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GENDER-DIFFERENTIATED HOUSEHOLD RESOURCE ALLOCATION - EMPIRICAL EVIDENCE IN SENEGAL

By

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ABSTRACT

GENDER-DIFFERENTIATED HOUSEHOLD RESOURCE ALLOCATION - EMPIRICAL EVIDENCE IN SENEGAL

By

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This paper examines the weak condition of pareto efficiency maintained by the unitary and collective models of the household. Farm production data collected from Senegalese households over a two-year period are used to test whether resources are allocated efficiently across male- and female-managed plots within a household. Coefficient estimates show that gender-based discrepancies in input usage across plots ultimately lead to lower yields on female-managed plots. Across the two years, female plot managers, on average, generated between 18% and 35% less revenue per hectare than did male plot managers living in the same household. These results suggest that Senegalese households do not achieve allocative efficiency in farm production because resource decisions within the household are driven at least partially on the basis of gender.

To my Mother

who wasn't able to see this come to fruition

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INTRODUCTION

The family plays a pivotal role in the allocation and distribution of resources . Yet much controversy exists over how these processes occur. The early analysis treated the household as an aggregate ignoring the specifics of member outcomes and preferences. Becker's (1965) theory of time conceptualized households as allocating time between the production of goods at home and the purchase of goods with income earned from participation in market activities. Recognizing that agricultural production generates a primary source of income for rural households in developing countries, Singh, Squire, Strauss (1986) extended the analysis of agricultural household behavior by acknowledging that small farmers participate as both producers and consumers in commodity markets to varying degrees[1]. Individuals buy and sell inputs and commodities in the market while consuming some of their production and utilizing their own resources, namely labor, for production. Chiappori (1988 and 1992) among others[2] recognized that the unitary model of

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The degree depends on whether farmers are net buyers or net sellers. Using data from Senegal, Goetz, 1990 and 1992, models this decision as a two-stage process: first, do farmers participate in the market, and second, if so, do farmers participate as net buyers or net sellers.

2

Manser and Brown, 1980, and McElroy and Horney, 1981, initiated the two-person Nash bargaining framework as an alternative to representing the household as an aggregated entity in which members pool their resources and maximize a single utility function. These studies offered the possibility that two individuals would consider forming a household on the basis of whether the utility gains associated with marriage would be greater than the sum of each individual's indirect utility, a function of prices related to the consumption of private goods and non-labor income. An individual's indirect utility is representative of her best possible alternative state--either remaining single or choosing another partner, given the household was neither illuminating about the real processes of distribution occurring within the household nor fundamentally linked to neoclassical theory. This work demonstrated that households should be represented as a set of members who may have distinct goals and preferences. Using consumption data, Browning, et al (1996), Thomas (1990), and Hopkins and Haddad (1994), showed that either different types of expenditures made in the household or the timing of these expenditures could be linked to the shares of income claimed by the various members. While these studies disputed the relevance of the unitary model, they made only minimal assumptions about how members resolve conflicts: The outcome of the distributive process was generally posited as being an efficient outcome.

Confronting the weak condition of pareto efficiency, Udry (1996) tested whether the behavior of agricultural producers in Burkina Faso could be assumed to meet this criteria.[3] His findings showed that households allocated agricultural inputs to members in such a way as to cause losses in agricultural output. His results suggest that neither the unitary nor cooperative model suffice to explain household behavior.

Following the important contribution of Udry's (1996) inquiry into intra-household

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information about possible alternatives. The economic gains associated with the marriage are evaluated according to the indirect utilities of the individuals which become threat points to the potential dissolution of the union.

Lundberg and Pollack, 1993, tempered the notion of the fall-back position by suggesting that a non-cooperative marriage could result in the partners retreating to their 'separate spheres' and not necessarily in divorce.

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Jones, 1983, tested whether labor supply behavior of women living in agricultural households in Cameroon could be characterized as allocatively efficient. She concluded that compared to widows, who maintained complete control over the remuneration of their labor, wives spent 40% less time in rice planting activities that generated higher returns to labor than other crops but which were expected to be handed over to men. Under circumstances in which the returns to women's labor are contested by male household members who hold different preferences, Jones suggested that the problem associated with dividing the proceeds will be resolved by bargaining.

resource allocation in Burkina Faso, this paper will explore whether similar findings can be supported in Senegal, another west African setting. Operating within the neoclassical framework of separability in supply and consumption decisions, and on the weak assumption maintained by the unitary and collective models-- namely that allocations of household resources are efficient-- I test whether the gender of the plot manager affects input usage across fields within a household whose members manage separate fields using two years of cross-section data. Similar to Udry, I control for the heterogeneity of resource endowments across households by using an OLS dummy variable regression approach. The results obtained from this method are analogous to those generated by using a time-demeaned fixed effects approach with panel data. This strategy enables me to isolate the comparison of input usage across male- and female-managed fields planted to the same or similar crops within a particular household and without having to match fields over time. The matching of plots is not possible in this setting because land was both reconfigured and reassigned to different household members for each of the agricultural seasons occurring during the survey period. I examine the gender-specific effects separately across the two-year period because agricultural conditions appeared to be extremely time-sensitive, although pooling the two years of data may have led to more robust results. I find gender-based discrepancies in input usage across plots within a household which ultimately lead to lower yields on female-managed plots. These findings provide further corroboration that neither the unitary nor the cooperative bargaining models used currently to analyze the determinants of intra-household decision making are realistic.

SETTING

Most ethnic groups in Senegal live in extended family units and maintain polygamous households.[4] The extended family may be comprised of more than one nuclear family, unmarried siblings, and other dependents. These families reside in a vertical hierarchy of succeeding generations, known as a concession, in which married sons and their dependents are subordinate to their father. It is the father, or head of concession, who determines agricultural production by delegating available land as communal (family) fields or personal fields.[5] As an obligation to the household head, all members must allocate some of their labor to the household fields which are utilized for the production of food crops. In exchange, the household head provides food for the family and land for personal use. Women are entitled to land for their own use which they may allocate to cash crop production. Some of the returns generated from women's personal fields are used to provide condiments, including vegetables and dried fish, to the meal. In addition to working in

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About 43% of the married male household head respondents had more than one spouse. While this occurrence is higher than the 31.3% reported by Goldman and Pebley, 1989, who use 1976 census data, it may be comparable. Census data report the incidence of polygyny for all married men, whereas the IFPRI/ISRA data contain a large number of concession heads who would be wealthier on average than a nationally representative household sample.

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Men and women farm separately throughout many societies in West Africa, but the allocation of land by men to women and their ultimate control of the agricultural production process has historical precedence. Guyer (1980) defines the sexual division of labor for the Beti, an ethnic group in Cameroon: During precolonial times men's contributions to farming was substantial. They cleared the forest for planting, felled trees, built enclosures to protect crops from destruction by animals, and constructed storage houses for crops. These fields were considered owned by men although women weeded, harvested and took general care of them. However, it is the men's work which defined field size and length of fallow.

In modern times, by making annual plot assignments to household members, men still determine the field size and length of fallow for land utilized as personal plots within the family.

family and personal fields, women perform other home maintenance activities and may be engaged in off-farm income activities.

Thus, the pattern of agricultural production in Senegal corresponds with the pattern found in Burkina Faso. Household production is implemented on multiple parcels of land and controlled by different members of the household. Crop choice and input decisions are made independently by each of the members who are allocated land while the household serves as a pool of labor for production. Men, women, and children perform specific agricultural tasks determined usually on the basis of gender. In the Senegal context, agriculture is managed within the household by multiple individuals but is dependent upon the complementarities of male and female labor supply. Additionally, family plot managers who grow peanuts, the family's most important cash crop, may be dependent upon the household head for obtaining peanut seed. Peanut seed has been cited by Senegalese farmers as one of the most critical input constraints (Kelly,1996).

The dynamics of interdependent household production in Senegal generate a setting in which plot managers are successful only if they can negotiate for shares of various inputs from other household members. When members fail to obtain the inputs necessary for optimal productivity they may incur losses attributed to inefficiency. Particularly when credit is scarce and the only available resources obtained by the household head are not dispersed to other members, the only asset under a women's domain is her productive labor women. Goetz (1990) suggests that labor cooperation between men and women may fall apart during periods of low food productivity. He depicts the Senegalese household as a coalition of individuals with divergent interests. The household head is charged with the responsibility of growing a sufficient amount of cereal to meet nuclear household food requirements.

Wives, young sons, and migrant workers, in contrast, are focused on generating cash income. Each of these members in the household pursues a distinct objective, but economies of scale will be obtained if these members form a coalition. If the sum of the benefits obtained by the individual members working together as a group is greater than the sum of the individual member's gain from working alone, cooperation should be sustainable. However, if the benefits received by the coalition differ from those contracted, the coalition may fail.

THE HOUSEHOLD MODEL

Pareto efficiency in a cooperative agricultural household implies that factors be allocated efficiently across its productive activities. Consider a household with two members, a male, m, and a female, f, who produce a crop, (q_c), on separate parcels of land owned by the household.[6] The crop is produced with two inputs of labor (L_i^m) and (L_i^f) on each of two land parcels embodying characteristics of size and quality. The household has an endowment of land, comprised of multiple parcels, (A_i), and labor time, (L^T).[7] Although these members apply their labor to the production on both land parcels, they allocate labor to other activities associated with home production, z, and to off-farm production, q_o. Since the household's objective is to maximize the profits achieved from its fixed assets of land, it will utilize labor until the marginal revenue product of labor is equated to a shadow wage–or market wage depending on the existence of a well functioning labor market. In a

6

The model can be generalized to a multiple person, multiple crop, and multiple plot setting.

7

Although the data show that some of the sampled households employed hired labor, most of households didn't seem to rely upon the hired labor market. Therefore, hired labor is not considered in the model.

recursive setting, where market substitutes may be obtained for family labor or home-produced goods, the household will determine labor demand independently of its tastes and household composition.[8] Considerations such as the gender of the plot manager or the bargaining weight which determines a particular member's income share shouldn't be factored into production decisions. Thus, male and female household members allocate their time to crop production managed on their own field and on the field of the other member, off-farm work, and home production.[9] The production of crop q_c is a function of $G_i(L_i^m, L_i^f, A_i)$, where $G_i(.)$ embodies the technology associated with a particular crop. The optimal technology choice available to a household is conditioned by its ability to access factor, commodity, and credit markets. These conditioning factors will be time-varying.[10]

Technology, defined by the level, intensity, and timing of input usage on a particular plot, plays a pivotal role in the assessment of whether households allocate productive resources efficiently. Although we would expect optimal technology choice to vary by crop, we would not expect optimal choice–or having access to the choice–to be sensitive to household parameters such as the gender of the plot manager. In this scenario, both allocative efficiency and the separability of agricultural factor demand decisions from

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See Singh, Squire, Strauss, 1996, and Benjamin, 1992, for a full treatment of separability and recursivity in agriculture household models.

