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GENDER AND THE IMPACTS OF INTERNATIONAL MIGRATION: EVIDENCE FROM RURAL MEXICO

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The impacts of international migration are often thought of as effects on labor markets in destination countries. Given that more than 175 million people live outside their country of birth, destination-country impacts are, indeed, important (O'Neil 2003). However, migrants also leave family, friends, businesses, and communities behind. The impacts of international migration on households and communities of origin have been the subject of a growing literature in economics and the other social sciences. Despite a growing awareness that gender shapes the *determinants* of international migration, almost no economic research has focused on gender-specific *impacts* of migration in migrant-sending areas.

This chapter takes a step toward filling the void in research on the gender impacts of international migration. It addresses two critical questions. First, how does the gender of migrants affect the impacts of international migration on the economic activities of household members left behind? We specifically investigate households' participation in cropping and nonagricultural activities. Second, what impact does female and male migration have on household investments in education and health?

Theoretically, if a household is welfare maximizing, it would only choose to have migrants if that decision increased welfare. However, increases in welfare may come at the expense of some or all nonmigration activities, and the impact of migration on these activities may differ depending on the gender of the migrants.

In an effort to address these questions, we construct and estimate an econometric model of migration and its impacts and estimate this model using data from the 2003 Mexico National Rural Household Survey (Encuesta Nacional a Hogares Rurales de México—ENHRUM). We begin by briefly discussing hypothesized impacts of migration and remittances in existing migration models. We then present our econometric model, describe and summarize the data, and report the econometric results. A final section summarizes our conclusions.

Review of Literature on the Impacts of Migration in Economic Models

International migration potentially produces both direct and indirect impacts on households in migrant-sending areas.

The most visible direct impact is the lost-labor effect of migration on household production and income activities. Family labor invariably decreases when a family member migrates away from the farm, and household production and other income-generating activities adjust. In addition, migrant remittances add directly to the receiving household's income.

Indirect effects are more complex. They are associated with the role of migrants as financial and risk intermediaries, providing households with liquidity to invest in new production activities or technologies and income security, as well as the income effect that migration and remittances may have on the supply of family labor for production activities, highlighted by research on what has become known as the new economics of labor migration (NELM; for example, see articles reprinted in Stark 1991).

A household perspective provides a useful basis for considering both the direct lost-labor and remittance effects and the indirect influences of migration on rural households. In an agricultural household model with perfect markets, as in the basic model presented by Singh et al. (1986), neither the loss of family labor to migration nor the receipt of remittances is hypothesized to influence household production activities. This is because, as a wage taker in local labor markets, the household can simply hire laborers to take the place of those who migrate, and remittances, while adding to the household's budget, do not affect any of the conditions for profit maximization. In such a model the only impacts of migration and remittances are on the consumption side. These effects include an increased demand for leisure and other normal goods. A finding that migration significantly affects farm-household production would not be consistent with the perfect-markets model.

In the past two decades, as the emphasis of development economics shifted toward the study of market imperfections, new perspectives emerged stressing the complexity of migration as an economic institution, interrelationships between migration's determinants and impacts, and the household's role in migration decision making (Stark 1991; Taylor and Martin 2001). Migrant-sending households, particularly in rural areas, typically find themselves in a context of missing or imperfect markets. The presence of market imperfections vastly increases the potential scope for migration impacts on sending households.

In a context of market imperfections, migration can produce both positive and negative effects. For example, if migrant remittances enable households to overcome credit and risk constraints on production, migration may increase incomes in migrant-sending households by more than the dollar amount that migrants remit, creating an income multiplier of remittances *within* households.[1] However, if households cannot hire perfect substitutes for the labor of family members who migrate, there may be negative lost-labor effects on production. Remittances also can have a negative effect on production if they increase incomes in migrant-sending households, leisure is a normal good, and households cannot hire perfect substitutes for their labor in family production activities. These negative impacts of migration on production activities are not necessarily inconsistent with a positive impact on welfare. However, they may dampen or even reverse positive effects of remittances on household income, production, and expenditures on education, health, and other items. Econometric studies find evidence of negative lost-labor effects of migration in migrant-sending households, but positive remittance effects (León-Ledesma and Priacha 2004; Rapoport and Docquier 2005; Rozelle et al. 1999; Taylor et al. 2003), particularly in the long run (Taylor 1992).

Chapter 2 of this volume presents some compelling reasons to expect that the impacts of migration and remittances on production, incomes, and expenditures are shaped by the gender of both those who migrate and those who stay behind. Rural household surveys and ethnographic research reveal that men and women often are engaged in different household production activities. If male and female workers are not perfect substitutes in these activities, then migration may have different opportunity costs for men and women. For example, suppose that prior to migration women are employed largely in unpaid household work, while men work the fields. In this case, it is possible that migration by women would not reduce crop production, while migration by men would. However, if female migration pulls male labor out of the fields and into household activities traditionally occupied by women, then female migration could reduce crop production via a labor substitution effect.

Migrants' remittances may either mitigate this lost-labor effect by loosening capital and risk constraints on production or reinforce it by increasing the household's demand for leisure. There is very little empirical evidence available on gender differences in remittance behavior, but the evidence that does exist suggests that both the magnitude and motives for remitting may be different for men and women. A study in the Dominican Republic finds that female migrants send home more remittances, on average, than male migrants, and they are more likely to send money when there are income shocks due, say, to a parent's illness (de la Brière et al. 2002). That is, in addition to being more committed remitters, female migrants seem to play more of an "insurance" role for their household than do male migrants. Another study finds that Philippine male migrants abroad are more likely to remit than females (Semyonov and Gorodzeisky 2005). Differences in remittance behavior create the potential for gender disparities in the economic returns to households from migration as well as in the investment and insurance effects of remittances. A burgeoning literature examining intrahousehold resource allocation suggests that the person who controls resources within a household can influence the way in which these resources are allocated, with important implications for efficiency (for example, see Udry 1996; Schultz 1990). In the case of migration, who receives the remittances (or monitors their use) could shape the effects of remittances on a household's expenditures on production inputs, education, health, and other items. The gender of both the migrants and those remaining in the household could matter (for more details on these issues, see chapter 5 in this volume).

