristics that are relevant to the adoption process.

The Study Area

The study was conducted in the major wheat producing Districts of Narok, Nakuru, and Uasin Gishu. These Districts combined account for 80% of Kenya's domestic wheat production (KARI 1989).

Narok, Nakuru, and Uasin Gishu Districts are located in the high potential (>1,800m) and low potential (<1,800 m) agroecological zones. The high potential zone generally receives more rainfall over a longer period of time than the low potential zone.

Rainfall ranges from 500 mm to 1,000 mm in low potential zones and 1,200 mm to 1,800 mm in high potential zones. Rainfall is unimodal with distinct peaks in April and August. The wheat season stretches from June to November, sufficient time for the wheat crop to mature, given varying planting dates.

Soils in study areas vary. Nakuru District mainly has soils developed from volcanic ashes that are generally deep and well drained. Narok District has soils developed from igneous rocks that are shallow to deep and excessively drained. Uasin Gishu District has soils developed from tertiary or older basic igneous rocks that are extremely deep and are well drained.

Methodology

Sampling Procedure

Primary data were collected using a structured questionnaire from a sample of 80 wheat farmers distributed across the three Districts during the 1997 cropping season. These were the same farmers interviewed in another wheat survey conducted in 1990 by Hassan et al. (1993).

A multi-stage stratified random sampling process was used to select wheat farmers for this study. Districts were stratified by agroclimatic conditions into high and low potential zones. Farmers in these zones were then divided according to scale of production. Large-scale farmers were farmers who owned more than 20 hectares of land and small-scale farmers were farmers who owned less than 20 hectares of land.

In total, 96 farmers were interviewed but the data set was complete for only 76 farmers, consisting of 50 small-scale farmers and 26 large-scale farmers. There were 49 farmers from Nakuru/Narok Districts and 27 from Uasin Gishu District. Forty-one farmers were from high potential areas and 35 were from low potential areas.

Theoretical framework

Adoption studies in agriculture generally attempt to establish factors that influence the adoption of a technology in a specific locality. It is nonetheless recognized that attributes influencing the adoption of agricultural technologies are inherent in the farmer and farm, in the technology itself, and the farmer's objectives (Adesina and Zinnah 1992).

Farmer and farm attributes that influence adoption include, but are not limited to, farm size, agroecological zone, and education level. The technology's attributes are commonly considered in terms of whether they are embodied or disembodied (e.g. seed or knowledge). It is also critical to establish the technology's other requirements. For example, is there complementarity between the introduced technology and other technologies currently practiced or not practiced? The kind of farming that is practiced— commercial versus subsistence farming— also constitutes another attribute that can influence adoption of new technologies.

To analyze farmers' adoption of new wheat varieties, a qualitative (binary) dependent variable function was used. Binary functions cannot be estimated through the ordinary least squares method, since the predicted values from the resultant linear probability model cannot be constrained to the required interval without imposing restrictions on the values of independent variables. Binary functions can, however, be estimated through maximum likelihood methods. The logit model was selected for analysis of adoption behavior on the basis of ease of computation. The logit model postulates that the probability of a farmer (P) adopting a new variety is a function of some characteristic (X_i). These characteristics may be socioeconomic, institutional, technological, or geographical. The model uses a logistic curve to transform binary responses into probabilities within the 0-1 interval. The logit model is specified as:

$$P(i) = 1 /(1 + \exp (\beta^1 X_i))$$

where $P(i)$ is the probability of adopting a new wheat variety and X_i are a farmer's characteristics (Davidson and Mackinnon 1995).

A new wheat variety is defined as one that has been used for less than 10 years from the year of release. Conversely, old wheat varieties are those that have been used for more than 10 years from the year of release.