9

It is possible that time allocated to one or more of these activities is zero for one of the members.

10

de Janvry, et al (1991) suggests that market failures are generally not pandemic, rather markets fail selectively for a particular household. Thus, a market failure occurs when the gain from utilizing a market is below associated costs.

household supply characteristics would fail.[11]

Consumption is comprised of goods produced on farm and goods purchased with proceeds generated by sales of tradeable crops or by off-farm income activities. Goods may be purchased for either private consumption or public consumption. Privately consumed goods may be defined as goods assignable to a particular individual whereas publicly consumed goods are not separable across individuals. Leisure, l^f and l^m, is separable between the two individuals. Output prices are normalized to one.

Thus, the household's problem is to

$$\max U_m(c_m, c_f, z, l_m, l_f) + \lambda u_f(c_m, c_f, z, l_m, l_f)$$

subject to :

$$Y = G(L_1^m, L_1^f, A_1) + G(L_2^m, L_2^f, A_2)$$

$$Z = z(z^f, z^m)$$

$$T^f = (L_1^f + L_2^f + q_o^f + z^f + l^f)$$

$$T^m = (L_1^m + L_2^m + q_o^m + z^m + l^m)$$

$$P_m C_m + P_f C_f \leq [(Y(.) - w_m(L_1^m + L_2^m) - w_f(L_1^f + L_2^f)) + w_m q_o^m + w_f q_o^f]$$

$$\bar{A} = A_1 + A_2$$

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Benjamin (1992) conveys an obvious example of labor demand and supply separation: "...with separation, the number of workers in Baron Rothchild's vineyards should not depend on the number of daughters he has."

The separability condition may fail for a household when one or several factor markets are either nonexistent or malfunctioning. Previous studies using data from Africa have documented the impact of missing labor markets on peasant household labor allocation (Barrett, 1996; Collier, 1983; Udry, 1998). Responding to labor market failures, farmers--differentiated by their existing endowments of capital and labor--will utilize their labor according to specific household supply parameters, or a household shadow wage. Thus, these disparities in factor endowments result in labor marginal productivities that are widely dispersed across farms. Differentiated labor use intensity across farms of different size has been associated with the inverse farm size productivity debate.

The maximized value of U(.) is increasing in income. So, the problem can be solved by first maximizing income, or production with respect to labor, land, and technology, and then maximizing utility.

The household's production problem is to

$$\max \quad [G(L_1^m, L_1^f, A_1) + G(L_2^m, L_2^f, A_2)] - w_m (L_1^m + L_2^m) - w_f (L_1^f + L_2^f)$$

$$\text{s. t. } A_1 + A_2 = \bar{A}$$

This generates 4 productive efficiency conditions:

$$(1) \quad \frac{\partial G(L_1^m, L_1^f, A_1)}{\partial L_1^m} - w_m = 0$$

$$(2) \quad \frac{\partial G(L_1^m, L_1^f, A_1)}{\partial L_1^f} - w_f = 0$$

$$(3) \quad \frac{\partial G(L_2^m, L_2^f, A_2)}{\partial L_2^m} - w_m = 0$$

$$(4) \quad \frac{\partial G(L_2^m, L_2^f, A_2)}{\partial L_2^f} - w_f = 0$$

$$(5) \quad \frac{\partial G}{\partial A_1} = \frac{\partial G}{\partial A_2}$$

We can equate conditions (1) with (3) and conditions (2) with (4) to get the following two conditions:

$$(1) \quad \frac{\partial G(L_1^m, L_1^f, A_1)}{\partial L_1^m} = \quad (3) \quad \frac{\partial G(L_2^m, L_2^f, A_2)}{\partial L_2^m}$$

$$(2) \quad \frac{\partial G(L_1^m, L_1^f, A_1)}{\partial L_1^f} = \quad (4) \quad \frac{\partial G(L_2^m, L_2^f, A_2)}{\partial L_2^f}$$

The marginal product of men's labor allocated to their own plots should be equivalent to what men allocate on women's plots, the same for women's allocation of labor. Solving the system of 5 equations and 5 unknowns from the first order conditions we get the endogenous factors of labor (L_1^m, L_2^m, L_1^f, L_2^f, A_1, A_2) as functions of (w_f, w_m, $\bar{A}$).

Household members growing the same crop on similar plots should produce equivalent yields. This condition of constant returns to scale should hold if plots managed by household members were of the same size, comprised similar levels and qualities of micro- and macro-nutrients, and were exposed to similar agro-climatic conditions.

Households choose labor and land to maximize income. Thus, optimal production decisions depend only upon input prices and plot characteristics and they should be independent of household parameters. In other words, the choices made towards the production of the same crop occurring on separate plots, controlling for soil characteristics, within a particular household should be similar, irrespective of the gender of the plot manager or the preferences expressed by these two individuals.

The process by which resources are allocated to the preferences of these two individuals is another matter. In a cooperative setting, allocation might be considered as a two stage process.[12] First, income would be allocated towards public goods consumption, or to those items that are not identified uniquely with a particular member, and to each of the members for expenditure on their own consumption. The issue of jointness may be particularly complex when considering the polygamous household. The consumption of food, for example, would be difficult to identify with a particular member, but it is possible that it could be assignable to a wife and her children, a sub-unit of the extended household.

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Browning,et al, 1996; Chiappori, 1988 and Chiappori, 1992 suggest the two stage income allocation rule as a plausible candidate for the intra-household allocation process. Chiappori (1997) generalizes the resource allocation process as a function of both members' wages and non-wage incomes.

Second, each member spends her or his portion of total household income on nonpublic goods. The allocation of income across members would be based on multiple factors, including shadow wages or economic opportunities available outside of the household and predetermined agreements for income sharing concluded as part of the household formation process. However, the sharing rule should not influence household income generation decisions or member preferences.

EMPIRICAL ESTIMATION

The state of productive efficiency is determined exclusively by technology and the inherent characteristics of the inputs and fixed factors used to grow crops. When two plots of land are used to grow the same crop in a household, the only differentiation in outcome should result from differences occurring in soil characteristics between the plots. For the same crop, technology choice, which embodies the timing, intensity, and type of labor inputs, should be identical. [13] Therefore, the empirical content of the paper examines whether the deviation of plot yield from the mean yield of a household is related to the gender or status of its plot manager.[14] A general output supply equation is estimated to account for differences in technology use resulting from crop choice and for factors that condition a household's ability to engage in market activity:

$$(6) \qquad Q_{hci} = \beta_0 + \beta_1 X_{hci} + \beta_2 G_{hci} + \beta_3 \nu_h + \beta_4 \gamma_c + \xi_{hci} ,$$

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Land quality may affect technology choice decisions. Therefore, if two household members were assigned plots of different quality, technology choice could vary over these two parcels of land.

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Productive efficiency should also incorporate decisions of land allocation: Land should not be allocated on the basis of the gender of the plot manager. Rather, the household head should allocate land based on the marginal revenue product of the crops grown on each of the household's land parcels.

where Q_{hci} is output/hectare obtained on a given plot; X_{hci} is a dummy variable capturing plot-size effects; G_{hci} is the gender of the individual who controls the plot; ν_h is a household fixed-effect dummy that restricts attention to the variation in yields across plots planted within a single household; γ_c is a crop dummy that controls for the impact of technology-specific crop effects; and ξ_{hci} is an error term that summarizes the effects of unobserved plot quality variation and plot-specific production shocks on yields. Similarly, an input demand equation is estimated for each type of household labor input and for selected non-labor inputs to examine whether differences in input intensities across fields within the same household may be attributed to the gender of the plot manager. If gender influences the underlying household decision rule in factor allocations, then β_2 would be significantly different from zero in these estimations. The results are estimated separately for the two years.

DATA

The data used for this paper were collected under the International Food Policy Research Institute (IFPRI) and the Institut Senegalais de Recherches Agricoles (ISRA) study, *Supply and Consumption Impacts of Agricultural Price Policies in the Peanut Basin and Senegal Oriental.* The survey, covering approximately 300 households, comprised three years[15] of household panel-data collection and was designed to learn how changes in agricultural policy affect household behavior. Coverage was focused on the Peanut Basin, an area comprising one-third of the country's land area and over two-thirds of its rural population. The data provide detailed information on rural and urban household consumption and production patterns, including both farm and off-farm activities.

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The survey commenced during the 1988 harvest so detailed crop information are available for only two complete farm-year cycles.

Enumerators obtained data on labor and non-labor input usage on each plot throughout the farm cycle for two seasons. These efforts generated usable data on approximately 2700 plots.[16] Data collection comprised 18 separate surveys on the following topics: household demographics; food consumption; purchases and sales related to crops and livestock; expenditures on all other services and products; cash transfers; household assets; individual net income from all economic activities; gross income and input costs; and detailed production data by plot for 1989/90 and 1990/91 crop seasons. Sample selection was based on an earlier reconnaissance survey that synthesized information on general characteristics of the area.

Data Issues

Plot-level Revenue This variable is the product of total output harvested per hectare on a plot and the average village1989 commodity price. These prices were used for both cross-section years to facilitate the comparability of results. A number of fields were planted with multiple crops which are not comparable to mono-cropped fields.[17] Thus, these fields were excluded from the crop-specific analysis but were incorporated into the all fields analysis.

Labor Inputs Detailed labor information is available from the survey on the hours

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During the first year of the survey each plot was measured, but in the subsequent year only a subset of plots was measured directly or estimated.

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Benjamin (1995) speculates that studies using a measure of aggregate value output to estimate the relationship between farm size and productivity could have led to a bias toward finding the frequently observed inverse relationship. The bias would be particularly sensitive when aggregate output comprises both high- and low-value crops and data on land quality are not available. If high quality land is more expensive-which is observed by the producer- then efficiency would prescribe that the more expensive crops be planted on it.

allocated to each field by activity and for each type of labor input: household male, female, child, and owned animal equipment hours as well as for various types of hired or in-kind labor. Because hired labor is employed only sporadically by these households, I do not estimate the effects of hired labor usage on yield outcomes.

