

HOW MUCH ARE LANDRACES WORTH TO FARMERS? THE CASE OF TRADITIONAL MAIZE IN MEXICO

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ABSTRACT. In this paper, I investigate whether the value of traditional maize varieties to small scale farmers in rural Mexico is more than market prices. I use nationally representative rural household data from Mexico – the center of diversity for maize – to estimate farmer-specific subjective values of traditional maize varieties. I conclude that subsistence farmers’ valuation of traditional maize varieties is significantly higher than market prices, confirming previous emphasis on non-market values of these crops. I use estimated subjective values to identify the key determinants of the value of traditional maize for farmers. I find that farmers’ subjective values are negatively correlated with having irrigation and high soil quality, but positively correlated with being male, indigenous and living further away from community center. This analysis has policy implications that can guide programs for the conservation of traditional maize in Mexico.

The southern leaf blight and the Irish potato famine demonstrated the consequences of relying on genetically homogenous farming systems. These events underlined the importance of conserving the diversity of crop genetic resources (CGR) and initiated a growing body of literature on how to do this effectively. The initial focus on gene banks shifted gradually to on-farm conservation. Unlike the gene banks, on-farm conservation maintains the evolutionary processes that contribute to diversity with “continuous cultivation and management of diverse set of populations by farmers in the agro-ecosystems where a crop has evolved” (Jarvis et al., 2000). Recent case studies from all around the world identify socio-economic and agro-ecological variables that are correlated with on-farm conservation of various crops (Smale, 2006). These studies contribute to our understanding of farmer valuation of diversity that can help us design efficient conservation policies.

Previous studies, however, are limited in their scale due to costly data requirements. Most of them use data from special surveys designed to understand farmer valuation, but cover small areas due to the tradeoff between survey specificity and coverage. In this paper, I use

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a method to identify farmers' subjective valuation of traditional crops that can be applied to conventional farm household data.¹ I use nationally representative data from rural Mexico to estimate subsistence farmers' valuation of traditional maize varieties. I then analyze the determinants of their valuation to identify potential policy entry points for the conservation of maize landraces in Mexico at least cost. The method I use is flexible enough to be applied in other regions and with other crops.

1. CONSERVATION OF CROP GENETIC RESOURCES

Landraces are highly variable crop populations that have been selected and cultivated by farmers to adapt to local environments and meet various needs. An important characteristic of landraces is that they display considerable genetic variation as compared to improved varieties (Bellon and Brush, 1994). Plant breeders use this variation to improve crops' resistance to continuously evolving pests and diseases and to increase yields to meet the needs of increasing population (Smale et al., 2001). Conserving genetic diversity in gene banks was the initial solution to the conservation problem. Relying only on gene banks for conservation, however, is questionable because of the problems faced in maintaining and utilizing the existing accessions (Wright, 1997; Koo et al., 2003). Moreover, gene banks treat CGR as static stocks by freezing them to conserve, rather than facilitating the evolutionary processes that build more genetic material. On-farm conservation allows for these processes and provides a richer genetic stock for crop breeders to work with (Bellon and Smale, 1998). Therefore, on-farm conservation is increasingly used to complement the conservation in gene banks (Jarvis et al., 2000). The centers of crop domestication and diversity have special importance for targeting on-farm conservation programs, because of the wide genetic diversity contained in landraces in these locations (Bellon and Brush, 1994).

The feasibility of on-farm conservation in centers of diversity has been investigated by previous studies (Doss, 2003; Bellon and Smale, 1998). A decline in on-farm genetic diversity was predicted to be a result of increasing market integration, as farmers would adopt modern crop varieties for commercial production. However, these concerns did not materialize fully, due to *de-facto* conservation of landraces especially in their centers of diversity (Brush and Meng, 1998; Dyer-Leal and Yunez-Naude, 2003). *De-facto* conservation occurs because farmers find it optimal to continue cultivating landraces due to their various attributes that suit farmers'

¹I develop this method with a theoretical model of farmer's decision making in another paper titled "Farmers' subjective valuation of subsistence crops and markets: the case of traditional maize in Mexico." (<http://tinyurl.com/6q85m>.)

production and consumption needs, which are not necessarily valued by markets (Brush and Meng, 1998; Smale et al., 2001; Edmeades et al., 2004; Badstue et al., 2006). These private benefits of landraces to farmers offer possibilities for decreasing the costs of on-farm conservation by targeting farmers with a higher likelihood of *de-facto* conservation (Bellon and Smale, 1998; Brush et al., 1992; Smale et al., 2001).

