

Factors that Influence Adoption of New Improved Wheat Varieties by Farmers in Nakuru and Narok, Kenya

Anne Gichangi, Adrian Mukhebi, and Festus Murithi

ABSTRACT

This study examines the factors that influence the adoption of new improved wheat varieties (NIWV) by wheat farmers in Nakuru and Narok counties in Kenya. Cross-sectional data from 344 randomly selected wheat farmers from the Njoro and Rongai sub-Counties in Nakuru County; and Narok South and Narok North sub-counties in Narok County, Kenya were investigated. Probit model was run to estimate the factors influencing the adoption rate of improved new wheat varieties. Results derived from model estimates indicate that farmers' adoption of improved wheat varieties in the study area is positive due to education, availability of information, off-farm income, distance to inputs and produce markets, and exposure to extension advice services and access to credits. The study recommends that the public and private sectors promote access to advisory services to improve the dissemination of certified wheat seeds to farmers through training, workshops, and seminars.

Keywords: adoption, Kenya, new improved varieties, wheat.

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I. INTRODUCTION

Wheat is an important cereal crop in Kenya and ranks second after maize in its cereal crop priority for food security commodity [1]. For urban households, it has become an important food requirement and constitutes a great proportion of the household food budget [2]. Wheat demand has been growing at an average of about 4% per annum [3] driven by an upswing population, booming incomes, and rural-urban migration [4]. Changing preferences to wheat-based diets associated with urbanization has been a significant factor driving wheat demand upward [5].

Annually, Kenya produces, on average, 300,000 metric tons of wheat on an estimated 140,000 hectares of land [6], [7]. However, in the last four decades, there has been negligible growth in wheat production, an area under production, and yields [8]. On average, wheat yields are about 2.4 metric tons per hectare but may vary between 1.8 and 3.3 metric tons per hectare depending on the season, region, and scale of production. The expanding gap between production and consumption is largely met through wheat imports. Currently, Kenya imports approximately two million metric tons of wheat, more than five times its production [7].

The major wheat growing regions in Kenya are Nakuru, Uasin Gishu, Narok, Trans-Nzoia, Meru, and Laikipia counties [3], [9]. Large and medium-scale farmers are few in number, however, they produce the bulk (80%) of the total wheat produced, while small-scale farmers, who are the majority, produce 20% of the total output [6].

Abiotic and biotic factors such as drought, diseases, and pests, which are increasing in intensity and frequency due to climate change have been associated with Low wheat productivity [10]. In Kenya, high incidences of the Russian wheat aphid have been confirmed, compared to neighboring countries of Ethiopia and Uganda [11].

Diseases such as stem rust have remained problematic with minimal success in the production of disease-resistant varieties [9]. Other constraining factors to wheat production are low adoption and varietal turnover rates [12], poor soil and water management practices [9], lack of credit, low rate of technology adoption, and weak extension systems [9]. However, among the factors contributing to low yields and productivity, high costs of production have been very important [6].

II. MATERIALS AND METHODS

A. Sampling Procedures and Sample Size

A multistage sampling technique was used in the selection of Counties, Sub-counties, and respondents. Due to resource constraints, the first stage involved the purposive selection of two out of the seven wheat-growing counties in Kenya, namely Nakuru and Narok, (Fig. 1). The second stage involved the selection of four sub-counties, two from Narok County, and two from Nakuru County. The sample size was determined using the precision criterion, which assumes that the dominant characteristics of a population would occur if the confidence interval is set at 95%. In total, the sample size selected for the detailed household survey was 344 households from Narok and Nakuru Counties in Kenya. Data collection took place between May-July 2018.

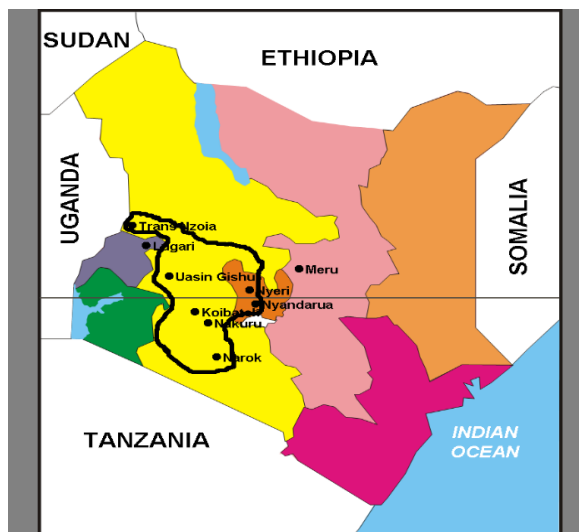


Fig. 1. Wheat growing areas of Kenya.
Key: Dots represent the wheat producing areas. Source: [13].