Farmer characteristics that were postulated to have some influence on adoption of wheat varieties were:

- Distance from source of seed: The farther the distance between the farmer and the source of new seed the lower the probability of adoption. This variable was measured as a dummy indicating farmers within 10 km of seed source and those beyond.
- Household size: It is hypothesized that a larger household is less likely to adopt new wheat varieties due to high family maintenance requirements.
- Farm size: Because farmers who have more land are in a better position to multiply seed, it is hypothesized that farm size (ha) has a positive impact on probability of adoption.

- Commercial wheat price: Producers always respond to price changes since it is an indicator of possible profits. A higher commercial wheat price (in Kenyan Shillings per bag of 50 kg) is therefore thought to positively influence adoption of new wheat varieties.
- Period of seed recyling: It is expected that longer recyling periods result in lower probabilities of adoption. This variable (yr) is used as an indicator of the effects of poor seed management practices.
- Wheat farming experience: It is hypothesized that longer wheat farming experience (yr) contributes to better decision making and has a positive effect on adoption.
- Education level: Education contributes to general awareness and favors adoption of new varieties.
- Seed selection at harvest: This variable is used as an indicator of sound seed management practices, which are hypothesized to have a positive effect on adoption. Seed selection is recorded as a binary variable.
- Agroecological zone: Specific varieties are grown in different agroecological zones, but since yields in high potential areas are higher, farmers there have better incentives to adopt new varieties. Agroecological zone is indicated by a binary variable (1 = high potential, 0 = not high potential).
- Age of household head: It is not certain whether this variable influences adoption positively or negatively, owing to the erratic influence of age on perceptions regarding change; this characteristic was included in the analysis but we present no hypothesis about its influence on adoption.

Socioeconomic Characteristics of Sample Farmers

Socioeconomic Characteristics by Agroecological Zone

To determine the influence of agroecological zones on socioeconomic characteristics, a test for the means of independent samples was conducted (Table 1).

Table 1. Socioeconomic characteristics of sample farmers by agroecological zone, Narok, Nakuru, and Uasin Gishu Districts, Kenya.

	Low potential		High potential		
Characteristics	**Mean**	**Standard deviation**	**Mean**	**Standard deviation**	**T- Statistic**
Age of household head (yr)	48.4	9.8	45.4	15.4	0.831 NS
Farming experience (yr)	10.0	9.2	13.8	8.4	1.7*
Household adults (no.)	5.3	6.3	4.9	2.8	0.376 NS
Children 14-18 years (no.)	2.6	2.1	2.3	2.1	0.454 NS
Children <14 years (no.)	4.0	4.5	3.5	2.1	0.569 NS
Household members (no.)	10.5	5.1	8.1	4.6	1.3 NS
Farm size (ha)	784.3	219.78	188.46	60.42	1.8*
Wheat area (ha)	998.9	247.32	93.9	43.96	2.4**
Arable/cultivated area (ha)	745.6	216.18	87.6	19.14	2.1**

Note: NS = not significant; * = significant at $p<0.1$; ** = significant at $p<0.05$.

Wheat farmers in high potential zones exhibited significantly higher means in terms of farming experience (t=1.7, p<0.1). In contrast, wheat farmers in low potential areas exhibited significantly higher means with respect to farm size (t=1.8, p<0.1), area under wheat (t=2.4, p<0.1), and total cultivated area (t=2.1, p<0.1). Household size and farmer's age, on the other hand, are not significantly different within agroecological zones.

Socioeconomic Characteristics by Farm Size

To determine the influence of socioeconomic characteristics on the scale of farming, a comparison was made between smallscale and largescale farmers and again tested using the independent sample mean t-test (Table 2).

Table 2. Socioeconomic characteristics of sample farmers by farm size, Narok, Nakuru, and Uasin Gishu Districts, Kenya.