Non-labor Inputs Although field applications of all inputs are detailed in the survey, usage of any particular input is not widespread. Accordingly, I estimate usage for only seed, manure, chemical fertilizer, and fungicide. With the exception of seed, I translated the non-labor input quantities into dummy variables and estimated their usage as a linear probability model because they were measured imprecisely.

Commodities In addition to estimating the models on all of the relevant fields for each year, I selected millet, sorghum, and peanuts as representative crops grown by men and women and provide separate results for fields cultivated with either millet or sorghum and for fields cultivated with peanut. These choices are useful because they typify a food staple grown for household consumption and managed by a household head, and a cash crop intended for market sale by both males and females. Peanut production accounts for the largest share of cash income from crop production, although some of the harvest could be reserved for consumption. Millet and sorghum could also be planted as cash crops, but it is more likely that they would be produced for home consumption. I combine the millet and sorghum fields to achieve more robust results. It is not possible to identify explicitly fields as either communal or personal. However, it is likely that a field planted with millet or sorghum and managed by a household head will be considered communal.

Plot Size I transformed continuous plot size data into a categorical variable of plot-size quintiles. The grouped data elucidate the plot-yield relationship more clearly.

RESULTS

Table 1 displays descriptive statistics of agricultural yields (value per hectare) and input intensities per hectare for the two survey years by gender of plot manager. In 1989, women generated more revenue per hectare than men, although the difference between these two groups was not significant. The reverse held true for men in 1990 and their gain over women's average revenues was more substantial. The relative variation of men's and women's revenues between the two years may be explained by the distribution of crops farmed by the two groups across the two-year period. Peanut farming generates more value per hectare than other crops and in 1990 the number of fields allocated by men to peanuts represented 32.8% of all fields farmed by both men and women. In 1989, men's peanut fields accounted for only 25.3% of all fields. Udry reported higher average revenues for women's than for men's fields in Burkina Faso, where the relative proportion of groundnuts farmed favored women (15.6% of women's fields compared to only 5.1% of men's fields).

In contrast to the above mentioned variations in plot yield, the differences found in the average levels of inputs used by men and women over both years are stark. In both years, women farmed plots that were less than half of the area of men's plots. Male labor and animal traction labor were utilized more intensively on male-managed plots while females used substantially more female labor and seeded their plots in greater densities. Men applied more manure, fertilizer, and fungicide on their own fields, but overall use was not high.

Table 1

Mean Revenue, Area, and Input by Gender of Field Manager

	1989[1] Men's Fields	1989 Women's Fields	T-Statistic $H_0:u_m=u_f$	1990 Men's Fields	1990 Women's Fields	T-Statistic $H_0:u_m=u_f$
Ag Revenue per Hectare	48864.6 (45393.1)	51189.9 (44387.6)	-0.97	31791.8 (3496.6)	26782.8 (33302.5)	2.354
Area of Plot (hectare)	1.007 (.8625)	.4353 (.3662)	18.7	.991 (.028)	.436 (.019)	16.2
Male Labor[2] (hours per hectare)	156.27 (185.62)	88.5392 (124.01)	8.6	113.05 (113.19)	77.38 (68.67)	6.7
Female Labor (hours per hectare)	26.42 (70.76)	173.30 (416.96)	-7.8	15.03 (40.98)	81.52 (151.83)	-8.2
Child Labor (hours per hectare)	85.00 (166.62)	85.15 (148.62)	-0.02	68.44 (86.98)	57.90 (97.12)	1.8
Animal Traction (hours per hectare)	49.6717 (66.13)	40.1506 (57.43)	2.9	44.17 (44.09)	37.16 (32.37)	3.1
Seed (kg/ hectare)	39.38 (63.87)	63.87 (56.76)	-8.9	47.89 (146.93)	79.93 (192.66)	-2.8
Manure Use (1 if used; 0 if not)	.064 (.24)	.022 (.15)	4.2	.07 (.26)	.005 (.075)	4.8
Fertilizer (1 if used; 0 if not)	.021 (.1451)	.004 (.063)	3.4	.089 (.2849)	.081 (.2732)	0.46
Fungicide (1 if used; 0 if not)	.2086 (.4065)	.1218 (.3273)	4.6	.4531 (.016)	.4208 (.022)	2.2

Note- Standard deviations are in parentheses.
[1] Data was determined not to be suitable for pooling. Chow tests are provided in the appendices, tables D1-D3.
[2] Harvest and post-harvest labor activities are not included in labor hours for any type of labor.

Leaving aside differences in input intensities, other factors could explain variations in yield outcomes.[18] Without controlling for these factors, it would be difficult to disentangle outcomes that are linked to market phenomena occurring across all households from those that are linked to the decision patterns concerning resource allocations to different members within the same household. Therefore, it's important to examine yield variations between men and women farming the same crop within the same household during the same year.

Tables 2a and 2b provide evidence that plots controlled by women produce substantially lower yields. The All Crops columns in both tables report estimates of equation (6), yield differences for all of men's and women's fields while controlling for household and crop effects. Referring to the Column (2) specification under All Crops, women generated 35% less revenue per hectare from their plots than did men on average in 1989.[19] This striking difference in disparity of outcomes by gender was repeated in 1990. Women generated 27% less then the average yield per hectare found on men's plots. These estimates provide further justification to Udry's claim that productive household resources are not being allocated across members in a pareto-efficient manner[20].

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Udry provides several explanations contributing to differences in men's and women's yields within the same household. One, systematic variations in nutrient soil quality across men's and women's plots would exacerbate differences in yields by gender. Two, customary crop choices by gender would generate different yield outcomes. Three, the prevalence of inefficient land and labor markets would create distortions across households in their capacity to use factors of production efficiently resulting in different factor shadow prices. Four, nonexistent credit markets could distort factor shadow prices across time. All of these factors could be supported within the Senegal context.

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The gender differential in yield is computed as the percentage difference from average household yield.

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Udry found that women's yields were reduced by 30% of the average yield on plots farmed in Burkina Faso.

The Peanut and Millet/Sorghum columns restrict estimates of gender-differentiated yields to fields cultivated exclusively with peanut, millet or sorghum. Differences in yield outcomes between men's and women's fields remain substantial. Female peanut cultivators produced 24.4% less output per hectare than the average peanut yield in 1989 and 19.7% less in 1990. Yield differentials between male and female cultivators of millet and sorghum fields provide even more stark contrasts. Females growing millet and sorghum produced 52.7% less output per hectare on average than their male kin. In 1990, this production loss climbed to 63.5%.

The gender effects on yields reported above control for plot size - yield effects.[21] All of the 1989 specifications incorporating plot-size quintiles and the 1990 all crops specification demonstrate a strong negative relationship between plot size and yield. However, unobserved differences in input intensity, plot characteristics, or prices may be correlated with plot size and/or the assignment of plots by the household head to other members. If any one or combination of these factors underlies the inverse plot size - yield relationship, then plot size becomes endogenous in the above specifications.

For example, cultivators of smaller parcels of land may use inputs more intensively. Most probably, smaller parcels of land would be identified as personal plots compared to the larger ones identified as family, or communal plots. Input differences across personal and communal plots may ascribe to differences in the quality and timing of labor inputs. Individuals would be inclined to allocate more efficient units of labor to their own plots

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The frequently observed inverse relationship between size and productivity in the literature refers to farm size and not plot size.

compared to the labor they expend on communal plot production. Therefore, communal plot managers would have to allocate time to the monitoring and supervision of family labor to obtain equivalent labor inputs. Monitoring and supervision time represent additional costs to the communal plot manager.

Household heads may respond to variations in land quality by dividing land of higher quality into smaller parcels, or they may own noncontiguous parcels throughout the village that were sized according to the underlying characteristics. If so, then unobserved soil quality would be inversely correlated with plot size and the household head may be assigning plots nonrandomly on the basis of soil quality. In this scenario, the gender and plot-size coefficients would be biased downward when soil quality is omitted from the equation.

In contrast to the above notion that small plots embody superior soil characteristics, plot size may also be correlated with distance from the household. The afore-mentioned relationship may describe plots that are located only within some concentric interior. Although no information about the distance of plots from the household exists in this data set, previous Senegalese studies depict land belonging to a particular household as being organized within concentric circles around the compound.[22] Women are allocated parcels of land that are located towards the periphery of the household's holdings. Not only would the large distance imposed on the managers of these plots represent an additional cost, but

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See John Waterbury , "The Senegalese Peasant: How Good is our Conventional Wisdom?" in Gersovitz and Waterbury, 1987, for more details on rural livelihoods and the coping mechanisms employed by Senegalese households to confront prevalent conditions of risk. Waterbury notes that women's personal fields, along with those provided to non-family labor, are located the farthest away from the household and considered 'bush fields'. The reference suggests fields of marginal quality.

these plots would be of lesser quality. Women would be farming plots that are not only smaller than the average size of a household plot, but are of inferior quality compared to the average parcel of land owned by a household. Thus, when I control for plot size I may be comparing yields on male- and female- managed plots that exhibit substantial differentials in quality. This comparison would inflate the gender-differentiated effect in yield outcomes.

Without controlling for crop or household effects, Table 1 showed that women farm on substantially smaller plots than men. If it is the case that women are allocated smaller plots on a systematic basis and smaller plots produce higher yields, we would expect the impact of gender on yield variation to decrease when controlling for plot size. The Column (1) specifications in Table 2a and Table 2b report estimates of gender yield differentials without plot-size quintile dummies but control for crop and household fixed effects estimates for all fields and household fixed effects for the specific crop estimates. Comparing these column estimates to those that control for plot size, I find that the gender effect is smaller when the inverse plot size relationship holds true. In 1990, the inverse plot size - yield relationship did not hold for peanut fields.

The gender coefficient is smaller in each of the Column (1) specifications compared to the gender coefficient reported in the corresponding Column (2) specification because it is picking up the average differential in yields associated with the inverse size effect. Though smaller, the Column (1) gender coefficient identifies the total gender effect, whereas the Column (2) coefficient a partial gender effect. On average, women are allocated smaller parcels of land--which is further substantiated by the reduced form estimates of input intensities discussed below--and the total gender effect captures this yield effect.

