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Farmers' Demand for Extra Yield from Improved Tef [(*Eragrostis tef* (Zucc.) Trotter] Varieties in Ethiopia: Implications for Crop Improvement and Agricultural Extension

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ABSTRACT

For maximum impact, high yielding improved varieties with significant yield advantages must be targeted to farmers and localities that value this trait most. Explaining farmers' demand for yield can serve as a means of targeting the development and dissemination of high yielding varieties. This paper analyzes data collected from 395 farmers in northern Ethiopia using a zero-limit Tobit regression. According to the results, poor and marginalized farmers prefer varieties adaptable to poor weather and soils, early maturing, and those which can address diverse concerns than varieties exceptionally good in a single trait (like yield). The richer farmers demand more yield advantage over the existing ones to convince them to use Improved Varieties. For farmers operating in relatively good farming systems (soils, weather, etc.), investment has to be made not only on crop improvement but also on complementary inputs, improved practices, and market development. Farmers who consider improved varieties more marketable and valuable take up high yielding varieties with relatively marginal yield difference. In areas and farmers where there is lower demand for yield, other variety traits (like early maturity, yield stability, and adaptability to local soils/weather) are also important to consider in future crop improvement activities. To ensure that farmers who demand more yield use IVs more productively, the yield advantage, compared to the existing varieties under use, must be high enough and stable.

Keywords: Modern crop varieties, Significance of yield to smallholders, Variety traits, Zero-limit Tobit regression.

INTRODUCTION

High yielding crop varieties have been adopted more rapidly than other agricultural innovations (Dalrymple, 1979) and in less than twenty years, they have covered half of the area used to food crops (Dalrymple, 1985). Improved varieties are micro-interventions improvements to existing technique, relatively easy to apply and not challenging with the existing beliefs and cultural practices (Douthwaite *et al.*, 2001). Farmers have certain demands and expectations from improved crop varieties which, in turn, affect their decision on whether or not to adopt. They often have multiple selection criteria including production, human consumption, and animal feed. This is in stark contrast to breeders who often focus on a single trait (Mekbib, 2006).

According to Horna *et al.* (2007), farmers, consumers of seed as a production input, prefer one variety over another based on the

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utility they obtain from its attributes, which depends on their own socio-economic characteristics. Farmers assess a new improved variety in terms of a range of attributes such as yield, input requirements, disease tolerance, maturity period, drought resistance, and intensity of crop management required (Abebe *et al.*, 2013). Depending on preferences, resource endowments and constraints that an individual farmer faces, a beneficial attribute for one farmer may be an undesirable one to another (Bellon and Risopoulos, 2001).

A variety of factors affect adoption of improved seeds. Those factors include seed availability (David *et al*., 2002), production and consumption characteristics of crop varieties (Sall *et al*., 2000; Dalton, 2004), farmers' needs, preferences and the prevailing farming conditions (Brocke *et al.*, 2010), farmers' perceptions of technological characteristics (Adesina and Zinnah, 1993), extension-related variables (Mariano *et al*., 2012), access to information (Wubeneh and Sanders, 2006), and complexity of the technology to understand and use (Douthwaite *et al.*, 2001).

Yield is one of the most important traits affecting production decisions (Yifru and Hammer, 2006). Increasing pressure on land (due to population growth) and labour (due to multiple competing uses) is ever increasing the importance of yield trait as a selection criterion (Almekinders *et al.*, 1994). Most crop variety production traits (eg. disease and pest resistance, drought tolerance, and performance under poor soil conditions) are very much linked to yield and its stability.

One of the main reasons for differences in crop variety adoption is that the expected increase in yield for some farmers is either small or nil, while for others it is significant (Ruttan, 1977). For instance, the marginal grain yield differences have induced the Himalayan village farmers in India to reject improved varieties (IVs) (Negi, 1994). In this paper, IVs refer to a strain released by state variety release committee for commercial cultivation by farmers (Lal, 2010). When yield potential is high and climatic risk is low, IVs are more demanded as they are more likely to generate better return (Thiele, 1999).

Yield was one of the most important technology characteristics that influenced the adoption of improved soybean seeds in Nigeria (Idrisa *et al.*, 2010). Thus, examining farmers' demand for yield can also explain improved variety adoption/non-adoption to the extent that the value to farmers of the new varieties is linked to yield *i.e.* it informs breeders and extension workers on who are more likely to adopt crop varieties developed with the primary objective of achieving high yield.