	Small-scale (<20ha)		Large-scale (>20ha)		
Characteristics	Mean	Standard deviation	Mean	Standard deviation	T- Statistic
Age of household head (yr)	46.7	10.2	44.6	13.8	0.3NS
Farming experience (yr)	8.0	4.6	14.3	8.9	3.1*
Adults (no.)	3.9	1.6	5.7	5.1	1.6NS
Children 14-18 years (no.)	1.8	1.2	2.6	2.3	1.5NS
Children <14 years (no.)	2.5	1.6	4.2	3.0	2.2**
Household members (no.)	8.0	2.6	11.2	5.2	2.3**
Farm size (ha)	10.8	5.0	602.51	171.01	1.8*
Area under wheat (ha)	244.2	51.0	439.1	163.65	1.2 NS
Arable/cultivated area (ha)	12.9	29.6	475.7	159.76	1.4 NS

Note: NS = not significant, * = significant at p<0.1; ** = significant at p<0.05.

Large-scale farmers had significantly higher levels of farming experience compared to small-scale farmers (t = 3.1, p<0.01). This finding can be attributed to the observation that more large-scale farmers live their whole lives on the same farm (which they later inherit) and consequently get exposed to wheat farming earlier and for long periods, resulting in more experience. Large-scale farmers had larger households (11.2 persons) than small-scale farmers (8 persons). This difference was found to be significant (t=2.3, p<0.05).

Farmers' Wheat Varietal Knowledge and Varieties Grown

Wheat Varietal Knowledge and Wheat Varieties Grown by Farm Size

To establish respondents' knowledge and adoption of wheat varieties, they were asked to indicate the wheat varieties that they knew and grew. The results, classified by farm size and variety, are shown in Tables 3 and 4.

Most small-scale farmers knew the wheat varieties Mbuni (89.5%), Pasa/Fahari (75%), Nyangumi (74%), and Kwale (73%), while large-scale farmers knew Tembo (93%), Mbuni (83%), Fahari (82%), and Kwale (73%) (Table 3). Mbuni was most widely grown by both small-scale and large-scale farmers (85% and 75%, respectively). In addition to Mbuni, small-scale farmers tended to grow Fahari (55%), Kwale (40%) and Pasa (33%), while large-scale farmers grew Kwale (63%), Pasa (58%), and Tembo (48%) (Table 4). Recently released varieties such as Duma, Mbega, and Ngamia were neither known nor grown by both types of farmers. This does not mean that new varieties were unpopular but reflects lack of knowledge and/or unavaibility of seed of new varieties. New varieties are more likely to be grown by largescale farmers, as in the case of Duma.

Wheat varieties known and grown by agroecological zone

Table 5 shows that old and established varieties such as Mbuni and Kwale are fairly well known in both high and low potential zones, regardless of NPRBC recommendations. New varieties were less well known in both zones, with the exception of Ngamia, which is better known in the high potential zone despite it being recommended for the low potential zone.

Table 3. Wheat varieties known to farmers according to farm size, Narok, Nakuru, and Uasin Gishu Districts, Kenya.

			Small-scale farmers (<20 ha)		Large-scale farmers (>20 ha)	
Variety	**Year**	**Recommended zone**	**Farmers (%)**	**Variety rank**	**Farmers (%)**	**Variety rank**
>10 years since release						
Bounty	1967	-	-	-	-	-
Chiriku	1989	All	62	5	50	9
Fahari	1975	High†	75	2	82	3
Kiboko	-	-	14	12	17	13
Kongoni	-	High	57	7	63	8
Kwale	1987	All	73	4	73	4
Mbuni	1987	All	89.5	1	83	2
Nungu	1975	High	29	9	29	12
Nyangumi	1979	High	74	3	66	7
Nyoka	1975	High	16	11	16	14
Pasa	1989	All	75	2	69	5
Paka	1975	High	25	10	65	8
Popo	1982	All	58	6	68	6
Tembo	1975	High	55	8	93	1
<10 years since release						
Duma	1994	Low‡	14	12	33	11
Mbega	1994	Low	14	12	36	10
Ngamia	1994	Low	25	10	29	12

† High potential agroecological zone ‡ Low potential agroecological zone

Table 4. Wheat varieties grown by farmers according to farm size, Narok, Nakuru, and Uasin Gishu Districts, Kenya.