I attempt to disaggregate the average effect of plot size on gender by estimating the

Table 2a
1989 Plot-level Revenue per Hectare with Household and Crop Effects

	All Crops		Peanut		Millet/Sorghum	
	(1)	(2)	(1)	(2)	(1)	(2)
Gender	-9254.51	-17149.92	-12283.99	-17121.68	-7369.98	-17537.63
	(3.78)	(6.57)	(3.13)	(3.83)	(1.86)	(4.30)
Plot size:						
2nd quintile		-16185.35		-20269.78		-18477.36
		(4.77)		(3.14)		(3.66)
3rd quintile		-18801.76		-18587.55		-28572.87
		(5.26)		(2.60)		(5.74)
4th quintile		-25462.98		-22548.92		-30329.36
		(6.75)		(3.03)		(6.01)
5th quintile		-32931.54		-26411.48		-35852.08
		(8.21)		(3.39)		(6.90)
Constant	23851.56	57945.32	82194.45	108605.90	1891.89	37743.97
	(0.88)	(2.16)	(1.96)	(2.58)	(0.07)	(1.36)
Mean of Ag Revenue/hectare		49204.9		70260.25		33287.69
F- Statistics						
HH Dummies	1.92 [0.00]	1.86 [0.00]	1.83[0.00]	1.85 [0.00]	2.53 [0.00]	2.08 [0.00]
Plot Dummies		17.76 [0.00]		3.54 [0.00]		2.08 [0.00]
R^2	.35	.39	.39	.41	.52	.57
Number of Fields	1579	1579	627	627	623	623

Note: Absolute value of t-statistics in parentheses; P-values are in brackets

Table 2b
1990 Plot-level Revenue per Hectare with Household and Crop Effects

	All Crops		Peanut		Millet/Sorghum	
	(1)	(2)	(1)	(2)	(1)	(2)
Gender	-6134.16	-8111.74	-6099.65	-5326.11	-14587.55	-14734.88
	(3.54)	(4.25)	(3.45)	(2.54)	(4.54)	(4.34)
Plot size:						
2nd quintile		-2760.25		2636.02		5700.86
		(1.15)		(0.87)		(1.75)
3rd quintile		-3374.70		413.65		7035.21
		(1.20)		(0.11)		(1.90)
4th quintile		-5415.02		1916.95		3416.90
		(2.02)		(0.58)		(0.96)
5th quintile		-7356.67		4301.75		1300.63
		(2.55)		(1.21)		(0.36)
Constant	33313.79	37591.73	14030.46	12118.85	56466.67	51240.61
	(2.89)	(3.20)	(1.23)	(1.02)	(4.73)	(4.16)
Mean of Ag Revenue/hectare		29516.89		26986.38		23209.96
F- Statistics						
HH Dummies	5.24[0.00]	5.22[0.00]	12.21[0.00]	12.11[0.00]	2.65[0.00]	2.64[0.00]
Plot Dummies		1.83[0.12]		0.58[0.68]		1.64 [0.16]
R^2	.57	.58	.82	.83	.54	.55
Number of Fields	1178	1178	450	450	464	464

yield equation with both plot size dummies and gender- plot size interactions for each quintile, excluding the first category of each group. These results, along with those that attempt to establish whether similar partial effects may exist across household generations, are presented in Tables 3a and 3b. The estimates control for both crop and household effects. The gender-plot size interactions are not jointly significant which suggests that the pattern of yield differences by plot size does not vary according to the gender of the field manager. Therefore, there is no empirical evidence to substantiate the claim that women sustained lower yields on land parcels of similar size than men who planted the same crop and lived in the same household. With the exception of one gender-plot interaction term in 1989, the interaction terms are neither singularly significant nor jointly significant for either year. The test statistic evaluating the strength of the gender-land relationship in 1989 is distributed as $F(4, 1364)$ and has a value = 1.69 ($p = 0.15$). The 1990 test statistic is distributed as $F(4, 1008)$ and has a value = 0.14 ($p = 0.97$).

The results demonstrate that the inverse size-yield relationship do not affect male- and female-managed plots differently. Although it is not possible to control for unobserved differences in soil quality or location between men and women's fields, these results suggest that men and women farm plots of relatively similar characteristics.

If one is concerned about the nonexogenous nature of plot size allocation and gender, stature within the household may suggest a potential source of additional endogeneity: Assuming that women are allocated the smallest plots, it is plausible that household heads reserve the largest and most productive plots for themselves. Therefore, column (2) in these two tables estimates the impact of headship status on yield to identify whether systematic biases occur between the head and other male members. These estimates were based only on

Table 3a
OLS Fixed Effects of Plot-Yield Relationship
1989–All Crops (Household and Crop Effects)

	(1) Gender-Plot Size Interactions All Fields Ag Revenue (per hectare)	(2) HH Status- Plot Size Effects Only Male-Controlled Fields Ag Revenue (per hectare)
Nonhead (0= HH head, 1=other males)		-14400.140 (4.54)
Plot size:		
2nd quintile	-10106.88 (2.18)	-12785.34 (2.73)
3rd quintile	-17357.73 (3.85)	-19771.98 (4.28)
4th quintile	-25190.48 (5.63)	-29088.86 (6.24)
5th quintile	-31319.55 (6.82)	-36493.21 (7.40)
Gender	-13504.62 (2.71)	
2nd * gender	-12698.36 (1.93)	
3rd * gender	-2769.70 (0.41)	
4th * gender	5274.65 (0.59)	
5th * gender	-2518.48 (0.22)	
Constant	56359.99 (2.09)	73744.13 (2.75)
F- Statistics		
HH Dummies	1.87 [0.00]	1.71 [0.00]
Plot Dummies	14.19 [0.00]	15.86 [0.00]
Gender*Plot Size	1.69 [0.15]	
R^2	.39	.44
Number of Fields	1579	1110

Table 3b
OLS Fixed Effects of Plot-Yield Relationship
1990–All Crops (Household and Crop Effects)

	(1) Gender-Plot Size Interactions All Fields Ag Revenue (per hectare)	(2) HH Status- Plot Size Effects Only Male-Controlled Fields Ag Revenue (per hectare)
Nonhead (0= HH head, 1=other males)		-8258.433 (3.56)
Plot size:		
2nd quintile	-4127.54 (1.29)	-4446.767 (1.31)
3rd quintile	-4011.37 (1.18)	-3467.427 (0.94)
4th quintile	-6459.73 (2.06)	-6608.929 (1.96)
5th quintile	-8143.01 (2.49)	-10744.570 (2.93)
Gender	-9860.95 (2.86)	
2nd * gender	-2924.82 (0.65)	
3rd * gender	-999.56 (0.19)	
4th * gender	-3389.45 (0.59)	
5th * gender	-1565.88 (0.22)	
Constant	38252.62 (3.22)	41677.19 (3.04)
F- Statistics		
HH Dummies	5.20 [0.00]	3.70 [0.00]
Plot Dummies	1.80 [0.00]	2.66 [0.03]
Gender*Plot Size	0.14 [0.97]	
R^2	.58	.59
Number of Fields	1178	845

fields managed by men. Nonhead males, like females, were found to generate less yields per hectare than the residing head. For both years the plot quintile dummies are jointly significant and in 1989 the inverse relationship between plot size and yield of male cultivators is strong.

The third column in each of the tables presents yield estimates on the combined sample of male and female plots with plot-size dummies and gender-plot interactions. With the inclusion of the nonhead dummy in this specification, the gender coefficient increases in magnitude because it is picking up the differential in yields between female-managed plots and those under the control of the household head. Thus, both the gender and the status of the plot manager moderate the effect of the inverse size-yield relationship associated with these plots.

Gender-Differentiated Input Intensities

Allocative efficiency, a basic condition of pareto efficiency, is achieved by equating the marginal value product of inputs used in production to their unit costs. Thus, allocative inefficiency stems from a failure to use profit maximizing levels of inputs. Cultivators producing under constant returns to scale who are confronted with similar production technologies and factor input prices should apply inputs in an equally intensive fashion. Thus, assuming that these conditions hold, efficiency in production implies that input intensities should be equalized in equilibrium across male- and female-managed plots within the same household. Access to factor inputs should not be determined on the basis of one's gender.

Table 4a displays estimates of the labor intensities used per hectare on all of men's and women's fields. These results corroborate Udry's findings: With the exception of female labor, all labor inputs on a per hectare basis are used much less intensively on female-managed plots in the same household. Women allocate more of their own labor--about 130% more hours--to their own plots than to those in the household managed by men. Conversely, women farmed plots with less of every other type of labor input. On average, women's plots received 71.4% less hours of male labor per hectare than men's plots in 1989 as displayed in column 3. The household's children contributed 33.5 % less hours of their labor to female plots. Animal traction labor, which is most often combined with male labor, was provided 40% less per hectare on female plots.[23]

Moreover, the negative differential in the allocation of labor inputs revealed on women's plots could affect both the level and timeliness of application of other inputs. Thus, these disparities could have a negative impact on both the marginal productivity of labor used to complete certain types of agricultural tasks, and of other inputs used, such as fertilizer and seed.

Since 1960, animal traction has been considered one of the most important catalysts for productivity growth in the country and was the agricultural technology most singularly adopted by cultivators throughout the Peanut Basin (Kelly, et al 1996). Although originally considered as a technology to raise growth via extensification, the real gains come from using animal traction to increase intensification by applying other inputs more efficiently. Animal traction can be used throughout the agricultural cycle - beginning with land preparation tasks and finishing with harvesting - to increase the marginal productivity of other inputs. For example, animal traction increases the effectiveness of fertilizer and manure applications. Although used sparingly in Senegal, greater benefits from the application of fertilizer and

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Animal traction labor is comprised of both human and animal labor inputs, and thus is reported jointly.

Table 4a
OLS Fixed Effects of Labor Input Intensities
1989–All Fields (Household and Crop Effects)

	Female Labor per Hectare		Male Labor per Hectare		Child Labor per Hectare		Animal Traction per Hectare	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	88.72	74.20	-58.99	-98.62	-3.54	-28.23	-6.36	-19.17
	(9.80)	(7.61)	(5.88)	(9.39)	(0.39)	(2.91)	(1.69)	(4.82)
Plot size:								
2nd quintile		-57.07		-87.54		-78.47		-31.25
		(4.50)		(6.41)		(6.22)		(6.04)
3rd quintile		-74.08		-117.59		-91.20		-42.86
		(5.55)		(8.17)		(6.87)		(7.87)
4th quintile		-79.74		-141.61		-98.99		-46.48
		(5.66)		(9.33)		(7.07)		(8.08)
5th quintile		-63.85		-163.26		-114.53		-54.93
		(4.26)		(10.11)		(7.69)		(8.98)
Constant	6.06	71.28	86.38	255.17		173.28	60.71	117.44
	(0.06)	(0.71)	(0.78)	(2.36)		(1.74)	(1.46)	(2.87)
Mean of labor hrs	56.9	56.9	138.1	138.1	84.2	84.2	47.6	47.6
F-Statistics								
HH Dummies	2.08[0.00]	2.14 [0.00]	2.28[0.00]	2.22 [0.00]	2.61[0.00]	2.65 [0.00]	2.32[0.00]	23.52 [0.00]
Plot Dummies		9.95 [0.00]		29.41[0.00]		17.93 [0.00]		2.35 [0.00]
R^2	.32	.34	.28	.34	.28	.32	.27	.32
Number of Fields	1579	1579	1579	1579	1579	1579	1579	1579

manure could be obtained if these substances are worked deeper into the soil than possible by using only human labor to move and spread the inputs.