This paper, thus, aims to examine farmers' demand for additional grain yield from any future improved tef [(*Eragrostis tef* (Zucc.) Trotter] variety. Farmers demanding more yield are challenging breeders to develop more productive IVs and they are more likely to take up and benefit from such a technology only if there is a meaningful yield difference between the already existing and the new variety. Those farmers demanding less yield are either valuing other variety traits more or are willing to use improved varieties with marginal yield differences. The way the response variable is captured is discussed in Section 4.

Understanding the factors affecting farmers' yield demand will have an important role in crop improvement priority setting and targeted agricultural extension. This information would serve as a useful entry point to undertake targeted variety development and design targeting mechanisms for agricultural extension strategies. The IVs with the desired trait (s) can then reach farmers who need them most for maximum productivity and welfare impact.

Tef is an important ingredient for a staple of Ethiopian traditional flat bread called "*injera*". "*Injera"* provides approximately two-thirds of the diet in Ethiopia (Stewart and Getachew, 1962). As to its nutritional and health value, tef has got worldwide demand these days, having been found free from gluten. Infrequent nature of anemia in Ethiopia is often attributed to the strong iron

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content of the crop (Mamo and Parsons, 1987). The crop is also used for making porridge, local alcoholic drinks, called '*tela*' and '*arekie*'. The straw from tef is the most appreciated feed by livestock. It is also used in the construction of local houses.

Vavilov identified Ethiopia as the centre of origin, domestication, and diversity for tef (Ketema, 1997). Annually, tef accounts for about 28% of the total acreage and 19% of the gross grain production of the major cereals cultivated in the country (CSA, 2012). Tef area cultivated with IVs is about 0.75 percent of the total area allocated for the crop (Fufa *et al.*, 2011). Compared to fertilizer which is more intensively used in tef production (50 to 60 percent during the last 10 years), irrigation is hardly used, less than 0.75 percent (Fufa *et al.*, 2011).

Tef is primarily cultivated for household consumption and cash. It is cash crop owing to the relatively high market prices of both the grains and the straw. Ethiopian farmers continue to cultivate tef as a source of reliable income because of the following additional advantages (Ketema, 1997; Assefa *et al.*, 2011a): (i) It is adaptable for use in versatile farming systems, (ii) In moisture stress areas, farmers use it as a rescue crop since it often survives when other crops fail, (iii) Compared to other cereals, it has little threats of diseases and pests. Moreover, it grows better on marginal soils and tolerates water logging. It needs relatively short growing period and it is a reliable and low-risk crop. It can also be stored easily under local storage conditions.

IVs are used in many regions, but in very small areas within each region. The national average grain yield of the crop in 2011/2012 cropping season was 1,281 kg ha^{-1} (CSA, 2012). On-farm tef yield from IVs is about double the current national yield (Fufa *et at.*, 2011).

The major production constraints in tef husbandry are low productivity and susceptibility to lodging (Assefa *et al.*, 2011b). The national tef improvement program has, therefore, taken the development of lodging-resistant varieties as one of its priority areas. Other production constraints include: low resistance to moisture stress, frost, weeds, poor soil fertility, diseases and insects.

MATERIALS AND METHODS

The Variables Considered to Explain Farmers' Demand for Yield

Farmers' demand for yield from IVs can be shaped by a variety of factors. The variables shown in Tables 1 and 2 were identified based on theoretical constructs and field observations during the discussions with farmers. They are subsequently discussed and relationships hypothesized.

The first variable considered is farmers' experience in farming (EXPERENC)(The description of the variables (given in upper-case in brackets) is contained in Tables 1 and 2). Farmers' attitudes and expectations from IVs are the cumulative effects of their farming experience. Depending on the nature of experience and how the attributes and expectations are formed over time, experience could increase or decrease farmers' demand for yield. Thus, the relationship is unpredictable.