Due to resource constraints and, therefore, a limited sample size for this study, the results obtained may not be generalizable to the rest of Kenya. However, the results would be a good indicator of returns to wheat research in Kenya, and could be augmented by further similar studies in the country.

B. Probit Regression Models

To study farmers' behavior on adoption, the current study used the probit model because it captures both decision to adopt improved varieties or not and the rate (or percent) of the adoption. The probit regression of adoption is specified as a function of these variables.

The probit model is specified as equation (1) where μ_i is an independently, normally distributed error term with zero mean and constant variance σ^2 [14]:

$$Y_i^* = X_i\beta + \mu_i, Y_i = \begin{cases} 1 & \text{if } Y_i^* = X_i\beta + \mu_i > T \\ 0 & \text{if } Y_i^* = X_i\beta + \mu_i \leq T \end{cases} \quad (1)$$

where:

Y_i is the intensity of use and the probability of adoption;

Y_i^* is a variable that is not observable;

T is a threshold level that is non-observed. If the Y_i^* is greater than T , observed variable Y_i becomes a continuous function of the explanatory variables, and 0 otherwise (i.e., no adoption) [15].

According to [15], the Probit model uses all observations, those at the limit, usually zero (e.g., no adoption), compared to other frameworks using only observations above the limit value. Moreover, it captures the intensity level of adoption, which reduces the loss of information by [16] into a probit model as follows:

$$\mu_i = y_0 + y_1X_1 + y_2X_2 + \dots + y_nX_n + \mu_i \quad (2)$$

where

μ_i is the adoption of improved wheat varieties;

X_1 to X_n , are the explanatory factors included in the model;

y_0 to y_n , are parameters to be estimated,

μ_i is the disturbance term.

Table I shows the variables, their description, measurement, and expected sign of explanatory variables on the adoption of improved wheat variety.

TABLE I: DESCRIPTION OF THE EXPLANATORY VARIABLES

Variables Name	Description	Measurement	Expected sign
Gender	Gender of the household head	1 if male and 0 otherwise	+
Level of Education	Level of formal education of the household head	Years of schooling	+
Family size	Number of household members	Number	+
Experience	Household head's experience in farming	Years	+
Off-farm income	Whether household participated in non-farm activities or not	1 if yes and 0 otherwise	+
Contact-Extension	Contact between the household head and extension agent during production season	Number	+
Land-size	Amount of cultivated land that a household owned	Hectare	+
Distance-market	The remoteness of the household to the closest market	Kilometer	-
Impression on yield	Whether household head perception is positive towards improved wheat variety or not	1 if positive and 0 otherwise	+
Impression on Cost	Whether household head perception is cheap towards improved wheat variety cost or not	1 if cheap and 0 otherwise	+
Varietal information	Whether household accessed to improved wheat variety information or not	1 if accessed and 0 otherwise	+
Access-Credit	Whether household accessed to credit or not	1 if accessed and 0 otherwise	+

III. RESULTS AND DISCUSSIONS

A. Proportion of Wheat Farmers Recycling the New Improved Wheat Seeds

Seed recycling is a common practice in wheat-growing areas of Kenya. As shown in Fig. 2, about 85% of the sample farmers depend on recycled seeds while only 15% used new seeds. Further examination of Fig. 2 reveals that about 33%

of the sample farmers recycle wheat seeds at most for 5 years whereas 30% of the sample farmers recycled wheat seeds at most for two years.

B. Attribution of the Sampled Wheat Farmers

As shown in Table II, most of the variables like family size, Level of education, distance to the input-output market, farm size, access to extension, wheat farming experience, varietal information, perception of input cost, and access to wheat farmers in Nakuru and Narok are substantially unlike.

However, in gender and perception of grain yield, there is no significant difference between the two Counties. Table II shows the mean and t-test results of continuous variables, percentage and chi-square test for independent variables.