Animal traction also enables cultivators to complete agricultural tasks within shorter timeframes and thus follow prescribed dates that fall within narrow windows of opportunity to achieve optimum yields. Combining animal traction with seeding tasks ensures that plots will be seeded within the suggested timeframe for planting. Research conducted in Senegal found that peanut yields are extremely sensitive to planting dates and decrease for each day that seeding is delayed beyond the first seasonal rain. When cultivators use animal traction to perform harvesting tasks they can reduce the risk of peanut crop failure. With the introduction of a short-season peanut variety, it has become necessary to harvest the peanut crop immediately after it has matured because it will regerminate if it is exposed to additional rain. Using animal traction enables cultivators to harvest their fields more quickly.

Table 4b reports input labor demand estimates for only monocropped peanut fields. Labor use is significantly differentiated by gender of the plot manager. On average, female cultivators receive 75.1% less male labor per hectare and 37.3 % less animal traction labor per hectare than male cultivators. Even more telling, the household's children spend significantly less time on women's plots than on men's plots. Possibly devised as a strategy to compensate for these other labor deficits, women allocate 106.6% more labor hours per hectare to their own fields than to those managed by men in the same household.

Table 4c reports estimates of labor intensities for millet and sorghum fields in 1989. Gender-based differentials of male and child labor hours on these fields are similar to those found on peanut fields. However, animal traction is used even less intensively on women's millet and sorghum fields than women's peanut fields. On average, 73% fewer labor hours

Table 4b
OLS Fixed Effects Estimates of Labor Input Intensities
1989–Peanut Fields (Household Effects)

	Female Labor per Hectare		Male Labor per Hectare		Child Labor per Hectare		Animal Traction per Hectare	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	60.93	51.34	-67.65	-97.88	-28.80	-54.07	-8.26	-17.50
	(7.58)	(5.58)	(5.68)	(7.29)	(1.91)	(3.17)	(2.16)	(4.07)
Plot size:								
2^{nd} quintile		-27.88		-37.92		-86.40		-10.06
		(2.10)		(1.96)		(3.51)		(1.62)
3^{rd} quintile		-37.99		-61.30		-89.78		-21.37
		(2.58)		(2.86)		(3.29)		(3.11)
4^{th} quintile		-44.55		-92.05		-105.41		-25.64
		(2.91)		(4.12)		(3.71)		(3.58)
5^{th} quintile		-42.18		-106.79		-125.46		-32.14
		(2.63)		(4.57)		(4.22)		(4.29)
Constant	0.0	42.18	134.92	241.71	92.59	218.05	92.60	124.73
	(0.0)	(0.49)	(1.06)	(1.91)	(0.58)	(1.36)	(2.28)	(3.08)
Mean of labor hrs	48.1	48.1	130.3	130.3	86.0	86.0	46.9	46.9
F- Statistic								
HH Dummies	2.32[0.00]	2.26 [0.00]	2.26[0.00]	2.17 [0.00]	2.14[0.00]	2.19 [0.00]	3.09[0.00]	3.07 [0.00]
Plot Dummies		2.46 [0.00]		6.17 [0.00]		5.11 [0.00]		5.2 [0.00]
R^2	.51	.52	.47	.49	.43	.45	.52	.55
Number of Fields	627	627	627	627	627	627	627	627

of animal traction were allocated to women's fields than men's fields in the same household.

As suggested above, the benefits of animal traction may be indirectly transmitted through the more efficient application of other inputs such as fertilizer. In particular, cereal crops are more responsive to fertilizer than are peanuts (Kelly, 1993). Therefore, the yield return that millet and sorghum cultivators experience from using fertilizer would be less for those who are female because they use significantly less animal traction labor.

Table 4d reports estimates of non-labor input intensities for all fields in 1989. On average, women are allocated plots that are 65.8% smaller than ones farmed by men in the same household. While a negative plot size - yield relationship was found, women produce less output for every size category than men when controlling for plot size effects.

The estimates show that, on average, women seed their plots less intensively than males in the same household. Access to certified seed stocks, particularly for peanut farming, has been identified by Senegalese farmers as a critical constraint in increasing yields. Until 1985, seed was formerly distributed in a program that enabled farmers to exchange part of their harvest in the current period for seeds to be used in the following agricultural season. After the program was discontinued by the government, cultivators could only obtain new seed with either cash or credit purchases. This change in policy forced some cultivators –namely women and unmarried sons living in the household within their extended family networks–to switch from growing peanuts as a cash crop to cereals. Thus, the estimates of seeding densities would under report the differential impact that women would experience in obtaining seed. For those women who would have been most constrained in their capacity to obtain reliable peanut seed, it is likely that they were forced to farm alternative crops. The estimates do not capture this severe form of constraint.

Table 4c
OLS Fixed Effects Estimates of Labor Input Intensities
1989–Millet and Sorghum Fields (Household Effects)

	Female Labor per Hectare		Male Labor per Hectare		Child Labor per Hectare		Animal Traction per Hectare	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	65.80	54.44	-41.76	-102.45	-9.06	-49.38	-16.71	-35.19
	(6.13)	(4.72)	(1.76)	(4.21)	(0.53)	(2.78)	(1.83)	(3.69)
Plot size:								
2nd quintile		-38.11		-148.36		-111.85		-44.60
		(2.67)		(4.93)		(5.08)		(3.78)
3rd quintile		-48.468		-197.72		-138.20		-65.309
		(3.45)		(6.67)		(6.38)		(5.62)
4th quintile		-45.23		-205.09		-140.09		-62.04
		(3.17)		(6.82)		(6.37)		(5.26)
5th quintile		-46.93		-225.45		-155.69		-71.01
		(3.20)		(7.29)		(6.88)		(5.85)
Constant	.00	71.28	56.76	282.22	34.05	189.74	34.05	105.07
	(0.0)	(0.71)	(0.33)	(1.71)	(0.27)	(1.57)	(0.52)	(1.62)
Mean of labor hrs	36.0	36.0	136.5	136.5	78.3	78.3	48.2	48.2
F-Statistics								
HH Dummies	1.84[0.00]	1.75 [0.00]	1.64[0.00]	1.59 [0.00]	1.46[0.00]	1.36 [0.01]	1.26[0.03]	1.25 [0.04]
Plot Dummies		3.42 [0.01]		15.06 [0.00]		13.48 [0.00]		9.90 [0.00]
R^2	.47	.49	.41	.48	.37	.44	.34	.40
Number of Fields	623	623	623	623	623	623	623	623

Table 4d
OLS Fixed Effects Estimates of Non-Labor Input Intensities
1989–All Fields (Household and Crop Effects)

	Plot Area (Hectares)	Seed (Kg per Hectare)		Manure (1 if used)		Fertilizer (1 if used)		Fungicide (1 if used)	
	(1)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	-0.55	-3.21	-10.87	-.026	-0.01	-.007	0.00	-.14	-0.07
	(12.69)	(1.46)	(4.69)		(0.49)	(1.23)	(0.30)	(7.75)	(3.67)
Plot size:									
2nd quintile			-20.13		0.05		0.01		0.05
			(6.68)		(2.75)		(1.47)		(1.87)
3rd quintile			-21.60		0.04		0.01		0.08
			(6.81)		(1.97)		(1.35)		(3.03)
4th quintile			-28.17		0.09		0.02		0.14
			(8.41)		(4.69)		(2.57)		(5.17)
5th quintile			-33.41		0.07		0.03		0.27
			(9.38)		(3.38)		(3.66)		(9.02)
Constant	1.98	-3.44	31.02	.03	-0.04	.006	-0.03	.39	0.12
	(4.10)	(0.14)	(1.30)	(0.22)	(0.30)	(0.10)	(0.47)	(1.96)	(0.59)
Mean of input Use	.84	46.5	46.5	.05	.05	.01	.01	.19	.19
F-Statistics									
HH Dummies	2.03 [0.00]	2.19[0.00]	2.20 [0.00]	2.56[0.00]	2.66 [0.00]	1.34[0.00]	1.34 [0.00]	6.43[0.00]	6.31 [0.00]
Plot Dummies			24.58[0.00]		6.06 [0.00]		8.81 [0.00]		24.61[0.00]
R^2	.36	.66	.68	.34	.35	.54	.54	.57	.57
Number of Fields	1579	1579	1579	1579	1579	1579	1579	1579	1579

The table also reports that fewer women than men utilized manure but this differential was insignificant. The estimates suggest an increased usage of fertilizer by women over men, but the coefficient is not significantly different from zero. Fewer women apply fungicide to their seeds than do men which could have a negative impact on the level of seed germination and, thus, on yield outcomes. Although the gender differential is significant, the point estimate is extremely small.

The use of manure and fertilizer is not widespread in Senegal. Therefore, it is not possible on the basis of these estimates to contend that the marginal product of fertilizer is decreasing and that further benefits could be exploited by redistributing these inputs to women's fields planted to the same crop in the household. These estimates do not support Udry's findings regarding fertilizer application on fields cultivated in Burkina Faso.[24]

Table 4e reports estimates of non-labor input use on peanut fields in 1989. The estimates of plot size allocation and seed density provide telling evidence of resource disparities by gender. On average, women farmed peanut plots that were 32.1% smaller than those farmed by men in the same household.

Peanut seed, however, is considered by most Senegalese as the critical resource constraint, and having access to quality seed is the key to increasing peanut yields. New seed must usually be purchased either with cash or credit. Alternatively, peanut stocks from one's own harvest of the previous season are used as seed during the next one for those who lack the means to obtain new seed. But the productivity of stored seed does not match the new seed that can be purchased from the government. Seed density per hectare is also inversely

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Udry estimated a fertilizer coefficient of -16.33 kilograms per hectare and a t-statistic of -2.54 for female cultivators. The mean of the dependent variable was reported as 7.78 kg/hectare, conditioned on use greater than zero.