Migration networks have become central to most models of international migration behavior, and there are compelling reasons to expect that the effects of networks are gender specific. Migrant networks convey information and provide assistance to prospective migrants, thus reducing the costs and risks and increasing the benefits of future migration. As a result, they can positively influence the probability of migration and also the economic returns from migrating (Munshi 2003; Winters et al. 1999). Networks are thus a form of social capital, which together with human and physical capital creates disparities in the costs and benefits of migration across households and individuals. Network formation may be endogenous from a household perspective; households may strategically invest in establishing networks that influence their future economic returns from migration. If the information and assistance value of family networks is gender specific, then a family's optimal choice may be to invest in the gender network that maximizes future net benefits—for example, keeping the only son at home to work on the farm, which minimizes the negative direct lost-labor effects of migration, while sending off the oldest daughter, who can constitute a network that will facilitate future migration by her younger female siblings. While no empirical study has attempted to test this specific hypothesis, it is well accepted that past migration directly influences future migration, and recent studies support the notion that the gender of migrant networks matters (chapter 3 of this volume; Curran and Rivero-Fuentes 2003).

Econometric Model

Our econometric model is designed to test for gender-specific migration impacts on migrant-sending households. Consider a "thought experiment" in which a set of rural households is randomly selected to participate in migration. Specifically, from a population of identical households, a random sample of households is chosen to receive a female migration treatment (by having one or more female members plucked out and sent to the United States), a male migration treatment, or no migration treatment at all. If such an experiment were possible, one could test whether participating in international migration significantly affects household production activities and expenditures and, if so, whether this migration effect differed depending on the gender of the migrants. One could do this simply by comparing production activities and expenditures between households that did and did not have male or female migrants.

This thought experiment is unrealistic for at least two reasons. First, households are not identical. Thus it is necessary to use statistical methods to control for variables that influence household participation in different production activities, expenditures, and other outcomes, independent of migration. Second, households and individuals are not randomly selected to participate in international migration. If the selection bias of migration choices is ignored, estimated effects of migration on household production, expenditure, and income outcomes may be biased. Table 4.1 shows that migrant and nonmigrant households are in fact quite different with respect to many demographic variables. Instruments for migration are needed to address this endogeneity problem.

Let M_{gi} denote migration by gender g in household i; let Y_i denote an outcome of interest in household i—for example, income from crop production or investment in schooling; and let X_{Mgi} and X_{Yi} denote exogenous variables that explain migration by gender and the outcomes in household i, respectively. Finally, let ε_{Mgi} and ε_{Yi} denote stochastic errors. The core equation of interest in our model is for the production, remittance, or expenditure outcome, Y_i:

$$Y_i = \gamma_0 + \gamma_{1g} M_{gi} + \gamma_2 X_{Yi} + \varepsilon_{Yi}. \quad (4.1)$$

The parameter γ_0 is an intercept, and γ_{1g} and γ_2 are parameter vectors representing, respectively, the effects of male and female migration and other variables on the outcome being modeled.

Equation 4.1 has a number of interesting implications. For production outcomes (for example, $Y_i =$ the quantity or value of crop or noncrop production), a perfect-markets household-farm model would predict that the elements of γ_{1g} are all zero; that is, neither gender's migration affects production. An imperfect labor market that results in a household's inability to obtain a perfect substitute

Table 4.1. Summary Statistics, by Household Migration Status

Variable	No migrants in household	Migrants in household	T-test of difference in the means
Household head age	47.25	55.33	−8.96**
Household head experience	37.58	46.75	−9.01**
Household head education	4.67	3.59	5.21**
Male average education	4.98	5.58	−3.67**
Female average education	4.88	5.37	−3.11**
Household size	5.85	8.13	−13.27**
Number of children (<16 years of age)	1.80	1.38	4.39**
Percent of males who are married in household	0.44	0.53	−4.67**
Percent of females who are married in household	0.45	0.57	−6.27**
Speak indigenous language	0.22	0.07	6.73**
Number of hectares farmed	3.89	8.48	−3.16**
Hectares of good-quality land	1.60	1.38	0.29
Average number of days sick of members of household	7.07	9.14	−1.36
Household experienced natural disaster	0.33	0.39	−2.12*
Number of observations	1,388	377	

Source: 2003 ENHRUM.

**Significant at 5 percent.

*Significant at 10 percent.

for migrants' lost labor, other things equal, would imply $\gamma_{1g} < 0$ for the gender for which the labor market constraint is binding. A positive insurance effect of migration (that is, a promise by migrants to remit in the case of crop failure that encourages crop investments), other things being equal, would imply the opposite. If remittances by male or female migrants (or both) loosen the liquidity constraints on production, this could counteract the negative lost-labor effect, possibly making $\gamma_{1g} > 0$ for at least one of the genders. However, if remittances increase the household's demand for leisure, we expect the opposite effect. In light of this, the sign of this coefficient is ambiguous a priori; it must be determined econometrically.

The variables X_{Yi} include household assets that influence production, including physical capital (land, machinery) and human capital (education of the household head and other family members at home). The parameter vector γ_2 denotes the returns to these assets in the production activity.[2]

For Y_i = expenditures on schooling or health, the variables X_{Yi} include determinants of total income or expenditures. They may also include household characteristics and demographic variables that influence marginal utilities (Deaton and Muellbauer 1980) and variables that permit one to test for gender influences described earlier. If migration by either gender does not influence expenditure on a given item, controlling for total expenditures, then $\gamma_{1g} = 0$. A finding to the contrary would imply that migration influences the marginal utility of expenditures in some fashion.

The vector of variables X_{Yi} controls for the fact that households are not identical. Nevertheless, econometric estimation of equation 4.1 is complicated by the fact that migration by both genders is endogenous. To correct for this endogeneity problem, instruments for the participation of household members in international migration are needed. These migration instruments are obtained by estimating a probit equation for participation in international migration of the following form:

$$\Pr[M_{gi} = 1 | X_{Mgi}, \beta_g] = F(X_{Mgi}^{'} \beta_g), \qquad (4.2)$$

where X_{Mgi} is a vector of variables used to obtain an instrument for household *i*'s participation in male or female international migration, β_g is a vector of parameters, and $F(\bullet)$ is the normal cumulative distribution function. Thus we estimate two separate probit regressions: one for male international migration and one for female international migration.