Given the vast amount of effort and resources put into the on-farm conservation of landraces, a thorough understanding of farmers' incentives to continue cultivating landraces is essential. This research contributes to previous literature by introducing a novel approach to analyze subsistence farmers' incentives to conserve the on-farm diversity of landraces. To the best of my knowledge, this is the first study on a national scale on this subject.

2. MAIZE IN MEXICO

Maize is the third most important food crop (after wheat and rice) in the world in terms of area harvested (Turrent and Serratos-Hernandez, 2004). It was domesticated in Southern Mexico around 7000 BC and it has been evolving since then with natural and farmer selection to adapt to a wide variety of soil and climate conditions, as well as to satisfy farm households' various consumption needs (Dowswell et al., 1996). This makes Mexico the center of diversity of maize with 59 different races (Berthaud and Gepts, 2004).

Besides being the staple food source, maize has a very special place in the cultures of the Mesoamerica. According to Mayan creation myths, Gods created the humankind by mixing corn dough with their blood (Salvador, 1997). Even today, maize is considered to be the most important crop for small farmers, who continue to grow it mainly for home consumption. For this group of farmers maize is the main source of daily calories and a basic ingredient of many types of dishes.² Consequently farmers choose which maize variety to cultivate based on multiple traits such as yield, softness of the dough, ease of shelling the grains, color and taste. This selection process has been underlined in a number of studies as a reason for the persistence of cultivation of landraces among subsistence farmers in Mexico (Brush and Meng, 1998; Smale et al., 2001; Dyer-Leal and Yunez-Naude, 2003; Berthaud and Gepts, 2004; Brush and Chauvet, 2004; Badstue et al., 2006; Dyer-Leal, 2006).

The implication of these various traits farmers care about is that market prices do not fully reflect the value of maize to small scale farmers (Smale et al., 2001; Dyer-Leal and Yunez-Naude, 2003; Dyer-Leal, 2006). It is not rare to find that small scale maize farmers in Mexico incur cash

²In an exhibition at the Museo de Culturas Populares in 1982, 600 different food preparations were documented, many of which require different types of maize (Brush and Chauvet, 2004).

losses (Heath, 1987; Dyer-Leal and Yunez-Naude, 2003; Brush and Chauvet, 2004). This finding does not reflect the “irrationality” of farmers, on the contrary, it reflects the existence of non-market benefits that farmers get from cultivating maize under given conditions. The cash losses lose significance if we take these non-market values into account. Dyer-Leal (2006) emphasizes the importance of “shadow values” (rather than market prices) in understanding responses of subsistence maize producers to economic changes, which differ from what conventional economic analyses would predict. Shadow values are farmers’ subjective valuations and capture the non-market values attached to traditional crops.

I estimate these “shadow values” and analyze whether they are really different from market prices and how they can help us design targeted policies for the conservation of CGR. I assume that farmers make rational resource allocation decisions given the constraints they face and the non-market benefits they receive from landraces. These decisions may seem inefficient if we use market prices to represent maize’s worth to them. Therefore, by looking at the difference between what they should be doing based on market prices and what they are doing based on their subjective valuations, we can identify which farmers value landraces more. This difference then provides us with information about their incentives to maintain landraces.

I use agricultural household data from the Mexican National Rural Household Survey (ENHRUM) that were collected in January-February 2003. This data set covers 1765 households in 80 communities in Mexico, and it is designed by the National Institute of Statistics, Geography and Informatics (INEGI) to be regionally and nationally representative of rural Mexico.³

86% of the maize plots in the sample are cultivated with traditional maize varieties, with considerable differences across regions as seen in Table 1. Southern and Central regions have the highest percentage of traditional maize cultivation. We can also see differences across regions

TABLE 1. Percentage of plots under different maize types by region

Region	% of Maize types	
	Improved	Traditional
South-Southeast	8	92
Central	7	93
Western Cent.	22	78
Northwest	85	15
Northeast	20	80
Total	14	86

with respect to household characteristics (Table 2). The South-Southeast is the region with

³For more details on the ENHRUM data see: <http://precesam.colmex.mx>

the lowest wealth index, followed by the Central region.⁴ Most of the households in the sample do not have irrigation except in the Northwest region, where 62% of the plots are irrigated (as opposed to 16% for all regions). Differences in household characteristics among regions mirror differences in major economic and social indicators. Southern Mexico includes the poorest states with high indigenous populations, whereas Northern states have higher GDP per capita, large scale farming and industrial production (Chiquiar, 2005). These fundamental differences create a need to control for regional variation when analyzing data on a national level.