Variety	Recommended zone	Small-scale farmers (<20 ha)		Large-scale farmers (>20 ha)	
		Farmers (%)	Variety rank	Farmers (%)	Variety rank
>10 years since release					
Bounty	-	-	-	-	-
Chiriku	All	14	6	23	8
Fahari	High[†]	55	2	33	6
Kiboko	-	-	-	-	-
Kongoni	High	-	-	25	7
Kwale	All	40	3	63	2
Mbuni	All	85	1	75	1
Nungu	High	-	-	-	-
Nyangumi	High	14	6	35	5
Nyoka	High	-	-	-	-
Pasa	All	33	4	58	3
Paka	High	-	-	-	-
Popo	All	14	6	8	10
Tembo	High	29	5	48	4
<10 years since release					
Duma	Low[‡]	-	-	15	9
Mbega	Low	-	-	-	-
Ngamia	Low	-	-	-	-

[†] High potential agroecological zone
[‡] Low potential agroecological zone

Table 5. Wheat varieties known by agroecological zone, Narok, Nakuru, and Uasin Gishu Districts, Kenya.

Variety	Recommended zone	Low potential zone		High potential zone	
		Farmers (%)	Variety rank	Farmers (%)	Variety rank
>10 years since release					
Bounty	-	-	6	10	11
Chiriku	All	30	5	36	7
Fahari	High[†]	50	-	71	3
Kiboko	-	-	-	16	10
Kongoni	High	3	7	47	5
Kwale	All	53	3	61	4
Mbuni	All	83	1	75	2
Nungu	High	3	10	24	8
Nyangumi	High	73	4	47	5
Nyoka	High	-	10	16	10
Pasa	All	43	-	61	4
Paka	High	30	6	43	6
Popo	All	30	7	47	5
Tembo	High	17	2	80	1
<10 years since release					
Duma	Low[‡]	13	6	16	-
Mbega	Low	7	8	21	9
Ngamia	Low	17	9	10	11

[†] High potential agroecological zone
[‡] low potential agroecological zone

In ranking widely grown varieties in both zones according to the percentage of farmers growing the varieties, it appears that farmers do not strictly adhere to NPBRC recommendations. Table 6 reveals that new varieties such as Duma or Mbega specifically targeted to low zones are not grown as widely. Old popular varieties such as Fahari and Nyangumi are grown in both low and high potential zones, regardless of whether they are bred to be grown there.

Table 6. Wheat varieties grown by farmers according to agroecological zone, Narok, Nakuru, and Uasin Gishu Districts, Kenya.

		Low potential zone		High potential zone	
Variety	Recommended zone	Farmers (%)	Variety rank	Farmers (%)	Variety rank
>10 years since release					
Bounty	-	-	-	-	-
Chiriku	All	3	6	16	7
Fahari	High†	13	4	30	5
Kiboko	-	-	-	16	7
Kongoni	High	3	6	16	7
Kwale	All	47	1	32	4
Mbuni	All	30	2	73	1
Nungu	High	3	6	24	6
Nyangumi	High	20	3	16	7
Nyoka	High	-	-	16	7
Pasa	All	20	3	39	3
Paka	High	-	-	10	8
Popo	All	14	6	8	10
Tembo	High	-	-	41	2
<10 years since release					
Duma	Low‡	10	5	-	-
Mbega	Low	-	-	-	-
Ngamia	Low	3	6	-	-

† High potential agroecological zone
‡ Low potential agroecological zone

Adoption of Wheat Varieties by Agroecological Zone, District, and Farm Size

The distribution of farmers who planted new or old varieties by agroecological zone, District, and farm size is shown in Table 7. More farmers in the high potential zone used new wheat varieties (52%) than farmers in the low potential zone (22%) ($c^2 = 5$; $p<0.05$). Similar results were found by Hassan et al. (1993). Farmers in the high potential zone may adopt new wheat varieties faster and more widely because this zone enjoys better extension service infrastructure. Even so, a considerably large proportion of surveyed farmers in both zones were not planting new varieties.