Table 4e
OLS Fixed Effects Estimates of Non-Labor Input Intensities
1989–Peanut Fields (Household Effects)

	Plot Area (Hectares)	Seed (Kg per Hectare)		Manure (1 if used)		Fungicide (1 if used)	
	(1)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	-0.61	-8.42	-23.47	.002	0.00	-.18	-0.01
	(9.64)	(1.89)	(4.87)	(0.22)	(0.36)	(5.54)	(0.26)
Plot size:							
2^{nd} quintile			-37.50		0.01		0.16
			(5.40)		(0.76)		(3.32)
3^{rd} quintile			-43.37		0.02		0.27
			(5.63)		(1.20)		(5.09)
4^{th} quintile			-49.94		0.02		0.40
			(6.24)		(1.03)		(7.27)
5^{th} quintile			-67.04		0.01		0.59
			(7.99)		(0.55)		(10.15)
Constant	1.89	74.07	141.11	0.0	-0.01	1	0.41
	(2.79)	(1.56)	(3.11)	(0.0)	(0.10)	(2.92)	(1.32)
Mean of input Use	.82	92.2	92.2	.01	.01	.34	.34
F- Statistics							
HH Dummies	1.26 [0.00]	1.84[0.00]	1.84 [0.00]	1.59[0.00]	1.58 [0.00]	4.37[0.00]	4.66 [0.00]
Plot Dummies			16.55 [0.00]		0.44 [0.78]		28.63[0.00]
R^2	.40	.39	.47	.36	.36	.62	.69
Number of Fields	627	627	627	627	627	627	627

Table 4f
OLS Fixed Effects Estimates of Non-Labor Input Intensities
1989–Millet and Sorghum (Household Effects)

	Plot Area (Hectares)	Seed (Kg per Hectare)		Manure (1 if used)		Fertilizer (1 if used)		Fungicide (1 if used)	
	(1)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	-0.66	.32	-3.53	.13	-0.099	-.009	0.00	-.07	-0.03
	(6.35)	(0.24)	(2.62)	(3.89)	(2.56)	(0.77)	(0.03)	(2.39)	(1.00)
Plot size:									
2^{nd} quintile			-8.44		0.02		0.00		-0.00
			(5.05)		(0.40)		(0.16)		(0.10)
3^{rd} quintile			-10.96		0.02		0.01		-0.02
			(6.65)		(0.57)		(0.86)		(0.40)
4^{th} quintile			-10.64		0.13		0.01		0.05
			(6.37)		(2.90)		(0.95)		(1.22)
5^{th} quintile			-12.56		0.06		0.03		0.10
			(7.31)		(1.42)		(1.85)		(2.38)
Constant	1.85	5.4	17.97	0.0	-0.06	0.0	-0.03	0.0	-0.10
	(2.46)	(0.57)	(1.96)	(0.0)	(0.27)	(0.0)	(0.35)	(0.0)	(0.45)
Mean of input Use	1.04	5.6	5.6	.07	.07	.01	.01	.12	.12
F-Statistics									
HH Dummies	1.60 [0.00]	1.51[0.00]	1.47 [0.00]	1.83[0.00]	1.85 [0.00]	3.34[0.00]	3.31 [0.00]	4.65[0.0]	4.67[0.00]
Plot Dummies			14.71		3.40 [0.00]		1.22 [0.00]		3.77 [0.01]
R^2	.44	.38	.45	.43	.45	.58	.58	.66	.54
Number of fields	623	623	623	623	623	623	623	623	623

related to the amount of labor time required to weed peanut plots and it is positively related to moisture content in the soil. Therefore, the density with which plots are seeded directly affects labor efficiency, soil quality, and peanut yield outcomes.

Compared to males in the same household farming peanuts, women seeded their plots with 25.5% less kilograms per hectare. Although these results indicate that women farm peanuts with differential levels of seed input than males living in the same household, they do not capture information on whether men and women use seed that is different qualitatively. It is plausible that women would be more credit constrained relative to men and would therefore be more likely to plant seed acquired from previous harvests than from new purchases.

Table 5a provides estimates of labor inputs utilized on all fields during the 1990 cropping season accounting for household and crop effects. Resource allocation follows the trends patterned in 1989. On average, women allocated more of their own labor (126.8% more labor per hectare) to their own fields while men allocated less (35.9% less labor per hectare). Women also farmed less intensively with child labor (20.9% less labor per hectare) and with animal traction (19.8% less labor per hectare) than men in the same household.

Table 5b provides estimates of labor inputs utilized on peanut fields in 1990. Although the same general pattern of gender-differentiated resource allocation is evident, women seem to be allocating even more hours to their own plots while other types of labor is applied to women's plots in a less discriminating manner. On average, women applied 130.4% more of their own labor hours per hectare to their own plots, but men applied only 11.5% less hours per hectare to women's plots. Regarding allocations of child labor and animal traction labor per hectare, the average differential is positive for women's plots but

Table 5a
OLS Fixed Effects Estimates of Labor Input Intensities
1990–All Fields (Household and Crop Effects)

	Female Labor per Hectare		Male Labor per Hectare		Child Labor per Hectare		Animal Traction per Hectare	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	40.78	34.99	-25.98	-37.52	-6.43	-13.61	-3.01	-8.460
	(11.85)	(9.31)	(4.17)	(5.54)	(1.33)	(2.57)	(1.14)	(2.96)
Plot size:								
2^{nd} quintile		-17.96		-40.52		-20.26		-14.954
		(3.80)		(4.76)		(3.04)		(4.15)
3^{rd} quintile		-21.94		-36.49		-19.39		-15.865
		(3.95)		(3.64)		(2.47)		(3.75)
4^{th} quintile		-21.76		-43.15		-24.12		-19.668
		(4.12)		(4.53)		(3.23)		(4.89)
5^{th} quintile		-24.82		-56.57		-32.78		-22.882
		(4.37)		(5.52)		(4.09)		(5.29)
Constant	51.84	74.27	83.89	126.53	145.73	168.65	43.20	61.279
	(2.27)	(3.21)	(2.03)	(3.03)	4.54	(5.17)	(2.47)	(3.48)
Mean of labor hrs	27.6	27.6	104.6	104.6	65.3	65.3	42.7	42.7
F-Statistics								
HH Dummies	7.12[0.00]	7.15 [0.00]	4.09[0.00]	3.8 [0.00]	7.16[0.00]	6.85 [0.00]	3.66[0.00]	3.44 [0.00]
Plot Dummies		5.94 [0.00]		8.66 [0.00]		4.45 [0.00]		8.02 [0.00]
R^2	.58	.59	.45	.47	.54	.54	.38	.40
Number of Fields	1178	1178	1178	1178	1178	1178	1178	1178

Table 5b
OLS Fixed Effects Estimates of Labor Input Intensities
1990–Peanut Fields (Household Effects)

	Female Labor per Hectare		Male Labor per Hectare		Child Labor per Hectare		Animal Traction per Hectare	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	39.86	32.47	-12.57	-9.44	3.60	2.19	0.54	0.678
	(10.80)	(7.54)	(2.81)	(1.78)	(0.70)	(0.36)	(0.30)	(0.31)
Plot size:								
2^{nd} quintile		-0.60		-6.32		-9.32		-4.355
		(0.10)		(0.82)		(1.06)		(1.40)
3^{rd} quintile		-10.38		-5.14		-6.18		-2.302
		(1.38)		(0.56)		(0.58)		(0.61)
4^{th} quintile		-19.40		0.80		-10.45		-3.057
		(2.88)		(0.10)		(1.10)		(0.91)
5^{th} quintile		-15.38		4.21		-8.51		-2.203
		(2.10)		(0.47)		(0.82)		(0.60)
Constant	-19.93	-10.74	56.25	60.41	61.95	70.41	25.93	29.186
	(0.84)	(0.44)	(1.96)	(2.02)	(1.88)	(2.05)	(2.22)	(2.40)
Mean of labor hrs	24.9	24.9	82.2	82.2	61.8	61.8	27.4	27.4
F-Statistics								
HH Dummies	2.23[0.00]	7.15 [0.00]	4.71[0.00]	3.84 [0.00]	4.05[0.00]	6.85 [0.00]	7.26[0.00]	3.44 [0.00]
Plot Dummies		5.94 [0.00]		8.66 [0.00]		4.45 [0.00]		8.02 [0.00]
R^2	.58	.59	.45	.47	.54	.54	.38	.40
Number of Fields	1178	1178	1178	1178	1178	1178	1178	1178

the estimates are not significantly different from zero.

Estimates of labor inputs allocated to millet and sorghum fields in 1990 are presented in Table 5c. Resource utilization followed the 1989 pattern. On average, women farmed more intensively with their own labor (85.0% more labor hours per hectare) and less intensively with male labor (47.8% less per hectare), child labor (36.8% less per hectare) and animal traction (40.2% less per hectare).

Table 5d presents estimates of non-labor input use on all fields in 1990. On average, female cultivators farmed significantly smaller plots than men in the same household. The average area of women's plots is about 60% less than the area of men's plots. Women farmed less intensively with the other inputs reported in the table. However, the estimated gender-differential of resource use is either not statistically different from zero such as for seed and fertilizer use, or overall use of the input for both males and females is low such as for manure and fertilizer.

Table 5e presents estimates of non-labor input use on peanut fields. On average, women utilized greater quantities of seed than men but the differential was not significant. In contrast, more men applied quantities of manure, fertilizer, and fungicide but the differences were insignificant. In 1990, the proportion of peanut cultivators who applied fungicide (52%) was much larger than the proportion of users in 1989 (19%).