The elements of the vector X_{Mgi} include human capital variables, assets, and migration network variables typically included in a household migration model. The human capital and migration network variables are defined separately for the two genders. In order for equations 4.1 and 4.2 to be identified, at least one element of the vector X_{Mgi} for each gender equation must be excluded from X_{Yi}. Our identification strategy entails the use of five such variables. These include two dummy variables, one for the presence of household female international migrants and the other for the presence of male international migrants in 1980, the first year covered by the migration life histories in our data (described in detail in chapter 3); a pair of similar dummy variables for 1980 participation in internal (within Mexico) migration, by gender; and historic state-level migration rates for the period 1955–59. The justification for these instruments is that they are clearly predetermined variables, sufficiently far back in time to be unlikely to influence production and other outcomes in 2002, the last year of the ENHRUM survey. However, because of the importance of migration networks in aiding migration and migrant's earnings, they are likely to be correlated with migration in 2002. The historic state-level migration rates were taken from González Navarro (1974); they have been used as an instrument for household migration in other studies,

Table 4.2. Hausman-Wu Test of the Instruments

Variable	Test results	Critical value
Dependent variable	*χ^2 test that instruments have no effect on the residuals*	*(5 percent) = 16.92*
Staple crops	1.117	Fail to reject
Nonstaple crops	0.438	Fail to reject
Agricultural income	0.158	Fail to reject
Livestock income	0.174	Fail to reject
Wage income	0.283	Fail to reject
Education spending	20.66	Reject
Health spending	2.199	Fail to reject
Poverty	0.096	Fail to reject
Instrumented variable	*F(5,1755) tests of insignificant IVs*	*(5 percent) = 2.21*
Male U.S. migration	193.145	Reject
Female U.S. migration	50.822	Reject

Source: 2003 ENHRUM.

including Woodruff and Zenteno (2001) and McKenzie and Rapoport (2004).[3] It has been suggested that these historic international migration rates were the result of the pattern of arrival of railroads in Mexico (Massey et al. 2002; McKenzie and Rapoport 2004). One can argue that households in communities with high levels of early twentieth-century migration will have a higher likelihood of having a migrant member than an otherwise identical household living in a community with low initial migration rates. Our identifying assumption is that these historic state migration rates and historic, gender-specific household migration do not affect income outcomes 23 to 43 years later. Our instrumental variables (IV) estimation relies on this exogeneity assumption. The results of a series of Hausman-Wu tests are presented in table 4.2.

The stochastic terms ε_{Yi} and ε_{Mgi} are assumed to be normally and independently distributed with variance σ_i^2. The right-hand-side gender-specific migration instruments in equation 4.1 are predictions from the binomial probits, in which the dependent migration variable equals 1 if the household is observed with an international migrant of the corresponding gender in 2002, and zero otherwise.

The vectors X_{Yi} and X_{Mgi} include household demographic and human and physical capital variables. An extensive literature explores the returns to schooling and other human capital in production (Jamison and Lau 1982) and in migration (Taylor and Martin 2001). Human capital measures include the education level, in years, and experience level of the household head. Other variables hypothesized to affect farm and nonfarm production include the availability and quality of land, household physical capital and demographic variables, and wealth.

Some type of two-step approach is needed to estimate the migration equation 4.2, which will be used to identify the outcome equation 4.1. However, the consistency and efficiency of simply estimating a probit model and using predicted probabilities in the outcome model are limited when multiple instruments are obtained from separate probit regressions and the outcome equation is also a probit or tobit model (Bhattacharya et al. 2006; Newey 1987). A more efficient estimation method is to use a maximum-likelihood estimation of Amemiya's generalized least squares estimator (see Newey 1987), which is referred to as IV probit. Alternatively, Angrist (2000) demonstrates that an instrumental variables linear probability model will produce a "best linear estimate" of average treatment effects in the case of binary endogenous variables. These alternative estimation methods are shown to produce qualitatively similar results.

Data

Our empirical analysis is based on data from the Mexico National Rural Household Survey (Encuesta Nacional a Hogares Rurales de México, or ENHRUM). This survey and the data are described in detail in chapter 3 of this volume.

Rural Mexico is an ideal laboratory for studying the impacts of migration on the rural economy. Figure 3.1 of chapter 3, constructed from retrospective migration data gathered in the survey, shows that the percentage of Mexico's village populations working at international migrant destinations increased sharply at the end of the twentieth century.[4] Throughout this time period, migration propensities were lower for women than for men, and the rate of growth of male immigration was higher. Villagers' propensity to migrate to U.S. jobs more than doubled from 1990 to 2002. This surge in migration mirrors an unexpectedly large increase in the number of Mexico-born persons living in the United States, as revealed by the U.S. 2000 census.[5] During this period, there was a sharp upward trend in the percentage of international migrants working in nonfarm jobs and a mildly upward trend of the percentage working in U.S. farm jobs.

Table 4.3 defines and summarizes the variables used in our econometric analysis. The top panel summarizes activity participation and migration variables; the bottom panel, exogenous variables. A substantial percentage of households participate in each income activity, implying that income diversification is common. (To be classified as participating in a production activity, a household had to produce the good or service; it did not necessarily have to sell it or make a profit.) Almost a third (30 percent) of all rural households participated in staple crop production, 34 percent in nonstaple crop production, 29 percent in livestock production, and 64 percent in wage work. Of all households, 19 percent had one or more male international migrants, and 8 percent had at least one female international migrant. A slightly smaller percentage received remittances from

Table 4.3. Summary Statistics

Variable	Mean	Standard error	Minimum	Maximum
Endogenous variables				
Male international migrants (indicator)	0.188	0.009	0	1
Female international migrants (indicator)	0.083	0.007	0	1
Remittances from male international migrants (indicator)	0.165	0.009	0	1
Remittances from female international migrants (indicator)	0.039	0.005	0	1
Staple production (indicator)	0.298	0.009	0	1
Nonstaple production (indicator)	0.343	0.010	0	1
Agricultural income (indicator)	0.363	0.010	0	1
Livestock income (indicator)	0.291	0.011	0	1
Wage income (indicator)	0.637	0.012	0	1
Below poverty level	0.812	0.010	0	1
Education expenditures[1]	3,923.81	206.629	0	83,400
Health expenditures[1]	2,595.02	173.416	0	85,000
Exogenous variables				
Household head age	49.222	0.417	15	95
Household head experience	39.623	0.478	1	90
Household head education	4.599	0.096	0	20
Male average education	5.240	0.074	0	15
Female average education	5.105	0.069	0	15
Household size	6.270	0.078	1	21
Number of children (<16 years of age)	1.646	0.040	0	12
Percent of males who are married in household	0.469	0.009	0	1
Percent of females who are married in household	0.483	0.009	0	1
Speak indigenous language	0.155	0.006	0	1
Number of hectares farmed	4.912	0.685	0	537.5
Hectares of good-quality land	1.744	0.538	0	500
Average number of days sick of members of household	7.452	0.633	0	360
Household experienced natural disaster in 2002	0.314	0.010	0	1

Source: 2003 ENHRUM.