Not only experience in farming but also experience in growing IVs (EVERUSEIV) affects their demand for yield. Practical experience about inputs/technologies is a key to producers (Douthwaite *et al.*, 2001), as information about the nature of the product (eg. organic food products) is to consumers (Haghjou *et al.*, 2013). However, the relationship very much depends on whether the experience is positive or negative. Those farmers who have positive (negative) experience will demand more (less) yield from IVs, making the relationship unpredictable. Another variable considered important is the trend in improved variety use by farmers (TRENDIV). Farmers who have been cultivating increasingly more IVs of tef during the last few years are more likely to

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Table 1. Description of continuous variables and the expected signs.[a]

Variable	Description	Mean (SD)	Expected sign
TEF YIELD	Minimum extra yield (compared to the traditional variety being used currently) that farmers would like to get from the improved tef variety (Quintals per hectare)	3.68 (1.88)	Dependent variable
EXPERENC	Experience of the farm household head in farming (in years)	25.7 (13.3)	-
EDUCATION	The highest level of schooling completed by the household head	1.28 (2.31)	+
NETWORKS	The number of local networks that household members are engaged in (such as cooperatives, labor sharing, local office, church, and credit / saving associations)	5.38 (2.39)	+/-
DEPEND	Number of dependents per household adjusted for consumption equivalence	1.44 (1.01)	-
LABOR	Labor endowment (active and non-dependent household members) in equivalence terms	3.63 (1.32)	-
DROUGHT	Frequency of natural shocks (mainly drought) during the last 10 years	6.61 (4.15)	+
LIVESTOCK	Logarithmic value of the total value of livestock including poultry and beehives	8.07 (1.36)	+
LAND	Total area on which the HH[b] has planted different crops (in hectares)	1.1 (0.70)	-
FOOD	Number of times that the farm household has faced shortage of food during the last five years (95 to 98 EC [c])	1.37 (1.75)	_
ADAPT	Farmers' preference for a tef variety which is more adaptable to their environment (drought, salinity, frost, wind, poor soil)	3.12 (1.89)	+
MATURE	Farmers' preference for a tef variety which matures early	4.32 (2.23)	+
EXTENSION	How many years have you been participating in the agricultural extension program?	2.86 (2.95)	+
MARKET	The relative importance of price or market related problems compared to production, credit/finance, and social/personal problems	2.79 (0.92)	-

[a] Source: Own computation based on 2007 Generic Resources Policy Initiative (GRPI) survey data, Ethiopia. [b] household, [c] Ethiopian Calendar.

Table 2. Description of categorical variables and the expected signs.[a]

Variable	Description	Level (Value)	Freq (%)	Expected sign
GENDER	Gender of the household head	Male (1)	347 (87.9)	+
		Female (0)	48 (12.15)	
EQUAL	At the moment, if you are given equal chance either to use the improved or indigenous varieties, which one would you plant?	Improved (1)	290 (73.60)	+
		Local (0)	104 (26.40)	
MKTPRICE	Which varieties of tef (local or improved) attract better market price?	Improved (1)	278 (74.73)	-
		Local (0)	94 (25.27)	
CHANCE	Do you have a chance to buy or get IVs whenever you want?	Yes (1)	253 (64.71)	+
		No (0)	138 (35.29)	
ABANDIV	Have you abandoned any IVs of tef?	Yes (1)	51 (12.94)	+
		No (0)	343 (87.06)	
EVERUSEIV	Have you ever used any improved variety of tef?	No (0)	256 (64.81)	+/-
		Yes (1)	139 (35.19)	
TRENDIV	The trend in the use of IVs	It has decreased (0)	102 (25.82)	+
		Remained constant (1)	141 (35.70)	
		It has increased (2)	152 (38.48)	
CHOICE	Which variety is your preference be it in good or bad weather conditions?	Local (0)	35 (9.23)	
		Neutral (1)	212 (55.9)	
		Improved (2)	132 (34.83)	

[a] Source: See Table 1.

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have positive experience and demand more yield.

Farmers' choice between improved and local varieties (EQUAL; CHOICE) affects their demand for yield. Those farmers who prefer IVs, given their current working conditions, and those who prefer IVs in both good and bad weather scenarios are more likely to demand more yield.

Education (EDUCATION) affects farmers' yield expectations. Better educated farmers are able to compare technologies (earlier and new ones). Education is, therefore, expected to increase yield demand.

Improved crop varieties are usually labor-intensive (Pachico and Ashby, 1983). This implies that farm households better endowed with labour (LABOR) (Labour endowment is computed using equivalence scales. Accordingly, members aged 16 - 59 get a value 1, children aged 7 - 15 get 0.4 and those above the age of 60 get 0.6 equivalence. Children going to school are assumed to spend 0.40 of their time on household activities. Children below 7 and inactive household members because of age or permanent sickness get zero. These conversion factors are derived from the literature (Mayo, 1944) and they are adapted based on the discussions made with the key informants during the survey), those with lower opportunity cost of labor, can better apply the required cultural practices and benefit from IVs. Thus, as their experience influences their demand, they are more likely to demand more yield.