Table 5f presents estimates of non-labor input use on millet and sorghum fields in 1990. The findings are similar to those discussed above for peanut fields. On average, female cultivator's plots were 58.6% smaller than male cultivator's. Women seeded their plots more intensively than males, but the point estimate is not significantly different from zero. On average, fewer women than men applied manure or fungicide but overall use is not

Table 5c
OLS Fixed Effects Estimates of Labor Input Intensities
1990–Millet and Sorghum Fields (Household Effects)

	Female Labor per Hectare		Male Labor per Hectare		Child Labor per Hectare		Animal Traction per Hectare	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	16.27	17.57	-36.72	-50.33	-23.63	-25.62	-11.79	-19.797
	(2.37)	(2.40)	(-2.14)	(2.81)	(1.71)	(1.75)	(1.56)	(2.51)
Plot size:								
2nd quintile		-5.23		-52.26		-23.46		-24.669
		(0.75)		(3.05)		(1.67)		(3.28)
3rd quintile		5.91		-32.26		-2.146		-23.537
		(0.74)		(1.65)		(0.13)		(2.74)
4th quintile		-0.05		-58.43		-16.63		-29.868
		(0.01)		(3.13)		(1.09)		(3.64)
5th quintile		-3.53		-69.41		-26.12		-35.349
		(0.45)		(3.60)		(1.65)		(4.17)
Constant	112.5	109.57	100.21	145.55	219.58	228.97	57.5	84.203
	(4.40)	(4.13)	(1.57)	(2.24)	(4.27)	(4.30)	(2.04)	(2.95)
Mean of labor hrs	20.7	20.7	105.2	105.2	69.6	69.6	44.3	44.3
F- Statistics								
HH Dummies	3.29[0.00]	3.20 [0.00]	3.03[0.00]	2.71 [0.00]	2.53[0.00]	2.38 [0.00]	1.71[0.00]	1.57 [0.00]
Plot Dummies		0.79 [0.53]		3.99 [0.00]		1.40 [0.00]		4.68 [0.00]
R^2	.59	.59	.57	.57	.52	.53	.43	.46
Number of Fields	464	464	464	464	464	464	464	464

Table 5d
OLS Fixed Effects Estimates of Non-Labor Input Intensities
1990–All Fields (Household and Crop Effects)

	Plot Area (Hectares)	Seed (Kg per Hectare)		Manure (1 if used)		Fertilizer (1 if used)		Fungicide (1 if used)	
	(1)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	-0.50	-5.29	-9.081	-.06	-0.037	-.007	-0.001	-.145	-0.090
	(10.31)	(0.48)	(0.75)	(4.04)	(2.13)	(1.0)	(0.14)	(6.88)	(3.94)
Plot size:									
2nd quintile			-9.72		0.05		0.01		0.06
			(0.64)		(2.26)		(1.26)		(1.93)
3rd quintile			-12.79		0.08		0.02		0.10
			(0.71)		(3.30)		(1.30)		(3.01)
4th quintile			-14.54		0.08		0.01		0.17
			(0.85)		(3.35)		(1.08)		(5.34)
5th quintile			-13.93		0.10		0.03		0.16
			(0.76)		(3.76)		(2.55)		(4.56)
Constant	0.81	8.37	21.74		-0.04	0.0	-0.02	-.12	-0.24
	(2.49)	(0.12)	(0.29)		(0.41)	(0.02)	(0.34)	(0.87)	(1.72)
Mean of input	.84	57.3	57.3	.06	.06	.08	.08	.28	.28
F- Statistics									
HH Dummies	2.45 [0.00]	2.27[0.00]	2.17 [0.00]	1.88[0.00]	4.23[0.00]	1.78[0.00]	1.75[0.00]	10.0[0.0]	10.11[0.00]
Plot Dummies			0.21 [0.9]		1.83 [0.00]		1.78[0.13]		8.85 [0.00]
R^2	.38	.32	.33	.28	.29	.91	.91	.67	.68
Number of Fields	1178	1178	1178	1178	1178	1178	1178	1178	1178

Table 5e
OLS Fixed Effects Estimates of Non-Labor Input Intensities
1990–Peanut Fields (Household Effects)

	Plot Area (Hectares)	Seed (Kg per Hectare)		Manure (1 if used)		Fertilizer (1 if used)		Fungicide (1 if used)	
	(1)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	-0.64	-0.08	6.17	-0.03	-0.00	-0.01	-0.01	-0.14	-0.03
	(9.05)	(0.01)	(0.88)	(2.03)	(0.04)	(1.35)	(0.57)	(4.61)	(1.04)
Plot size:									
2^{nd} quintile			2.36		0.02		-0.00		0.14
			(0.23)		(0.98)		(0.11)		(2.96)
3^{rd} quintile			-0.28		0.04		-0.01		0.23
			(0.02)		(1.55)		(0.30)		(4.01)
4^{th} quintile			19.24		0.05		-0.01		0.29
			(1.75)		(1.92)		(0.31)		(5.69)
5^{th} quintile			13.84		0.09		0.02		0.33
			(1.16)		(3.27)		(1.23)		(5.82)
Constant	0.872	112.63	108.46	0.01	-0.03	.006	0.01	0.068	-0.17
	(1.93)	(2.94)	(2.74)	(0.16)	(0.36)	(0.11)	(0.11)	(0.36)	(0.91)
Mean of input Use	.86	92.31	92.31	.02	.02	.01	.01	.52	.52
F- Statistics									
HH Dummies	1.26 [0.06]	2.00[0.00]	1.99 [0.00]	1.72[0.00]	1.76 [0.00]	1.55[0.00]	1.50 [0.00]	9.63[0.00]	10.41[0.00]
Plot Dummies			1.41 [0.23]		3.01 [0.02]		1.20 [0.31]		10.35[0.00]
R^2	.45	.44	.45	.41	.43	.38	.39	.80	.82
Number of Fields	450	450	450	450	450	450	450	450	450

Table 5f
OLS Fixed Effects Estimates of Non-Labor Input Intensities
1990–Sorghum and Millet Fields (Household Effects)

	Plot Area (Hectares)	Seed (Kg per Hectare)		Manure (1 if used)		Fertilizer (1 if used)		Fungicide (1 if used)	
	(1)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	-0.50	-0.64	4.51	-0.16	-0.12	0.0	0.01	-0.03	-0.00
	(3.75)	(0.04)	(0.25)	(3.48)	(2.43)	(0.0)	(0.59)	(0.85)	(0.10)
2nd quintile			17.08		0.03		.00		0.06
			(0.98)		(0.70)		(0.31)		(1.65)
3rd quintile			34.97		0.09		0.03		0.04
			(1.77)		(1.71)		(1.87)		(1.03)
4th quintile			18.08		0.11		0.01		0.09
			(0.95)		(2.13)		(0.94)		(2.27)
5th quintile			19.06		0.10		0.02		0.11
			(0.97)		(1.92)		(1.57)		(2.64)
Constant	0.70	10.0	-16.52	0.0	-0.10	0.0	-0.02	0.0	-0.07
	(1.40)	(0.16)	(0.25)	(0.0)	(0.56)	(0.0)	(0.41)	(0.0)	(0.48)
Mean of input Use	.86	12.56	12.56	.09	.09	.01	.01	.19	.19
F- Statistics									
HH Dummies	2.37[0.00]	2.29[0.00]	2.27[0.00]	2.03[0.00]	2.03[0.00]	2.22[0.00]	2.23[0.00]	12.09[0.0]	12.26[0.0]
Plot Dummies			0.79[0.53]		1.63[0.17]		1.42[0.23]		2.11[0.08]
R^2	.53	.50	.50	.47	.48	.49	.50	.84	.85
Number of Fields	464	464	464	464	464	464	464	464	464

high, nor is the fungicide estimate significantly different from zero. The estimates show a slight increase in the number of women using fertilizer but this is not significant.

Resource Allocation and Plot Size Effects

If it is the case that women are systematically allocated plots that are inferior relative to those cultivated by men, then differences in the allocation of resources based on gender of the plot manager could be justified. Comparing the 'gender-effect' across different yield specifications may provide some evidence that systematic differences in plot quality by gender does occur. Unfortunately, the scope of this survey did not cover issues related to soil productivity. Therefore, the only information available in this data related to plot characteristics is size.

The first columns appearing in each of the crop specifications in Tables 2a and 2b exclude the plot size quintile dummys from the specification. In general, when these dummys are not included the estimate of the absolute value of the gender coefficient becomes smaller. This would suggest that characteristics particular to women's plots have a positive effect on their yields. If women are allocated the same plots over time, then these quintile dummys may also be capturing information about soil characteristics.

Similarly, column (1) in each of the input demand specifications controls for household and crop effects but does not control for plot-size effects. As discussed above, if unobserved plot characteristics are correlated with other factor input intensities then the plot quintile dummy is endogenous in the specification. Therefore, the gender coefficients generated from the column (1) specifications should be interpreted as the total gender effect. With the exception of female labor use estimation, the gender differential is reduced when plot dummies are excluded from the specification. The gender coefficient in the column (2) specification is inclusive of plot-size effects. Smaller plots are farmed more intensively and women are allocated systematically smaller plots. Thus, the two specifications provide an upper and lower bound from which to estimate the effects of gender-based resource allocation within households.

The intensive farming of small plots may suggest that relative size distinguishes between communal or personal ownership within a household. Large fields, for example, may be reserved by the household head for the purpose of growing household food crops. Although family members would be expected to contribute some of their labor to these fields, it may be difficult to monitor whether these contributions are actually fulfilled or whether some shirking of labor responsibilities occur. Therefore, it may be more likely that small plots–designated as personal fields–would be farmed more intensively than large plots, particularly with regard to the intensity of labor inputs. However, this trend would not necessarily be sustained in the provision of non-labor inputs, because decisions concerning these factors do not depend upon the coercion of others or other monitoring costs.

Gender and Household Status Differentiation in Input Allocation

One might potentially argue that the real differences in intensity of input use do not stem from gender but from household status. In particular, resource decisions would be based on whether a plot was managed by the household head and whether it was being used to grow some portion of the household's food. The household head controls fields designated either as communal, which are used to grow cereals for consumption by the extended family, or personal. The personal fields would be planted with crops intended to be sold for cash. Thus, it is the communal fields managed by the head that would be receiving a major portion of the agricultural inputs controlled by the family and all other plots–those managed by women or by other males, namely unmarried sons residing in the family compound--would be allocated significantly fewer resources.

Along this line of argument, discrimination in access to resource allocation occurs between household heads and non-heads. However, one should remember that if household members in Senegal operated in a cooperative manner, it wouldn't matter whether a field was being used to grow food or cash crops because either could be converted into cash or food through the market, and the proceeds from all fields would be pooled. Thus, the pareto efficiency condition should still hold.

Tables A1 - C6, located in the appendix, report estimates of yields and labor and non-labor input use while controlling for resources allocated to non-head males living in the same household. All of the specifications reported in these tables incorporate a nonhead dummy allowing for comparison of resource use allocation between female- cultivated plots and between those cultivated by male heads, and for comparison between plots managed by male non-heads and those managed by male heads in the same household. Thus, we interpret the gender coefficient in this specification as the differential in resource use per hectare between female cultivators and male *head* cultivators, and the nonhead coefficient as the differential in resource use per hectare between male non-head cultivators and male cultivators. In contrast, the exclusion of the non-head dummy in the tables presented above allows us simply to focus on the differential in resource allocation outcomes occurring between males and females.