TABLE 2. Means of household characteristics by region

	Wealth Index (q-tile)	Edu- cation (years)	Total land cult. (ha.)	Irri- gated land (%)	Nr. of plots	Nr. of maize plots	Off- farm income (%)
South-Southeast	1.63	3.72	6.52	9.57	2.87	1.35	0.39
Central	2.03	3.43	1.65	21.06	2.03	1.15	0.48
Western Cent.	3.46	2.70	7.48	17.21	2.91	1.02	0.44
Northwest	4.85	4.54	11.88	61.54	2.38	1.08	0.46
Northeast	2.95	4.65	24.11	7.09	1.97	1.00	0.59
Total	2.28	3.60	7.09	15.85	2.51	1.19	0.45

I estimate farmer-specific subjective valuations (“shadow prices”) as defined by the theoretical model.⁵ I find that farmers value traditional maize varieties more highly than improved varieties (Table 3 on the next page). From the theoretical model we would expect that farmers who do not sell their maize must value maize higher than reflected by the market price. I test whether the subjective valuations are statistically significantly different from local market prices for sellers and non-sellers of both varieties. I conclude that the traditional maize varieties have a value to subsistence farmers that is significantly higher than market prices, whereas the same is not true for improved maize or for farmers who sell maize. Intuitively, the non-market values (e.g. resistance to pests, ease of shelling, ease of making tortilla dough, kernel color, ceremonial value) are important for traditional maize varieties only, because these characteristics are products of millennia-old traditions and local knowledge that are not necessarily captured by market prices. These values define farmers incentives to maintain diversity and can be used in targeting conservation policies.

⁴Wealth index is a variable created using Principal Component Analysis based on the characteristics of households’ primary residence, access to utilities, and ownership of TV and refrigerator.

⁵Shadow price is equal to $\frac{w}{MPL}$. I estimate *MPL* (i.e. Marginal Product of Labor) by first estimating a production function using a similar method to Jacoby (1993) and Skoufias (1994). I theoretically show that shadow price is greater than the market price for subsistence farmers, but less than or equal to market price for farmers who sell their product.

TABLE 3. Summary statistics for estimated shadow prices and observed market prices

Variable	Traditional	Improved
Shadow price for full sample	49.13	13.75
Shadow price for sellers	20.84	21.29
Shadow price for non-sellers	59.13	8.65
Observed market price/kg.	1.98	1.57

Wealth is found to affect on-farm diversity positively in most previous studies, except for the case of maize in Mexico (by Dyer in Smale and King (2005)). We can see a wide variation across the 5 regions in terms of estimated shadow prices and the wealth index. Figure 1 shows both the wealth index and shadow prices in quintiles to facilitate comparison across different regions and scales. We can observe what appears to be a negative correlation between shadow prices and wealth indices. Farmers in the South-Southeast region have high incentives for conservation and the lowest wealth, whereas farmers in the North-West region have the highest wealth and the lowest incentives for conservation. While this figure provides some intuition about the regional differences, it does not account for other factors that may affect this negative correlation, which I control for in the following regression.