The surveyed farmers have repeatedly mentioned land scarcity and land degradation as the dominant bottlenecks to use and benefit from IVs. To optimize on the scarce resource (LAND), farmers with smaller land holding are expected to demand more yield from IVs.

Farmers' networks (NETWORKS) and the information they get through those networks influence their demands and expectations about variety traits of which yield is one. Depending on the nature of the information they get about the yield potential of IVs, the relationship can be positive or negative.

The other set of variables are meant to capture household wealth/poverty status (LIVESTOCK, FOOD and DEPEND) (Equivalence scales are used to account for economies of scale in consumption and the age/sex differences of the dependents on their consumption requirement)(Nelson, 1993). Small extra yield means a lot to poor households and hence they are more likely to take on IVs even with little yield difference.

Farmers' contact with agricultural extension affects their attitude towards the viability of agricultural technologies (Feleke and Zegeye, 2006). Farmers' experience with agricultural extension (EXTENSION) is expected to increase their demand for yield. Similarly, farmers who have got better chance to easily get hold of IVs (CHANCE) are expected to have higher yield demand because IVs are relatively cheap to them. Those farmers who consider market access as a priority constraint (MARKET) are expected to demand more yield to maximize farm income.

Variety attribute preferences of farmers (ADAPT and MATURE) are the other important factors that can influence and shape their demand for yield. Farmers with more preference for these attributes are expected to have less demand for yield (Wale and Yalew, 2007).

Another factor is subjective perception of farmers about the variety which attracts better market price (MKTPRICE). Farmers who prefer IVs for price are expected to demand less yield. This is because they can compensate the lower yield with the higher prices of IVs they envisage to receive.

Wale (2012) has shown that farmers abandon crop varieties either when they get other better varieties and/or when the desirable traits of the varieties currently in use deteriorate. Farmers' own experience in abandoning IVs (ABANDIV) is, therefore, another important variable expected to positively influence their demand for yield.

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Drought is one of the most common events resulting in frequent crop failures. Farmers who have been most vulnerable to extreme weather events (such as drought) tend to stick to landraces (Cavatassi *et al.*, 2011). Farmers working in areas with more frequent drought (DROUGHT) are expected to demand more yield as a risk premium.

Multi-collinearity among the explanatory variables was checked using VIFs. All the VIF values are below 2, confirming absence of multi-collinearity problem. The expected signs and the description of the explanatory variables used in the analysis are summarized in Tables 1 and 2 below.

The Econometric Model

The response variable is the minimum additional yield (compared to the traditional varieties currently in use) that farmers would like to obtain from IVs of tef before they decide to adopt them. It is the yield farmers demand from any forthcoming improved variety of tef compared to a local variety that they are growing currently. Data on this variable is collected through a hypothetical contingent valuation type survey (see Table 1). The question is not about any specific improved tef variety. It is a general question that refers to any improved variety that might be released in the future. According to the survey data, the average extra yield that farmers would demand from forthcoming IVs of tef ranges from 1 to 8 quintals (or 100 to 800 kg) per ha, with a mean of 3.7 quintals (370 kg) per ha.

The mean extra yield that farmers demand from IVs is computed for different groups of farmers. Accordingly, men, wealthy farmers, farmers who usually plant IVs on better quality plots, farmers actively participating in the agricultural extension package program, farmers who continue to grow IVs, and farmers who have abandoned one or more IVs of tef demand more yield from IVs. The mean differences are statistically significant.

The response variable is only positive. If one is to use Ordinary Least Squares (OLS) to explain TEFYIELD, its predicted values can be negative for many combinations of x and β. Thus, OLS regression is not appropriate to explain such a variable. The response variable (y) can mathematically be expressed as:

$$y_i^* = x_i'\beta + \varepsilon_i \text{ if } y_i^* > 0$$

Where, x_i is a vector of independent variables (presented above and described in Tables 4 and 5) and y_i^* is the latent variable. $y_i = y_i^*$ is observed only if $y_i^* > 0$ and $y_i = 0$ is set if $y_i^* \leq 0$. In other words, farmers' demand for yield is constrained to exceed 0 for y to be observed i.e. the response variable is a censored variable because any y_i^* that is negative is not observed. Since the dependent variable is not taking values below 0, stata's lower-limit option (zero-limit) is employed to get the Tobit results reported in Table 5.