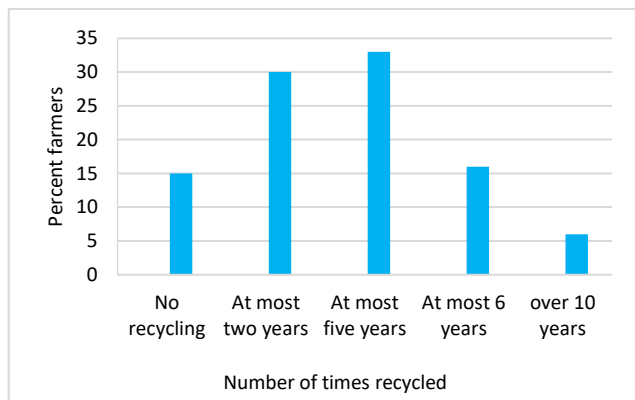


Fig. 2. Proportion of wheat growers recycling wheat seeds.
Source: Research Data (2018).

C. Drivers to Adoption of Improved Wheat

a) Varieties

Probit regression model was used in identifying explanatory variables that influence preference and uptake of improved wheat varieties (NIWVs) and their likelihood effects on whether to adopt or not by the interviewed farm households. Six binary independent and Seven continuous variables were included in the probit model estimation.

The LR χ^2 , wald test of the model was significant at a 1% level (Table III), specifying that all the independent variables included in the model have a significant impact on probability of the adoption of improved wheat varieties. Furthermore, results showed that the education of the head of

the household, access to information, distance to output and input market, off-farm income, number of contacts with extension, and access to credit were statistically significant with priori expectation signs (III).

Education Level (EDULEV) was significant at 1% and positively correlated to the adoption of new improved wheat varieties. For a level of education, the marginal effect of 0.087 implies that the higher the number of years schooled by the household head by a year, the more the likelihood of adoption of improved wheat varieties increases by 8.7%, other things being held constant (Table III).

This finding is similar to that by [17] which revealed that education is an important factor that positively influenced the adoption of improved rice varieties in Central Nepal. The result implies that education enhances farmer's awareness towards the new technologies.

This might imply that educated farmers can easily access and interpret information hence adopt the new technology.

Concerning availability of varietal information (AVAINFO), the estimated coefficient was positive and significant at the 5% significance level (Table III). The marginal effect of 0.332, is interpreted as a probability of those households who had access to varietal information was 33.2% higher than those households who had no access to information, keeping other variables the same.

The result is similar to findings by [18]. Found out that access to varietal information had a positive and significant influence on farmers' decision on adoption. Off-farm income (NOFFI) influenced positively and significantly the adoption of NIWVs at 1% (Table III). The marginal effect of Off-farm income, 0.638 shows that those households who engaged in off-farm income earning had a probability of 63.8% higher in adopting improved wheat varieties (NIWVs) than those who didn't engage in off-farm income earnings, keeping other variables constant.

This finding is similar to that by [19] who documented that participation in off-farm activities had a positive correlation to the adoption of new technology. This can be explained that the households who are involved in off-farm income generation have additional income to procure production inputs. Hence, participation in off-farm income generation positively influences wheat varietal adoption.

TABLE II: ATTRIBUTION OF THE SAMPLED WHEAT FARMERS

Independent variables	Nakuru (n = 158)		Narok (n 186)		t-test	t-value
	Mean	Mean				
Level of education	9.81	8.93			2.43***	5.13
Family- size	7.32	7.97			-1.14***	-2.62
Land- size	5.07	3.86			0.93***	3.22
Distance to market	3.58	5.31			-1.14***	3.48
Contact to extension	12.24	7.16			4.87***	6.73
Farming experience	28.92	24.82			4.18**	2.43

Binary explanatory variables	Description	Nakuru (N = 158)		Narok (N = 186)		X-value
		No.	%	Mean	%	
Sex	Male	91	0.97	56	0.97	0.06
Varietal information	Had access	50	0.53	16	0.27	9.682*
Off-farm activities	engaged	91	0.92	13	0.22	81.482
impression on yield	worthwhile	32	0.31	12	0.21	0.841
impression on cost	affordable	54	0.61	25	0.36	3.125*
Credit acquisition	acquired	53	0.61	7	0.21	29.225

***, ** and *, significant at 1, 5 and 10 %, respectively.

Source: Survey, 2018.