Table 7. New varieties farmers planted by agroecological zone, District, and farm size, Narok, Nakuru and Uasin Gishu Districts, Kenya.

	New varieties		
	Farmers growing (no.)	Farmers growing (%)	χ^2
Agroecological zone			5*
High potential	17	52	
Low potential	5	22	
District			2.3 (NS)
Nakuru and Narok	9	30	
Uasin Gishu	13	50	
Farm size			1.1 (NS)
< 20 ha	5	29	
> 20 ha	15	43	

Note: * = significant at $p<0.05$, NS = not significant

More farmers (50%) in the Uasin Gishu District planted new varieties compared to farmers in Nakuru and Narok Districts (30%). Even though the difference was not significant, one would have expected the reverse to be the case, as both Nakuru and Narok Districts are closer to the NPBRC. Technology adoption presupposes that proximity to a technology center confers certain advantages in diffusion and adoption that translates into higher adoption levels. Since the Kenya Seed Company (KSC) is closer to Uasin Gishu District, farmers there might have more access to seed of new varieties than farmers in Nakuru and Narok Districts, and may explain the higher adoption in that district.

Forty-three percent of large-scale farmers adopted new wheat varieties compared to 29% of small-scale farmers, but this difference was not significant. The main reasons that both large-scale and small-scale farmers adopted new varieties were high yield, disease resistance, and early maturity. The main constraints to adoption new wheat varieties were lack of seed and lack of awareness on the part of both small-scale and large-scale farmers.

Sources of Wheat Seed Grown in 1997

Other farmers were the main source of wheat seed for both small-scale (56%) and large-scale (49%) farmers (Table 8).

Table 8. Farmers' sources of seed in 1997 by farm size, Narok, Nakuru, and Uasin Gishu Districts, Kenya.

	Small-scale farmers (< 20 ha)		Large-scale farmers (> 20 ha)	
	Farmers		Farmers	
Seed source	(no.)	(%)	(no.)	(%)
Own seed	2	9	6	15
Other farmers	12	56	20	49
Seed dealer	—	—	1	2
Kenya Farmers' Association	2	9	2	5
Kenya Seed Company	4	17	2	5

Other seed sources for small-scale farmers were seed from the previous harvest, the Kenya Farmers' Association (KFA) (both 9%) and the Kenya Seed Company (KSC) (17%). Seed from the previous harvest (15%) , the KSC and KFA (both 5%) also constituted seed sources for large-scale farmers. Most small-scale farmers (50%) obtained their seed in the same village, although about 35% traveled more than 10 km to get seed. About 59% of large-scale farmers traveled more than 10 km to get seed, while about 28% obtained seed from their village.

Sources of Seed for New Wheat Varieties

The most important sources of seed of new wheat varieties for both small-scale (63.2%) and large-scale (51%) farmers were again other farmers (Table 9).

Table 9. Farmers' sources of seed for new wheat varieties by farm size, Narok, Nakuru, and Uasin Gishu Districts, Kenya.

	Small-scale farmers (< 20 ha)		Large-scale farmers (> 20 ha)	
	Farmers		Farmers	
Seed source	(no.)	(%)	(no.)	(%)
Other farmers	12	63	18	51
Kenya Farmers' Association	3	16	1	3
Kenya Seed Company	2	11	9	26

The KSC was another source of seed of new wheat varieties for both small-scale (11%) and large-scale (26%) farmers. About 84% and 93% of small-scale and large-scale farmers, respectively, reported that farm sizes of the farmers from whom they obtained seed were larger than their own. Twenty-four percent and 38% of small-scale and large-scale farmers, respectively, had problems getting new wheat seed varieties. The main problem for both was high price and unavailability of seed. About 11% of small-scale farmers and 8% of large-scale farmers used credit to purchase wheat seed. Both categories of farmers did not access or utilize credit for management operations. This may indicate either scarce credit or an unfavorable rating of wheat farmers by financial institutions. Other reasons could be high interest rates or wheat farmers' negative attitude towards credit. The main sources of credit were the Agricultural Finance Corporation and the KFA.