The Tobit specification is applicable in those cases where the observed zero values are a consequence of censoring and non-observability (Baltagi, 2002). The stochastic model underlying the Tobit regression is expressed as follows:

$$y_i = x_i\beta + \varepsilon_i \text{ ; if } x_i\beta + \varepsilon_i > 0$$
$$= 0 \text{; if } x_i\beta + \varepsilon_i \text{ or } y_i^* < 0.$$

The coefficients (or βs) are vectors of parameters to be estimated and ε_i is an independently distributed error term assumed to be normal with zero mean and constant variance σ^2.

Sampling and Data Collection

Before embarking on the structured survey, participatory rural appraisal was undertaken to understand the local context. Discussions were held with a total of 73 key informants. Moreover, information was collected from relevant individuals and records of local government agriculture offices.

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Table 3. Reasons farmers give for never planting IVs.[a]

Reasons	% of respondents [b]
High price	49
Lack of access (shortage of supply)	31
Lack of information	24
Lack of capital	24
Land and labor shortage	24
Local varieties are good enough	24
The use of fertilizer is sufficient to make local varieties yield as high as the improved ones	9
The quality of land is not suitable for improved varieties	6
Not sure about the incremental value of the improved variety	2

[a] Source: See Table 1. [b] Notes: The total sum of the percentages exceeds hundred because most farmers have given multiple reasons.

Table 4. Farmers' reasons for the choice of improved over local tef varieties.[a]

Reasons	% of respondents
Good yield and productivity	70
Better market demand	20
Adaptable to the local stress	14
Better quality than local varieties	10
Early maturing	7
The land is tired of local varieties	3
Others	5

[a] Source and Notes: See Table 3. Notes: (1) ***, ** and *= Significant at 1%, 5% and 10%, respectively, (2) Values in parentheses are the ratio of the coefficients to the respective standard errors.
(å) dy/dx is for discrete change of dummy variable from 0 to 1.

The sampling started with two Zones (South Gondar and North Wollo) in Amhara Regional State. The choice of the Region and the Zones is made in consultation with the Ethiopian Institute of Biodiversity Conservation. The Region and the Zones are found to be suitable for the project entitled '*Economic analysis of genetic resources conservation and inter-linkages with development interventions in Ethiopia*'. The objective of the survey was to understand the behavior of smallholder farmers in relation to sustainable use of improved and local varieties of crops.

This was followed by a multi-stage stratified random sampling. The aim was to identify homogenous groups at different stages and draw sample from each homogenous group. Development Agents (DAs) working at the respective District Agriculture Bureaus were instrumental to inform the team on the sources of heterogeneity among Zones, Districts, Peasant Associations (PAs)(In Ethiopia, Peasant Association is the lowest administrative (government) structure of one or a number of villages), and farmers. Accordingly, while poverty status was the major source of heterogeneity at the household level, access to markets and roads were the major sources of heterogeneity at Zone, District, and PA levels. These variables were used to stratify and choose the Districts, PAs and households. The other variables considered during the sampling at the household-level included importance of income sources outside agriculture, education, and gender.

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Table 5. Results of a zero-limit Tobit regression.[a]

Variable	Coefficient (t) [b]	Marginal effects: dy/dx[c]
GENDER	0.311 (0.98)	
EXPERENC	-0.003 (-0.42)	
EDUCATION	0.087** (2.23)	0.087
NETWORKS	0.0223 (0.46)	
DEPEND	-0.310*** (-3.12)	-0.310
LABOR	0.177* (2.09)	0.177
DROUGHT	-0.017 (-0.75)	
LIVESTOCK	0.178** (1.99)	0.178
LAND	-0.050 (-0.31)	
FOOD	0.044 (0.84)	
ADAPT	0.152*** (3.11)	0.152
MATURE	0.072* (1.58)	0.072
EQUAL[å c]	0.788*** (3.26)	0.788
MKTPRICE[å]	-0.603** (-2.23)	-0.603
CHANCE	-0.061 (-0.30)	
EXTENSION	-0.0009 (0.03)	
MARKET	0.063 (0.59)	
ABANDIV[å]	0.880*** (2.37)	0.880
EVERUSEIV[å]	-0.523** (-2.30)	-0.523
TRENDIV	0.238* (1.86)	0.238
CHOICE	0.368** (2.10)	0.368
Constant	-0.010 (-0.01)	
Dependent variable is TEF YIELD	Number of Obs= 331	
LR-χ^2(2)= 84.6	Prob> χ^2= 0.000	
Log-likelihood= -634.2	Pseudo-R^2= 0.063	
Predicted value of the response variable= 3.65		