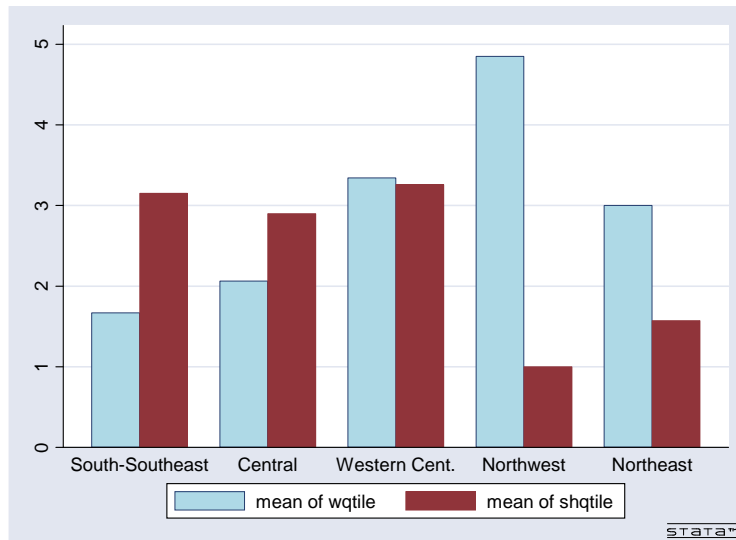


FIGURE 1. Regional distribution of estimated shadow prices and wealth index in quintiles

Given the estimated farmer-specific subjective values for traditional maize, we can identify which household and farm characteristics are correlated with high incentives for continued cultivation of traditional maize. I decompose the estimated subjective values using socio-economic and agro-ecological variables that are found to be correlated (positively or negatively) with on-farm crop diversity in previous case studies (Table 4).

TABLE 4. Determinants of incentives for on-farm conservation

Variable	Sign	Significance
Wealth index	-	
Household head's gender (male=1)	+	*
Household head's age	-	
Household head's education	-	
Household is indigenous	+	*
Household size	+	
Total land owned	-	
Total number of animals owned	+	
% of maize area in total area cult.	+	
Remittances received	0	
Government transfers	+	
Bought maize	+	*
Off-farm employment in the village (%)	+	
Credit access in the village (%)	-	
Soil quality (1:Bad, 2:Medium, 3: Good)	-	**
Irrigation dummy	-	***
Time to walk to community center	+	**
Farm fragmentation	+	
Central	-	**
Western Central	-	
Northwest	+	
Northeast	-	

Significance levels : * : 10% ** : 5% *** : 1%

Controlling for other variables, I find that wealth is *not* significantly correlated with farmers' incentives, confirming Dyer's finding on a larger scale. Male household heads value traditional maize more than women. This may indicate the differences between genders in terms of how they value production attributes and consumption attributes. The latter is believed to be more important for women because they are the ones who prepare food from maize, and the former for men because they are more involved with production. Previous studies have found that women's involvement in decision making positively affects on-farm diversity. This may indicate a gender bias in survey data because usually only males are interviewed. More balanced representation of genders in surveys on crop diversity would clarify such issues in future studies.

The results show that indigenous farmers value traditional maize more than other farmers. This is not surprising, because indigenous communities are believed to be the “keepers of maize” in Mexico (Bellon and Brush, 1994; Nadal, 2000). Maize’s importance in the indigenous cultures of Mexico makes them a potential target group for the efficient conservation of maize genetic diversity. This result controls for farmers’ wealth, hence indicate that policies that aim to decrease poverty among indigenous farmers need not conflict with on-farm conservation.

Agro-ecological characteristics such as soil quality and slope have varying effects on on-farm diversity in different settings. Environmental heterogeneity (i.e. farm fragmentation) has been found to support on-farm diversity by previous research (Smale and King, 2005). I find that soil quality and irrigation are negatively correlated with farmer valuation of traditional maize and that farm fragmentation is not correlated with farmer valuation.

Proximity to markets is seen as one of the reasons of decreasing on-farm diversity. Market access may decrease the need to conserve some varieties if farmers can buy them in the market, and some farmers may find it more profitable to specialize on one variety to sell in the market. I find that the farther away a farmer’s plot is from the community center, the higher the incentives to maintain traditional maize varieties. This does not necessarily suggest that improved infrastructure will decrease diversity, because some maize attributes are simply not observable in markets; thus some farmers will still have incentives to conserve varieties with those attributes.

The method I develop here can be used to understand the linkages between farm/farmer characteristics and incentives for conservation on a big scale. It allows us to identify pockets of diversity where farmers’ incentives to conserve diversity are large. In the current case, these pockets are where indigenous farmers cultivate traditional maize on rain-fed plots in isolated communities, especially in the South-Southeast region of Mexico. These findings confirm previous research with a novel approach that can be used to identify initial targeting regions. Once targeting regions are identified, we can follow up with more detailed studies of farmer selection in those regions as a basis for designing efficient on-farm conservation programs.

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