Note: Sample size is 1,765. Corrected for survey design.

[1] In Mexican pesos.

each. Households spent an average of 3,924 pesos (roughly $392) on education and 2,595 pesos ($259) on health. Based on the income data obtained from the survey, 81 percent of rural households had per capita daily incomes that put them below the official poverty line set by the Mexican government (Secretaría de

Desarrollo Social) at 28.1 pesos a day, including 15.4 pesos for food, 3.5 for basic health and education, and 9.8 for clothing, shelter, utilities, and transportation.[6] Household heads in the sample averaged 49 years of age and 4.6 years of completed schooling. However, average schooling of other household members was slightly higher, around five years for both males and females. Households in the sample had an average size of 6.3 persons, including 1.6 children younger than 16 years. They had 4.9 hectares of land, including 1.7 hectares that they considered to be of good quality. On average, household members were sick 7.5 days in 2002. Just over a third of all households suffered some kind of natural disaster that affected their production activities. An indigenous language was spoken by at least one household member in 6 percent of the households.

Econometric Findings

We now turn to the econometric results of the study.

Migration

The gender-specific international migration probit results appear in the first two columns of table 4.4. The error terms are clustered by village, and the reported coefficients are marginal effects on the migration probability. The instruments all have the expected signs. Both same-gender 1980 household network variables are significant and have positive coefficients in the respective international migration regressions. Same-gender national migration networks are negatively but insignificantly related to the probability of international migration. The state historic migration variable is positive and significant for both genders, but larger and more significant for males. Inasmuch as migration from rural Mexico in the 1950s consisted overwhelmingly of males, often aided by the Bracero program, which targeted single men for agricultural jobs, it is not surprising that this variable is more important in explaining male migration. Taken together, these historic migration variables appear to be good instruments with which to explain household participation in international migration in 2002. The cross-gender network effects are insignificant in the probit regressions.

Family size increases the probability of both male and female migration, while the number of children in the household decreases it, especially for migration by women. Household international migration has a quadratic relationship with the age of the household, proxied by the age of the household head; the probability of participating in migration first increases and then flattens out with the households age.[7] Higher education of household heads significantly discourages participation in international migration by both genders, consistent with a positive productivity effect of the household head's schooling on family labor at home. Higher average

Table 4.4. First-Stage Prediction of Migration

Variable	Probit		Ordinary least squares	
	Female migration (1)	Male migration (2)	Female migration (3)	Male migration (4)
Household head age (×10)	0.045	0.053	0.031	0.070
	(2.30)**	(1.42)	(0.86)	(1.10)
Household head age squared (×100)	−0.004	−0.007	−0.006	−0.013
	(2.51)**	(1.97)**	(1.57)	(1.98)**
Household head education (×10)	−0.035	−0.097	−0.084	−0.158
	(2.83)***	(2.56)**	(2.75)***	(2.10)**
Household size	0.010	0.036	0.051	0.119
	(8.69)***	(8.47)***	(6.15)***	(9.16)***
Number of children	−0.014	−0.029	−0.060	−0.130
	(5.96)***	(3.60)***	(5.52)***	(6.49)***
Female education (×10)	0.024	n.a.	0.006	n.a.
	(1.87)*		(0.16)	
Male education (×10)	n.a.	0.090	n.a.	0.045
		(1.70)*		(0.57)
Percent of females in household married	0.017	n.a.	0.060	n.a.
	(1.11)		(1.83)*	
Percent of males in household married	n.a.	−0.002	n.a.	0.009
		(0.07)		(0.16)
Indigenous	−0.033	−0.098	−0.049	−0.147
	(3.58)***	(3.03)***	(2.19)**	(3.57)***
Asset index	0.016	0.032	0.055	0.071
	(4.60)***	(4.16)***	(4.94)***	(3.96)***
Female international migrants, 1980	0.145	−0.002	0.787	0.156
	(3.11)***	(0.03)	(2.42)**	(0.58)
Female national migrants, 1980	−0.053	0.020	−0.122	0.081
	(1.51)	(0.49)	(3.51)***	(0.47)
Male international migrants, 1980	−0.007	0.160	0.060	0.802
	(0.37)	(5.25)***	(0.62)	(5.37)***
Male national migrants, 1980	−0.009	−0.036	−0.065	−0.135
	(0.69)	(0.88)	(2.19)**	(1.98)**
State migration rate, 1955–59	0.386	2.565	2.063	4.599
	(1.82)*	(2.79)***	(2.87)***	(4.19)***
Constant	n.a.	n.a.	−0.122	−0.242
			(1.37)	(1.51)
R^2	n.a.	n.a.	0.18	0.27

Source: 2003 ENHRUM.

Note: Sample size is 1,765. Regression is corrected for survey design where possible; where impossible regression is weighted to correct for the survey design and errors are clustered by village. Dprobit option is specified, so parameters are marginal effects and robust z statistics are in parentheses. dF/dx is for discrete change of dummy variable from 0 to 1.

***Significant at 1 percent.

**Significant at 5 percent.

*Significant at 10 percent.

n.a. Not applicable.

schooling of females increases the likelihood of female migration, and the average schooling of males has the same effect on male migration.[8] Households with larger asset holdings have a significantly higher probability of participating in international migration.[9] Households in which an indigenous language is spoken at home, other things being equal, have a significantly lower likelihood of having a male or a female international migrant.

Household Activity Participation

The two migration probits were used to construct an instrument for 2002 migration by each gender for each household in the sample. These, together with the other explanatory variables in table 4.3, were included in the probit regressions for household participation in each of five activities: crop production, staple production, nonstaple crop production, livestock production, and local wage work. The probit specification corresponding to equation 4.1 is

$$\Pr[Y_i > 0|Z_i, \gamma] = F(Z_i'\gamma), \tag{4.3}$$

where $Z_i = [X_{Yi}, M_{gi}]$, $\gamma = [\gamma_0, \gamma_1, \gamma_2]$, and $F(\bullet)$, as before, is the normal cumulative distribution function.