Farmers' Wheat Seed Management

Wheat seed management practices have a direct impact on yields and returns per unit of land. Wheat returns per unit of land, assuming the seedbed is adequately prepared, can be influenced by field germination percentage and weed/disease infestation levels, which can in turn be determined by farmers' initial seed management practice. For instance, seed contaminated with weeds or infected with diseases increases the cost of production for the seed user, who has to apply control measures resulting in lower returns per unit of land.

Since wheat seed is not bought every year, good seed management practices are imperative for maintaining the purity and vigor of subsequent generations of seed. Table 10 compares seed management practices between small-scale and large-scale farmers.

Table 10. Farmers' wheat seed management practices by farm size, Narok, Nakuru, and Uasin Gishu Districts, Kenya.

	Small-scale farmers (< 20 ha)		Large-scale farmers (> 20 ha)		
Seed managementpractices	Farmers (no.)	Farmers (%)	Farmers (no.)	Farmers (%)	χ^2
Buy seed annually	4	15	14	36	1.8 (NS)
Clean seed before planting	12	63	18	66	3.6 *
Dress seed	10	59	17	52	2.5 (NS)
Dry seed	9	47	16	47	0.6 (NS)
Have separate field for producing seed	3	16	15	50	4.6*
Select seed at harvest	9	53	17	63	3.4**
Thresh seed separately	5	31	6	29	2.5 (NS)
Store seed separately	13	68	29	83	2.7 (NS)
Test for germination	5	39	8	16	1.2 (NS)
Treat seed	14	74	29	76	1.4 (NS)

Note: NS = not significant, * = significant at $p<0.1$; ** = significant at $p<0.05$.

Fifty-three percent of small-scale farmers and 63% of large-scale farmers selected seed at harvest. This difference was found to be significant. Another significant difference in seed wheat management was the way farmers cleaned their seed before planting. Fewer small-scale farmers (63%) attached importance to the practice as compared to large-scale farmers (66%).

The use of separate fields for producing seed was another management practice that varied significantly according to farm size. Fifty percent of large-scale farmers used the practice in comparison to 16% of small-scale farmers.

Factors Influencing Adoption of New Wheat Varieties

The logit model was used to analyze adoption of new wheat varieties, as postulated in the theoretical framework (Table 11). The model's overall correct prediction of the likelihood of adoption of new wheat varieties was 76%. It also correctly predicted 84% of those farmers not adopting new varieties and 63% of those adopting new varieties. The general predictive power of the model was low, however, as indicated by the pseudo coefficients of determination which were all below 50%. Only one factor was found to have a significant (and positive) effect on adoption of new wheat varieties: wheat farming experience.

The effects of other estimated parameters were more consistent with the hypothesis mentioned in the theoretical framework, except seed selection and commercial wheat price, but these were not significant. Although not statistically significant, the increasing age of household head had a negative impact on adoption of new wheat varieties. The data suggest that educational attainment enhances the adoption of new wheat varieties. It is likely that educational attainment and age are related in that younger farmers commonly have higher levels of education. The probability of adoption of new varieties is higher for farmers in high, as compared to low, potential areas.

The computed chi-square for the model (χ^2 =19.293), $p<0.05$) suggests that the model parameters jointly are significantly different from zero for the adoption of new wheat varieties. This implies that whereas each individual variable may not be significant on its own account, all the variables taken together significantly influence the adoption of new wheat varieties.