[a] Source: See Table 1. [b] Notes: (1) ***, ** and *= Significant at 1%, 5% and 10%, respectively, (2) Values in parentheses are the ratio of the coefficients to the respective standard errors.
[c] (å) dy/dx is for discrete change of dummy variable from 0 to 1.

While South Gondar was relatively poor with relatively poor natural endowment for agriculture, North Wollo was a relatively rich zone. In South Gondar, Farta (accessible) and East Estie (less accessible) Districts were chosen, whereas in North Wollo, Guba Lafto (accessible) was selected. In each District, two PAs were selected based on their contrast in terms of prevalence of poverty i.e. Mainet and Kolley Dengorse in Farta, Shimagle Georgis and Sholekt in East Estie and Ala Weha and Woinye in Guba Lafto.

Poverty status of farm households was assessed using a simple and subjective wealth ranking done by engaging the key informants in each village. After ranking farmers based on their poverty status, farm households from each poverty group were sampled randomly and proportionately.

The records (rosters) from local agricultural offices were used as sampling frames in the respective villages. At the end, 55–76 farm household heads were interviewed per PA. In total, the sample involved 2 zones, 3 Woredas, 6 PAs, 25 villages, and 395 farm households. No statistical procedure was adopted to arrive at this sample size. Given the financial/time constraints and the purpose of the study, 395 was found adequate to achieve the objectives of the study. The survey was conducted during the 2006/2007 cropping season.

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RESULTS AND DISCUSSION

Descriptive Results

In the surveyed villages, about 66 percent of the respondents could buy or get IVs whenever they wanted. However, farmers' experience with IVs was very limited; 30 percent of them had never grown IVs at all. For details on why use of technology in Ethiopian agriculture is low, see Croppenstedt *et al*. (2003) and Kidane and Abler (1994). The reasons that the surveyed farmers gave as to why they had never planted IVs are summarized in Table 3.

Sometimes, the combination of varieties that farmers grow may not necessarily reflect their preferences. Their choice could simply be because they could not have other option (s). Hence, farmers' preferences are better captured by asking what they prefer, not what they grow. Having set certain hypothetical scenarios, farmers were asked their preferences and the associated reasons. Keeping institutional and environmental constraints constant, if farmers are given equal chance to plant improved or local varieties of tef, 85% of the 298 farm households would plant IVs. Their reasons are summarized in Table 4.

Table 4 underscores the overriding importance of yield in farmers' decision to choose IVs. In most of the crop improvement and agricultural extension work, yield is one of the priority variety attributes. Farmers' ranking of the different tef variety traits also confirms that yield comes first followed by adaptability to the local environment, early maturity, yield stability, fertilizer requirement, good straw quality, and good food quality.

Although it is not the case across the board, traditional varieties may often have higher mean yields in marginal environments (Cleveland *et al.*, 1994). About 80 percent of the 379 respondents noted that IVs were mostly more productive in a good season. During bad seasons, the local varieties are better according to 53 percent of the 393 respondents and IVs are better for 41 percent of them. Local varieties have become well adapted to environments that generally have received little modern technology (Sall *et al*., 1998).

Data were collected on which variety farmers would grow under good or bad weather scenarios. If farmers were able to predict good weather, 84 percent of the 286 respondents would grow IVs of tef and the rest would opt for traditional. They would do this mainly to achieve better yield. Their perceptions and decisions agree with the results of empirical studies that have found that IVs better respond to favorable conditions including irrigation, fertile soils, and good rainfall conditions (Negi, 1994; Sall *et al*., 1998). The descriptive results from the survey data showed that 52 percent of the 327 respondents usually planted the IVs on better quality plots.