A limitation of the two-step probit model is the inability to correct standard errors when multiple migration instruments are obtained from separate probit regressions. Alternative estimation methods alluded to previously have other limitations but provide a check on the robustness of our estimates. We estimate each activity-participation equation in four ways, the results of which are reported in columns 1 through 4 in each table: a two-stage probit; an IV probit; an IV linear probability model; and a three-stage least squares linear probability model. In the two linear probability models for activity choice, the migration instruments are obtained from an ordinary least squares (OLS) migration probability model. Columns 3 and 4 of table 4.4 report the results of the OLS migration probability estimation, which are similar to the probit results in columns 1 and 2. The methods employed correct the standard errors for the IV procedure, and the three-stage least squares method corrects for correlation between equations.

Tables 4.5 through 4.9 present results of the activity-participation probits. The tables report marginal effects of the explanatory variables on the probability of participating in each activity. Errors are clustered by village. Our findings are reasonably robust with respect to the estimation method used.

The results reveal strikingly different impacts of male and female migration on participation in some household production activities. Table 4.5 indicates that the impacts of male migration on crop production are significant and negative, while those of female migration are less clear cut. More clarity is attained when crop production is decomposed into staples and other crops.[10] Neither female nor male

Table 4.5. Second-Stage Activity Choice Regressions: Agricultural (Crop) Income

Variable	Two-stage probit[a] (1)	IV probit[b] (2)	IV linear probability[c] (3)	Three-stage least squares linear probability[d] (4)
Household head experience (×10)	0.103	0.092	0.097	0.077
	(2.53)**	(2.31)**	(2.87)***	(2.47)**
Household head experience squared (×100)	−0.014	−0.012	−0.013	−0.009
	(3.18)***	(2.86)***	(3.36)***	(2.64)***
Household head education (×10)	−0.235	−0.240	−0.215	−0.177
	(3.71)***	(3.52)***	(3.74)***	(3.48)***
Male education (×10)	0.126	0.126	0.067	0.096
	(1.93)*	(1.62)	(1.14)	(1.68)*
Female education (×10)	−0.051	−0.089	−0.032	−0.001
	(0.82)	(1.23)	(0.55)	(0.01)
Household size	0.029	0.046	0.044	0.032
	(2.38)**	(3.36)***	(4.39)***	(4.31)***
Number of children	−0.012	−0.023	−0.036	−0.012
	(0.74)	(1.15)	(2.61)***	(1.01)
Land (hectares)	0.012	0.014	0.003	0.003
	(2.73)***	(7.38)***	(2.96)***	(4.87)***
Hectares of good-quality land	0.014	0.012	−0.001	0.001
	(2.08)**	(3.27)***	(0.49)	(0.81)
Average number of days sick	−0.000	0.000	0.000	0.000
	(0.19)	(0.78)	(0.94)	(0.33)
Percent of household married	−0.017	0.033	0.046	0.019
	(0.30)	(0.53)	(0.87)	(0.41)
Indigenous	0.310	0.313	0.279	0.340
	(3.06)***	(7.15)***	(7.18)***	(10.06)***
Female migration	0.597	0.028	−0.334	0.110
	(2.83)***	(0.05)	(2.06)**	(0.41)
Male migration	−0.541	−0.444	−0.439	−0.394
	(2.10)**	(2.10)**	(2.83)***	(2.39)**

Source: 2003 ENHRUM.

Note: Sample size is 1,765. Errors are clustered by village. Probit option is specified, so parameters are marginal effects and robust *z* statistics are in parentheses.

***Significant at 1 percent.

**Significant at 5 percent.

*Significant at 10 percent.

a. Probit assuming that migration is endogenous, using predictions from first-stage probit in table 4.4, weighted and clustered for survey correction.

b. Maximum likelihood estimations of Amemiya's generalized least squares estimator (see Newey 1987). Not possible to weight or cluster errors.

c. Survey-corrected instrumental variables linear probability model.

d. Three-stage least squares linear probability model; not possible to weight or cluster errors.

Table 4.6. Second-Stage Activity Choice Regressions: Staple Crop Production

Variable	Two-stage probit[a] (1)	IV probit[b] (2)	IV linear probability[c] (3)	Three-stage least squares linear probability[d] (4)
Household head experience (×10)	0.118 (3.32)***	0.108 (3.00)***	0.105 (3.57)***	0.077 (2.52)**
Household head experience squared (×100)	−0.013 (3.70)***	−0.012 (3.14)***	−0.012 (3.61)***	−0.009 (2.76)***
Household head education (×10)	−0.160 (2.84)***	−0.159 (2.65)***	−0.121 (2.38)**	−0.168 (3.42)***
Male education (×10)	0.075 (1.13)	0.085 (1.24)	0.053 (1.04)	0.073 (1.34)
Female education (×10)	−0.070 (1.27)	−0.059 (0.94)	−0.034 (0.68)	−0.019 (0.39)
Household size	0.020 (1.67)*	0.029 (2.44)**	0.023 (2.66)***	0.035 (4.86)***
Number of children	−0.001 (0.09)	−0.001 (0.06)	−0.007 (0.60)	−0.010 (0.84)
Land (hectares)	0.001 (1.26)	0.002 (2.65)***	0.002 (2.00)**	0.001 (2.80)***
Hectares of good-quality land	0.011 (2.56)**	0.013 (4.79)***	0.000 (0.33)	0.001 (1.46)
Average number of days sick	−0.000 (0.47)	0.000 (0.54)	−0.000 (0.10)	0.000 (0.30)
Percent of household married	0.032 (0.61)	0.063 (1.17)	0.056 (1.19)	0.044 (0.98)
Indigenous	0.302 (3.44)***	0.334 (8.36)***	0.297 (8.07)***	0.325 (9.87)***
Female migration	0.104 (0.57)	−0.070 (0.15)	−0.205 (1.47)	−0.245 (0.94)
Male migration	−0.278 (1.17)	−0.210 (1.01)	−0.176 (1.31)	−0.348 (2.16)**

Source: 2003 ENHRUM.

Note: Sample size is 1,765. Errors are clustered by village. Probit option is specified, so parameters are marginal effects and robust *z* statistics are in parentheses.