Table 11. Parameter estimates of the logit model on adoption of new wheat varieties, Narok, Nakuru, and Uasin Gishu Districts, Kenya.

Independent variable	Estimated coefficient†	Wald statistic‡
Constant	0.63	0.02
Distance from seed source	0.21	0.51
Household size	0.10	0.48
Seed selection	-0.19	0.13
Commercial wheat price	-0.002	0.66
Age of household head	-0.03	0.48
Education level	0.67	0.45
Agroecological zone	1.34	2.21
Farm size	.001	0.89
Seed recycling period	-0.55	1.00
Years in wheat farming	0.13*	5.11

Note:*= significant at $p<0.05$

† The estimated coefficients are obtained by running the logit model and enables computation of the probability of adoption.

‡ The Wald Statistic is a Chi square-based measure that tests the significance of the estimated coefficient.

Conclusion

Wheat farmers' seed management and varietal adoption in Nakuru, Narok, and Uasin Gishu Districts of the Rift Valley province of Kenya was examined using a structured questionnaire. Descriptive analysis was used to establish differences between small-scale and large-scale farmers as well as between agroecological zones. The logit model, a qualitative binary estimation method was utilized to describe the relationship between wheat adoption and farmer characteristics.

Cross tabulation revealed that Mbuni, Nyangumi, Fahari, Pasa, Kwale, and Tembo wheat varieties were the most well-known among all survey farmers, while the most widely grown varieties were Mbuni, Pasa, Tembo, and Kwale. On the other hand, new varieties such as Duma, Mbega, and Ngamia were hardly known or grown by farmers. New wheat varieties were more likely to be found in the high potential zone. This does not mean that new varieties are unpopular with farmers but reflects lack of seed and knowledge of these varieties. The main source of wheat seed (old and new) for most farmers was other farmers, implying that farmers themselves were the major channels for seed.

Farmers' wheat seed management practices were similar. However, more large-scale farmers had separate fields for seed, selected seed at harvest, and cleaned seed before planting than small-scale farmers. Adoption of new wheat varieties was significantly higher in the high potential zone, in Uasin Gishu District, and among large-scale farmers than in the low potential zone, in Nakaru and Narok Districts, and among small-scale farmers.

The distribution of seed of new wheat varieties needs to be improved. The finding that wheat varieties are not adopted in the agroecological zone for which they were targeted should be of concern to wheat breeders and needs to be examined more critically, since the thrust is to breed for specific agroecological zones. The results also strongly emphasize the need for closer collaboration between research, extension, and seed suppliers.

Wheat farming experience has a positive impact on adoption of new wheat varieties. The implication of this finding needs to be considered by researchers, extension specialists, and policy makers, especially in designing intervention measures such as farmers' training. More effort needs to be directed toward increasing adoption of new wheat varieties in low potential areas, in Nakuru and Narok Districts, and by small-scale farmers.

References

Adesina, A., and M. Zinnah. 1992. Adoption, diffusion, and economic impacts of modern mangrove rice varieties in Western Africa: Further results from Guinea and Sierra Leone. In: *Towards a new paradigm for farming system research /extension*. Working Paper for the 12th Annual Farming system Symposium. East Lansing: Michigan State University.

Davidson, R., and J.G. Mackinnon. 1995. *Estimation and inference in econometrics*. New York: Oxford University Press.

KARI.1989. *Current situation of wheat production in Kenya*. Nairobi, Kenya: Kenya Agricultural Research Institute.

NPBRC. 1974, 1984,1987,1989. *Annual Reports*. Njoro, Kenya: National Plant Breeding Research Center.

Hassan, R.M., W. Mwangi, and D. Karanja. 1993. *Wheat supply in Kenya: Production technologies, sources of inefficiency and potential for productivity growth*. CIMMYT Economics Working Paper No. 93-02. Mexico D.F. CIMMYT.

ISBN: 970-648-098-6