Under poor weather conditions, returns to inputs (like IVs and fertilizer) tend to be lower than without the input, given the sunk cost of the input (Dercon and Christiaensen, 2011). If farmers were able to predict bad weather, 57 percent of the 284 respondents would grow local tef varieties and the rest would opt for the IVs. This also confirms that IVs may have a limited role in more marginal and high-risk environments (Negi, 1994; Mekbib, 2006).

The discussions held with farmers also underscored the overriding importance of yield in farmers' variety choice decisions. IVs often take long time and resources to be released. However, the desirable traits of those varieties do not usually last long after they are released. Crop varieties are perishable, normally rendering obsolete in an all-too-short period of time (Dalrymple, 1985). This will reduce farmers' incentives to continue to use the IVs. IVs dis-adoption is one area for future research in the context of smallholder agriculture. According to the surveyed farmers, for the most common crops (sorghum, wheat, tef, maize and barley), farmers used IVs for 3 to 5 years. Thus, in the future, breeders will have to

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give more attention not only to yield but also to stability of performance (Mekbib, 2003).

Results of the Regression Analysis

Table 5 reports the regression results of the estimated lower-limit Tobit.

Overall, the model fits the data well. The likelihood ratio test indicates the significance of the model. Amemiya (1984) has shown that the Tobit maximum likelihood estimator is not consistent under heteroscedasticity. To check this problem, the Tobit model was estimated with and without correction for heteroscedasticity. The likelihood ratio test supported the Tobit results with correction for heteroscedasticity. The results of Table 5 are, therefore, Stata's robust estimates.

As expected, more educated farmers had higher demand for additional yield from IVs. Previous literature suggests that education improves technology adoption (Lin, 1991), farmers' capacity to use resources more efficiently (Ogunniyi *et al*., 2012), and farmers' ability to collect and synthesize information (Asfaw and Admassie, 2004). The result can, therefore, be attributed to the fact that educated farmers can utilize IVs more productively.

Farmers who have used and then abandoned one or more IVs of tef (for whatever reason) have been found to demand more yield from IVs. This is because they need more yield to be convinced and take back IVs after they have dis-adopted one or more. Farmers who had never used any improved variety of tef also demanded more yield than those who had used IVs at least once. The higher extra yield demanded can be considered as a risk premium for the perceived risk associated with the use of IVs for the first time, as the new users lack confidence and experience about the potentials of the new varieties.

Farmers who preferred improved varieties to local varieties of tef, given their current working conditions, those who had increased the use of IVs during the last five years, and those who preferred IVs irrespective of the expected weather scenarios (bad or good) also demanded or expected more yield from IVs. Therefore, farmers who showed more interest for IVs were demanding more yield.

Market inaccessibility is often linked to low level of technology adoption (Feleke and Zegeye, 2006). The results suggest that farmers who preferred IVs for better price demanded less yield from IVs of tef. This confirms the idea that if farmers expect to get better price from IVs, they can take IVs even with marginal yield difference since each unit worths more to them.

Early maturity is a variety trait that may provide farmers with an *ex ante* means of escaping drought (Cavatassi *et al*., 2011). Moreover, early maturity is also important to poor farmers operating in marginal environments as they wish to get the harvest quick so that they can get food at very critical time. The results suggest that farmers who had better preference for early maturity and adaptability to local weather/soil conditions demanded less extra yield from IVs. This is partly because of the poverty of these farmers (Wale and Yalew, 2007) to whom any unit of extra yield had more value and they demanded more of other variety traits (eg. early maturity and adaptability to local weather/soil conditions) that support their livelihoods in terms of stabilizing income and maximizing survival. Farmers with many dependents also demanded lesser extra yield from IVs of tef, for a similar reason. In sum, demand for yield was poor among the rural poor. This is in line with the literature which shows that lack of alternative means of keeping consumption smooth leaves poor rural households unable to protect themselves against downside risk stuck in low return, lower risk agriculture, perpetuating poverty in agrarian settings (Dercon and Christiaensen, 2011).

On the contrary, livestock ownership increased farmers' yield demand from new varieties. This is in line with one of the lessons from the adoption literature i.e.

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wealth induces technology adoption (Feleke and Zegeye, 2006).

Finally, the results show that farm households with better labor endowment demanded more extra yield from IVs. IVs are more labor demanding because, to benefit from these varieties, farmers have to apply all the required cultural practices timely. Labor-endowed households who have been managing IVs well and benefiting more would, therefore, expect more yield.