***Significant at 1 percent.

**Significant at 5 percent.

*Significant at 10 percent.

a. Probit assuming that migration is endogenous, using predictions from first-stage probit in table 4.4, weighted and clustered for survey correction.

b. Maximum likelihood estimations of Amemiya's generalized least squares estimator (see Newey 1987). Not possible to weight or cluster errors.

c. Survey-corrected instrumental variables linear probability model.

d. Three-stage least squares linear probability model; not possible to weight or cluster errors.

Table 4.7. Second-Stage Activity Choice Regressions: Nonstaple Crop Production

Variable	Two-stage probit[a] (1)	IV probit[b] (2)	IV linear probability[c] (3)	Three-stage least squares linear probability[d] (4)
Household head experience (×10)	0.099	0.089	0.091	0.067
	(2.55)**	(2.27)**	(2.79)***	(2.11)**
Household head experience squared (×100)	−0.014	−0.012	−0.013	−0.009
	(3.44)***	(2.86)***	(3.48)***	(2.58)***
Household head education (×10)	−0.273	−0.265	−0.241	−0.225
	(4.62)***	(3.96)***	(4.29)***	(4.40)***
Male education (×10)	0.114	0.126	0.078	0.105
	(1.79)*	(1.67)*	(1.38)	(1.84)*
Female education (×10)	−0.025	−0.055	−0.013	0.013
	(0.40)	(0.79)	(0.23)	(0.26)
Household size	0.028	0.044	0.040	0.037
	(2.26)**	(3.30)***	(4.24)***	(4.93)***
Number of children	−0.015	−0.024	−0.033	−0.019
	(0.97)	(1.26)	(2.48)**	(1.59)
Land (hectares)	0.002	0.003	0.002	0.002
	(1.14)	(3.16)***	(2.10)**	(4.00)***
Hectares of good-quality land	0.015	0.017	−0.000	0.001
	(2.78)***	(5.33)***	(0.28)	(1.02)
Average number of days sick	−0.000	0.001	0.000	0.000
	(0.43)	(0.88)	(0.53)	(0.34)
Percent of household married	−0.001	0.032	0.040	0.009
	(0.03)	(0.54)	(0.77)	(0.19)
Indigenous	0.322	0.327	0.286	0.331
	(3.29)***	(7.50)***	(7.52)***	(9.73)***
Female migration	0.466	0.005	−0.317	−0.066
	(2.34)**	(0.01)	(2.03)**	(0.24)
Male migration	−0.515	−0.419	−0.388	−0.437
	(1.98)**	(2.10)**	(2.71)***	(2.63)***

Source: 2003 ENHRUM.

Note: Sample size is 1,765. Errors are clustered by village. Probit option is specified, so parameters are marginal effects and robust *z* statistics are in parentheses.

***Significant at 1 percent.

**Significant at 5 percent.

*Significant at 10 percent.

a. Probit assuming that migration is endogenous, using predictions from first-stage probit in table 4.4, weighted and clustered for survey correction.

b. Maximum likelihood estimations of Amemiya's generalized least squares estimator (see Newey 1987). Not possible to weight or cluster errors.

c. Survey-corrected instrumental variables linear probability model.

d. Three-stage least squares linear probability model; not possible to weight or cluster errors.

Table 4.8. Second-Stage Activity Choice Regressions: Livestock Production

Variable	Two-stage probit[a] (1)	IV probit[b] (2)	IV linear probability[c] (3)	Three-stage least squares linear probability[d] (4)
Household head experience (×10)	0.082	0.096	0.093	0.089
	(1.95)*	(2.65)***	(2.30)**	(2.71)***
Household head experience squared (×100)	−0.010	−0.011	−0.012	−0.009
	(2.31)**	(2.62)***	(2.67)***	(2.65)***
Household head education (×10)	−0.153	−0.138	−0.169	−0.134
	(2.15)**	(2.19)**	(2.58)**	(2.53)**
Male education (×10)	0.014	0.003	−0.016	0.002
	(0.22)	(0.04)	(0.24)	(0.04)
Female education (×10)	−0.038	−0.027	−0.042	0.029
	(0.66)	(0.35)	(0.66)	(0.53)
Household size	0.033	0.036	0.048	0.031
	(2.92)***	(2.38)**	(4.20)***	(3.91)***
Number of children	0.008	0.009	−0.017	0.007
	(0.54)	(0.39)	(1.09)	(0.55)
Land (hectares)	0.003	0.002	0.003	0.002
	(0.96)	(2.42)**	(2.31)**	(3.13)***
Hectares of good-quality land	0.013	0.010	−0.001	0.000
	(3.12)***	(2.91)***	(0.89)	(0.41)
Average number of days sick	0.000	0.000	0.001	0.000
	(0.45)	(0.86)	(1.47)	(0.40)
Percent of household married	0.067	0.079	0.101	0.062
	(1.09)	(1.33)	(1.73)*	(1.26)
Indigenous	0.186	0.174	0.141	0.176
	(3.42)***	(4.26)***	(3.31)***	(4.96)***
Female migration	0.100	−0.312	−0.623	−0.471
	(0.47)	(0.39)	(2.79)***	(1.67)*
Male migration	−0.419	−0.249	−0.393	−0.083
	(1.62)	(0.82)	(2.08)**	(0.48)

Source: 2003 ENHRUM.

Note: Sample size is 1,765. Errors are clustered by village. Probit option is specified, so parameters are marginal effects and robust *z* statistics are in parentheses.

***Significant at 1 percent.

**Significant at 5 percent.

*Significant at 10 percent.

a. Probit assuming that migration is endogenous, using predictions from first-stage probit in table 4.4, weighted and clustered for survey correction.

b. Maximum likelihood estimations of Amemiya's generalized least squares estimator (see Newey 1987). Not possible to weight or cluster errors.

c. Survey-corrected instrumental variables linear probability model.

d. Three-stage least squares linear probability model; not possible to weight or cluster errors.