Distance to input-output market (DISMKRT) negative and significant at a 5% significance level. The marginal effect of distance to input-output market of -0.083, implied that the longer the distance from production point to input-output market by one km, decreases the probability of varietal adoption by 8.3%, all other things held constant (Table III).

This result is in conformity with findings by [20]; and [21]. The result implies that being near the input-output market reduces marketing costs, hence increases chances of wheat varietal adoption.

Rate of contact with agricultural extension (FREXT) had a positive and significant association with wheat farmers' varietal adoption decision at 1% (Table III). The marginal effect of the rate of extension contact was 0.053, implying that that an one-day increase in contact with extension staff, the likelihood of farmer's wheat varietal adoption increased by 5.3%, other things held constant.

This finding is similar to that by [22]. He found out that farmers who had frequent contact with extension agents were more likely to adopt NIWVs.

Access to credit (ACREDIT) positively and significantly influenced the adoption of NIWVs at a 5% significance level (Table III). The marginal effect of 0.47 shows that farmers who had access to credit had a higher probability of 47% than those who did not have access, *ceteris palibus*.

The finding is the same as the results by [23]. This can be explained by the fact that farmers who had access to credit had adequate capital to enable them to purchase recommended farm inputs, including improved wheat variety seeds, hence enhancing the adoption of NIWVs adoption.

TABLE III: RESULTS OF PROBIT MODEL (N=344)

Independent Variables	Coef.	Marginal Effect	Std. Err.	z	P>z
SEX	-2.003	-0.230	1.320	1.620	0.122
EDUCLEVEL	0.308***	0.087	0.123	2.670	0.013
FAREXP	0.026	0.008	0.034	1.130	0.283
AVAINFO	1.245**	0.332	0.515	2.530	0.01
FAMSIZE	-0.144 .	-0.041	0.110	-1.360	0.221
NOFFI	2.080***	0.638	0.444	4.740	0.001
FARMSIZE	0.054	0.016	0.135	0.540	0.713
DISOMRT	-0.262**	-0.083	0.128	-2.120	0.046
ACREDIT	2.006**	0.470	0.770	2.511	0.022
PERYIELD	0.222	0.062	0.519	0.520	0.644
PERCOST	-0.675	-0.212	0.551	-1.190	0.221
MEMGP	-0.003	0.002	0.121	-0.130	0.953
Constant	-2.957*		1.824	-1.730	0.098
Number of observations		344.00			
LR chi ² (13)		148.19***			
Prob > chi ²		0.000			
Pseudo R ²		0.7400			
Log likelihood		-			
		26.082749			

***, ** and *, significant at 1, 5 and 10 %, respectively.

Source: Survey, 2018.

IV. CONCLUSIONS AND POLICY IMPLICATIONS

Adoption of new improved high-yielding varieties is a key input factor for the enhancement of crop production and food security status of the farmers in Kenya. On the other hand, in rural areas of Kenya, the adoption rate of the new wheat varietal seed is relatively low, especially among smallholder farmers.

The main motivation for the research was to assess determinants of the choice of the new bred wheat vintage in

Nakuru and Narok Counties of Kenya by using the probit model. This study used a random sampling method to collect the data from 344 wheat farmers through a face-to-face interview.

The results of the estimations reveal that education, access to information, landholding size, Distant to input and output markets, extension contact, and access to credit positively and significantly influenced uptake of the newly released wheat varieties by farmers in the selected study areas.

Based on this paper's empirical findings, our study suggests that the government and the private should hasten the dissemination of the new varieties among the farmers through demonstrations, field days, sensitization meetings, and shows, respectively. Credit a very important element influencing the uptake rate of new releases wheat varieties in the study areas. In rural areas of Kenya, agricultural credit is mainly provided to the farmers by commercial banks, Microfinance Institutions, and NGOs, respectively. It is also recommended that formal sources of credit should supply timely and easy agricultural credit to farmers at the sowing time of wheat crop and farmers get more benefits.

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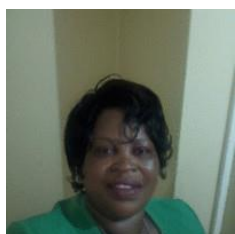
CONFLICT OF INTEREST

Authors declare that they do not have any conflict of interest.

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