CONCLUSIONS

Understanding farmers' demand for extra yield from IVs can be used to tailor crop improvement and agricultural extension strategies. Though farmers' demands from crop varieties are diverse, yield remains the most important trait that they look for and has an overriding effect when they take decisions on which improved variety to adopt. Preference for IVs does not necessarily mean that farmers will easily take them up. It all depends on which variety trait or combination of traits they value and demand. The results can be used to maximize yield impacts of IVs. For maximum impact, high yielding IVs with significant yield advantages must be targeted to farmers and localities that demand those most. The descriptive results have shown that farmers perceive the desirable traits of improved and local varieties differently. Overall, farmers' experiences with IVs suggest that these varieties perform better under good weather as well as better access to other inputs and market scenarios. If the impact of IVs on farm income is to be maximized, investment has to be not only on crop improvement but also on on complementary inputs, improved practices, and market development. The regression results suggest that farmers who consider IVs more marketable and valuable take up high yielding varieties with relatively marginal yield difference. Poor smallholder farmers often have more survival maximizing objectives than just yield and profit maximization. For these farmers, other variety traits (like early maturity, yield stability and adaptability to local soils/weather) will become more important to consider in future crop improvement priority setting. This partly explains the perpetuity of rural poverty in most parts of the country. The richer farmers demand more yield advantage over the existing ones to convince them to use IVs. Breeders and agricultural extension workers have to aim to meet the higher yield demanded by farmers, especially those farmers with no experience with IVs of tef. To ensure that these farmers productively use IVs, the yield advantage, compared to the existing varieties under use, must be high enough and stable.

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انتظارات کشاورزان از افزایش تولید با استفاده از بذر اصلاح شده گیاه Tef [(*Eragrostis tef* (Zucc.) Trotter] در اتیوپی: پیشنهادهایی برای اصلاح نباتات و ترویج کشاورزی

ی. واله و، ج. ن. چیانو

چکیده

برای بیشینه کردن اثر کاربرد رقم های اصلاح شده پر محصول که افزایش تولیدشان چشمگیر است می بایست کشاورزان و مناطقی که این صفت را ارزشمند میدانند هدف برنامه مربوطه باشند. برای هدف گذاری تولید و توسعه و پخش بذر ارقام پرمحصول می توان ازتوضیح انتظارات کشاورزان برای افزایش تولید به عنوان ابزاری استفاده کرد. در این ارتباط، در این مقاله داده های جمع آوری شده از ۳۹۵ کشاورز در شمال اتیوپی به روش حد-صفر رگرسیون توربیت (zero-limit Tobit regression) تجزیه وتحلیل شد. بر پایه نتایج این تجزیه، کشاورزان فقیر وحاشیه ای ، رقم هایی را که با شرایط نامساعد خاک و آب وهوا سازگار باشند، زود رس باشند، و بتوانند با شرایط متنوع نا مساعد بسازند بر رقم هایی که فقط یک صفت فوق العاده خوب (مثل عملکرد) دارند ترجیح می دهند. اما کشاورزان ثروتمندتر انتظار دارند عملکرد ارقام اصلاح شده جدید در مقایسه با رقم های موجود بیشتر باشد تا به استفاده از آن رضایت دهند. برای کشاورزان در سامانه های زراعی مناسب(از نظر خاک، آب و هوا وغیره) سرمایه گذاری نه فقط برای رقم های اصلاح شده که باید برای نهاده های تکمیلی، عملیات زراعی بهتر، وتوسعه بازار هم انجام شود. گفتنی است که کشاورزانی که رقم های اصلاح شده را بازار پسندتر و ارزشمند ترقلمداد می کنند رقم های پر محصول جدید را که عملکرد نسبی کمی بیشتر از رقم های موجودشان دارند نیز میپذیرند. برای کشاورزان و مناطقی که انتظارات کمتری از عملکرد دارند، صفات دیگری از رقم ها(مانند زودرسی، ثبات عملکرد، و سازگاری با شرایط خاک و آب و هوای محلی) نیز برای لحاظ کردن در برنامه های آتی اصلاح نباتات از اهمیت برخوردار است. برای تضمین بهره برداری بیشتر کشاورزانی که انتظار عملکرد بالاتری از رقم های اصلاح شده را دارند لازم است برتری عملکرد رقم اصلاح شده نسبت به رقم موجود زیاد و باثبات باشد.

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