Table 4.9. Second-Stage Activity Choice Regressions: Wage Income

Variable	Two-stage probit[a] (1)	IV probit[b] (2)	IV linear probability[c] (3)	Three-stage least squares linear probability[d] (4)
Household head experience (×10)	−0.056 (1.49)	−0.052 (1.41)	−0.029 (0.76)	−0.056 (1.70)*
Household head experience squared (×10)	−0.002 (0.62)	−0.004 (0.96)	−0.005 (1.27)	−0.003 (0.83)
Household head education (×10)	−0.197 (3.57)***	−0.175 (2.81)***	−0.169 (2.45)**	−0.190 (3.53)***
Male education (×10)	0.150 (2.28)**	0.141 (2.12)**	0.156 (2.23)**	0.129 (2.16)**
Female education (×10)	−0.052 (1.18)	−0.106 (1.69)*	−0.100 (1.49)	−0.033 (0.63)
Household size	0.049 (4.09)***	0.051 (4.36)***	0.054 (4.74)***	0.050 (6.37)***
Number of children	−0.022 (1.32)	−0.035 (2.13)**	−0.029 (1.79)*	−0.035 (2.82)***
Average number of days sick	−0.001 (1.36)	−0.001 (1.02)	−0.000 (0.37)	−0.001 (1.80)*
Percent of household married	−0.140 (2.58)***	−0.122 (2.20)**	−0.093 (1.60)	−0.131 (2.68)***
Indigenous	−0.156 (3.07)***	−0.182 (4.26)***	−0.168 (3.95)***	−0.161 (4.51)***
Female migration	−0.087 (0.35)	−0.010 (0.03)	−0.167 (0.47)	−0.186 (0.67)
Male migration	−0.674 (2.41)**	−0.674 (3.36)***	−0.730 (4.11)***	−0.667 (3.79)***

Source: 2003 ENHRUM.

Note: Sample size is 1,765. Errors are clustered by village. Probit option is specified, so parameters are marginal effects and robust *z* statistics are in parentheses.

***Significant at 1 percent.

**Significant at 5 percent.

*Significant at 10 percent.

a. Probit assuming that migration is endogenous, using predictions from first-stage probit in table 4.4, weighted and clustered for survey correction.

b. Maximum likelihood estimations of Amemiya's generalized least squares estimator (see Newey 1987). Not possible to weight or cluster errors.

c. Survey-corrected instrumental variables linear probability model.

d. Three-stage least squares linear probability model; not possible to weight or cluster errors.

migration has any effect on the propensity to produce staple crops. Other studies have suggested that staple crop production in rural Mexico resists decline despite strong economic incentives to the contrary (Preibisch et al. 2002; Dyer et al. 2006). If females are less likely to engage in crop production activities, the negative effect of their lost labor will be minimal. The production of maize and beans also is culturally important to rural households.[11] Nonstaple crop production, however, is less important to the subsistence of rural households and generally involves higher capital costs, more inputs, and substantially more intensive labor practices. In light of this finding, it is not surprising that participation in this activity responds negatively to male, but not female, migration (table 4.7). An alternative and possibly complementary explanation is that females are larger remitters than males and that remittances stimulate household production activities by loosening liquidity and risk constraints. It could also be the case that remittances from females are more likely to be channeled toward on-farm investments. Liquidity and risk constraints tend to be more binding for the production of nonstaple crops, with their relatively large input demands. Thus, it is possible that migration by males affects nonstaple crop production negatively, through the loss of labor, while female migration affects it mainly through a remittance effect that cancels out any lost-labor effects.

Livestock production (table 4.8) is not significantly affected by migration of either gender. In rural Mexico, small-scale livestock production requires little labor, and it is likely that substitute labor with the requisite skills to care for livestock can be found within the household (for example, children tending animals).

Wage income (table 4.9), in contrast, is significantly and negatively affected by male, but not female, migration. Males in rural Mexico are more likely to be involved in wage work prior to migrating, and there are often few opportunities for women to work outside of the household.

There is a quadratic relationship between the household head's experience and the probability of participation in all activities, as well as a negative (linear) relationship between the household head's age and wage income. As schooling of the household head increases, households significantly shift out of all household production activities. Schooling of male household members significantly increases household participation in nonstaple crop and wage activities, but the effect of female education on participation is insignificant for all of these activities. Other things being equal, larger households are more likely to participate in all activities. Landholdings, especially of high-quality land, increase participation in crop and livestock activities. Indigenous households are significantly more likely than others to participate in all activities except local wage labor.

Schooling and Health Expenditures

If all prices are fixed, migration by either gender can influence household expenditures via a simple income-transfer effect (increasing expenditures on "normal" goods if remittances increase household income). In this scenario, controlling for total expenditures and household demographics, one would expect migration by either gender to have no significant effect on expenditures for specific goods. Differential or negative effects of migration on expenditures would indicate other migration effects, independent of income, including influences of migration on household preferences or influences of migrants' preferences on household demands. For example, a female migrant might remit under the condition that funds be used for schooling or health, particularly if her own children are part of the sending household (as when grandparents raise children while parents are away). If preferences of male migrants are different, this will be reflected in a different impact of male migration on household expenditures, other things being equal.

A comprehensive analysis of the influence of international migration on household expenditures is beyond the scope of this chapter. As a first step toward doing this analysis, we tested for independent migration effects on household expenditures for two key items, health and education, using a tobit model similar to the probit model presented for other household outcomes. The tobit specification accounts for the fact that not all households have positive expenditures for health and education (64 and 60 percent, respectively). The results from a linear probability three-stage least squares regression are also presented, as before, to demonstrate the robustness of the estimates.

The results are reported in table 4.10. They show significant differences between the effects of female and male migration on household expenditures for education and health. Other things being equal, households with female migrants spend significantly less on education and more on health than otherwise similar households without female migrants. The negative effect of female migration on schooling investments stands in striking contrast to the finding that households with more educated females spend more on schooling (table 4.10) and that international migration selects positively on female education (table 4.4). This result could lend support to intra-household bargaining models that find that monitoring is important. If females are more likely than males to monitor their children's education and the household's educational expenditures, then female migration may cause a decrease in monitoring and thus in schooling expenditures.

The findings reveal a quadratic relationship between household head experience and schooling investments, similar to the effect of the household head's experience on participation in income activities. Inasmuch as the income effects of the household head's experience are implicit in total expenditures, this finding

Table 4.10. Effects of Migration on Education and Health Spending

	Education spending		Health spending	
Variable	Two-step tobit (1)	Three-stage least squares (2)	Two-step tobit (3)	Three-stage least squares (4)
Household head experience	462.373	180.511	−44.486	8.025
	(6.45)***	(4.21)***	(0.74)	(0.19)
Household head experience squared	−5.983	−1.971	0.500	0.104
	(7.41)***	(4.22)***	(0.78)	(0.22)
Household head education	0.463	97.213	60.924	100.792
	(0.00)	(1.38)	(0.61)	(1.43)
Male education	654.461	340.659	55.109	42.965
	(5.91)***	(4.38)***	(0.54)	(0.55)
Female education	801.937	405.733	−114.305	−112.200
	(7.97)***	(5.61)***	(1.24)	(1.55)
Household size	257.685	110.816	314.554	164.069
	(1.56)	(0.89)	(2.15)**	(1.31)
Number of children	1,795.464	647.661	−35.151	−56.131
	(7.52)***	(3.55)***	(0.16)	(0.31)
Asset index	783.403	415.245	411.517	377.947
	(3.17)***	(2.37)**	(1.82)*	(2.16)**
Total expenditures	0.020	0.016	0.019	0.015
	(6.00)***	(6.83)***	(6.11)***	(6.29)***
Average days sick	−15.634	−5.735	42.647	26.451
	(1.49)	(0.95)	(5.39)***	(4.40)***
Percent of household married	−6,888.555	−2,621.178	867.533	438.446
	(6.57)***	(4.06)***	(0.97)	(0.68)
Indigenous	−685.989	−522.696	−1,788.554	−639.133
	(1.01)	(1.21)	(2.79)***	(1.48)
Female migration	−8,428.056	−3,181.552	6,126.766	3,381.479
	(2.12)**	(1.63)	(1.97)**	(1.73)*
Male migration	−1,252.618	192.225	−1,755.249	−1,072.243
	(0.39)	(0.22)	(0.65)	(1.25)
Constant	−15,999.698	−4,906.693	−2,567.269	−174.157
	(9.00)***	(4.44)***	(1.65)*	(0.16)

Source: 2003 ENHRUM.

Note: Sample size is 1,754. Errors are clustered by village. Latent variable results $\delta E(y^*|x) / \delta x = \beta$ reported for tobit regressions. Robust *z* statistics are in parentheses.

***Significant at 1 percent.

**Significant at 5 percent.

*Significant at 10 percent.

almost certainly reflects household demographics: schooling expenditures are highest in the middle of a household's life cycle. Schooling investments also increase with household wealth and the number of children (controlling for household total size).

De la Brière et al. (2002) find that females remit more in response to family health shocks than do males, presumably in part to finance health care. Our findings are consistent with that result. Other things being equal, expenditures on health increase with household size, illness, and female (but not male) migration. The insignificant effect of male migration on health spending suggests that males have different motives to remit (also consistent with de la Brière et al.) or else that males return to work on the farm when other family members become ill—a labor response that would contrast with the remittance response of female migrants.

Conclusions

Our econometric findings offer strong evidence that the effects of migration on migrant-sending households depend significantly on migrants' gender. In some cases, a change in the gender of a household's migrants *reverses* the sign of migration's effect on production and wage income activities as well as on expenditures. Past studies report negative lost-labor effects of migration on household production. We find this only for migration by males, who are more likely than females to be engaged in household production activities such as nonstaple crop production and wage work prior to migrating. This result suggests that perfect hired substitutes for the male laborer who migrates are not available in rural Mexico or that remittance-induced demand for leisure increases significantly enough to decrease production. Positive migration effects, posited by NELM research, are evident only for female migration. This may be because females participate less than males in production activities prior to migrating or else work only in a subset of activities, such as the cultivation of maize and beans; thus the positive remittance and insurance effects of female migration counterbalance the negative lost-labor effects.

In a conventional demand analysis, one would not expect migration, let alone the gender of migrants, to independently affect household expenditures (that is, controlling for household total income and demographic variables). However, we find that, other things being equal, both migration and the gender of migrants significantly reshape expenditures on education and health. Female *education* has a larger positive and more significant effect on new schooling investments than male education. However, female *international migration* has a negative effect. Most migrants from rural Mexico enter the United States illegally, working in low-skill service jobs in which the returns to schooling are likely to be low. It is possible that international migrants send a signal to households not to invest in schooling. Alternatively, it is possible that females who have migrated lose the ability to monitor their household's schooling investments.

The overarching conclusion of this research is that the impacts, like the determinants, of international migration are gender specific. Studies that fail to differentiate between males and females produce findings that are likely to be both statistically biased and an unreliable basis for designing policies to enhance the positive and mitigate the negative effects of international migration in migrant-sending countries.

Endnotes

1. This is distinct from an income multiplier of remittances *among* households, as estimated by Adelman et al. (1988).

2. They also include market prices for inputs and outputs, which may vary over time but not across households at a given point in time, unless there are significant transaction and transportation costs. Because our analysis uses cross-sectional data, prices are not included as explanatory variables in the econometric model.

3. We are greatly indebted to David McKenzie for bringing González Navarro's data to our attention and for providing us with them.

4. The size of both villager and migrant populations in the synthetic cohorts created using retrospective data is biased downward as one goes back in time, because some individuals are removed from the population due to death and thus are not available to be counted in 2003. Permanent migration does not pose a problem, because information about migrants was provided by other family members in the village. In the relatively rare case where entire families migrated, overall migration estimates may be biased downward; however, it is not clear whether this would produce an upward or a downward bias in the *slope* of the migration trend.

5. The Mexico-born population in the United States increased from 6.7 million to 10.6 million between 1990 and 2000 (U.S. Census Bureau).

6. See http://www.sedesol.gob.mx/index/index.php.

7. The crossover point at which the age effect becomes negative is at a household head age of approximately 56 years for the female equation and 38 years for the male equation. These age variables are statistically significant only for female migration.

8. These average household-education effects do not necessarily imply that *individuals* with more schooling are more likely to migrate internationally; see Mora and Taylor (2006).

9. The asset index was created using principle components analysis; see Filmer and Pritchett (2001) for an overview. The asset index includes the value of land, business assets, and other assets owned by the household; the number of rooms in the house; whether the house has a kitchen, running water, drainage, electricity, or a telephone; and whether the house is owned by the household. Our index of assets is based on nonproductive asset holdings in the year prior to the survey year. Nevertheless, this predetermined variable may be correlated with past migration. To explore whether possible endogeneity of this variable confounds the effects of other variables in the model, we reestimated this and all other regressions in the chapter without the wealth variable, and none of the conclusions of this chapter changed.

10. Staple crops are defined as corn and beans. All other crops are included in the category of non-staple crops.

11. Small maize farmers in Mexico value maize for traditional, ceremonial, ritual values, as well as for their taste and cooking quality (Salvador 1997; Dyer-Leal 2006; Perales et al. 2003; Brush and Chauvet 2004).

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