Tables A1 and A2 report estimates of yield per hectare for the entire sample and selected commodities for 1989 and 1990, respectively. The gender differential throughout these specifications is larger in magnitude compared to similar specifications without the nonhead dummies (see tables 2a and 2b). These coefficients should be interpreted as the differential in yields per hectare between plots managed by females and those managed by male household heads. The nonhead dummies pick up the differential in yields per hectare between plots managed by male nonheads of the household and by male heads. Thus, productivity within the household is influenced by demographic variables.

Table B1 reports estimates based on 1989 labor input intensities for all of the combined fields. Women provide slightly more of their labor to male head plots than to those managed by male non-head cultivators. Comparing all of the other types of labor allocations (male, child, and animal traction) between the Column (2) specifications presented above and Column (2) specifications in the appendix, the disparity in resource access widens and becomes even more pernicious for female plot managers. The non-head coefficient indicates that differentiation in resource use exists between the plots controlled by male heads and male non-heads. On average, male non-head cultivators allocate 36.1% less male labor per hectare to their own plots and receive less female labor (-9.42%) per hectare, less child labor (-31.7%) per hectare, and less animal traction (-39.2%) per hectare.

Resource allocation of labor on millet and sorghum fields in 1989 exhibits the same patterns found above. Table B2 reports these estimates. On average, women allocated more of their own labor to plots managed by male heads than to the entire group of males, but they still reserved more of their labor for their own plots. Male non-heads received 64.0% less female labor per hectare on their own plots. More tellingly, male non-heads allocated 82.8% less male labor per hectare to their own plots than to those managed by other males in the household. On average, non-head male cultivators also received significantly less child labor

(-108.2%) and significantly less animal traction (-90.7%) per hectare. Comparing the Column 2 specifications for each type of labor reinforces the notion that women are allocated less labor input hours per hectare compared to all men in the household, and the differentiation only increases when restricting the comparison between female plots and male head plots.

Table B3 reports estimates of labor input use for peanut fields in 1989. The pattern of resource use disparity was similar for women while it was diminished for non-head male cultivators. These results may provide the most striking evidence that male and female conjugal units do not allocate resources efficiently. Restricting the sample to only monocropped peanut fields allows us to compare resource allocation across cash-crop fields which implicitly means personal fields. Women reserve more of their own labor for their own fields, but the differential decreases when the comparison is made between plots cultivated by male heads and those cultivated by females in the same household. The other types of labor were applied significantly less intensively to female plots when compared to all males or restricted to male-head plots, but the differential is reduced when compared to the plots of all males in the same household.

The dichotomous pattern of male-female and head-nonhead household labor allocation is maintained in 1990. Table C1 reporting results from all of the fields included in the 1990 sample shows that females allocate more of their own labor to their own plots than to those cultivated by household males, but the gap narrows when the comparison is restricted to plots of the household head. In contrast, females cultivate less intensively with every other type of labor than males in the same household. The estimates become even more significant when the nonhead dummy is incorporated into the regression, thereby restricting the comparison of resource use to between females and male heads of the household. On average, male non-head cultivators also used less male labor, child labor, and animal traction per hectare than the male heads, but the differential is smaller than what is found for women. Similar trends of labor use are depicted in Table C2 in which the estimates are restricted to fields planted with millet or sorghum.

Table C3 reports estimates of labor input intensities for peanut fields in 1990. These results diverge from the typified pattern. On average, women farm with less male labor per hectare but there is little differentiation in use of child or animal traction labor. The non-head dummy is insignificant in all of these estimations which means that no differentiation in labor use occurred between male non-heads and heads in the same household.

Estimates of non-labor inputs utilized on all of the fields in 1989 are reported in Table B4. Both female and non-head cultivators in the same household farm significantly smaller plots than compared to those of the household head. Women use substantially less seed per hectare than all other males in the household with little distinction between non-head males and heads. The differentiation in seeding intensity occurring between head and nonhead plots is insignificant. On average, the frequency of manure and fertilizer use on all household plots is low and any differentiation in use by household member is insignificant. Although 20% of the plots report some use of fungicide, male non-heads and females in the same household use substantially less than male heads.

Table B5 reports estimates of non-labor inputs for millet and sorghum fields in 1989. On average, both women and non-head males farm significantly smaller plots than the household head. Plot-size differentiation across these groups may not be surprising as most of the millet and sorghum fields managed by the household head would be intended to produce most of the cereals consumed by the family throughout the year. With the exception of fertilizer, all other inputs are used less intensively by females and non-head males than heads in the same household.

Non-labor input use on peanut fields in 1989 is reported in Table B6. Plot-size and seeding density per hectare are significantly different for female cultivators than for others in the same household. With the exception of land allocation, little differentiation in the intensity of farming occurs between non-head males and household heads. The application of fertilizer on peanut fields in 1989 was almost nonexistent. Thus, estimates could not be generated for this input.

As we might expect, fields generally considered to produce the household's primary staple (millet and sorghum fields managed by the household head) receive relatively more agricultural inputs than those designated as personal. This assumption is supported by the finding that both male non-head and female cultivators farm millet and sorghum plots less intensively than male heads in the same household. However, discrimination in access to resources occurs for plot managers of peanut fields–but only for female plot managers. This finding is not only counter-intuitive, but it reinforces the general finding of the data that households do not allocate agricultural resources efficiently and therefore can not be generalized as cooperative units.

The strong relationships found between plot size allocation and household characteristics in 1989 remain consistent throughout the 1990 specifications. However, many of the other relationships between non-labor resource allocation and plot manager characteristic are generally weak, primarily because utilization of these is inputs is low. Table C4 reports non-labor input intensities estimated for all fields in 1990 with household and crop effects. Females and male non-heads employ less manure (although overall use is low) and less fungicide than male heads. The differentiation associated with use of seed or with fertilizer is not significant.

Non-labor input intensities for fields mono-cropped with either millet or sorghum are provided in Table C5. Land area is the only input for which critical differences in allocation by gender or status of plot manager occur. Females and non-head males employ less manure and non-head males employ less fungicide per hectare than male heads in the same household, but overall use is marginal.

Table C6 reports estimates of non-labor input use on peanut fields in 1990. With respect to land area, both female and non-head males cultivate significantly smaller parcels of land than male heads in the same household. Interestingly, females and non-head males seeded their plots more intensively than household heads but neither of the point estimates were significant.

How Serious is the Misallocation of Resources?

It has been demonstrated that the manner in which households allocate productive resources across individually managed plots is inefficient, thereby resulting in a loss of potential output. But how serious is this loss and what can be done to remedy the problem? Without the existence of well-functioning labor and land markets, one might expect that yields generated by a household will vary according to its capacity to manage resources, respond to risk and operate in a cash environment where credit is almost nonexistent. Such an environment could lead to far greater variability and loss in production than what may be associated with intra-household inefficiencies. Therefore, it's important to evaluate the relative efficiency losses occurring within households and within villages.

A simple test can facilitate the comparison of yield variations resulting from differences across households to those from within the household. Household dummies capture the average dispersion in yields occurring across households. Such variation can be attributed to the differentiated set of land, labor, capital, and finance entitlements acquired by a household and its capacity for modifying this set through participation in existing markets. Climate will condition both the household's endowments and the responsiveness of markets.

In the following table I present descriptive statistics of the household coefficient matrix. By computing the interquartile range of these coefficients, I can compare the relative variation in yields accruing across households to the gender-based variation within households.

Table 6

Household Dispersion in Yields

	1989	1990
25th Percentile	-4843.06	-20516.80
50th Percentile	6144.51	-11014.86
75th Percentile	21165.87	6942.39
Inter-quartile Range	26008.93	27459.19

In 1989, the variation in yields across households is 26,008.9 cfa per hectare, almost three times the yield variation occurring between men's and women's plots. In 1990, the dispersion is further accentuated. Household variation in yields is about four times the yield variation occurring between men and women within the same household. Not surprisingly, the gender-based variation is small–but not insignificant-- in comparison to the interhousehold variation. Fluctuations in weather combined with substantial variations in Senegal's agroclimatic landscape drive much of the variability in yields across villages and across seasons.

Following along the dimensions that Udry used to measure the relative importance of household and village production losses, I re-estimate the output supply equation to determine the extent to which actual plot yields deviate from predicted yields if factors are allocated efficiently across individuals within a household, and if factors are allocated efficiently across households within each village. Gender is dropped from each of the following specifications because the objective is to explore for all possible sources of factor misallocation. Accordingly, although yield outcomes are sensitive to plot size, I do not control for any plot-size effects because land area is strongly correlated with the gender of the plot manager.

The specification is intended to measure the relative severity of factor misuse. First, assuming that individuals make rational and efficient decisions about resource allocation across the various plots under their control, I compare the deviation from predicted yields occurring under individual control to those at the household and village.[25] Theoretically, any deviation experienced by individuals should be attributed to variances in plot-level characteristics and would sum to zero if there was no unobserved plot characteristics. Thus, the error term of this equation, $\epsilon_{hc}(j)$, should contain yield variation resulting only from plot-specific risk or idiosyncratic plot effects–and not from factors related to factor misallocation.

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Plots are identified with a code based on the manager's relationship to the household head such as first wife, mother, or head of the compound. In most cases, these codes will serve to identify uniquely across plots managed within a household. However, if more than one unmarred son resides in the household and more than one of them manages a plot, then these managers will not be identified uniquely.

Second, the same equation is estimated with crop and household effects. The error term in this specification, ϵ_{hc} (h), comprises variation resulting from plot-level sources and from inefficiencies in factor allocations across household members.

The third specification is estimated with village and crop effects. The sources of variation captured in this error term, ϵ_{hc} (v), include inefficiencies in factor allocation occurring across plots controlled by different households within a village, as well as the sources identified above in the first and second specification.

Figures 1 and 2 report the results of a separate kernel density function estimate for each of these error terms by year. The functions are graphed on the same scale so that the dispersion can be compared visually.[26]

Inspecting the distributions of the error terms corresponding to the individual-crop effect and to the household-crop effect in 1989, it is apparent that the latter is more diffuse. This implies that there is more dispersion in yields occurring across plots managed by different people within the same household than there is in yields occurring across different plots but under the management of the same individual within the household. This notion is reinforced statistically. I test the hypothesis that the individual-crop effect, (ν_j), included in the first specification is equal to the household-crop effect, (ν_h), in the second specification. The test statistic for this comparison of regressors is distributed as F(400, 999)= 1.5 and has a p-value=0.0.

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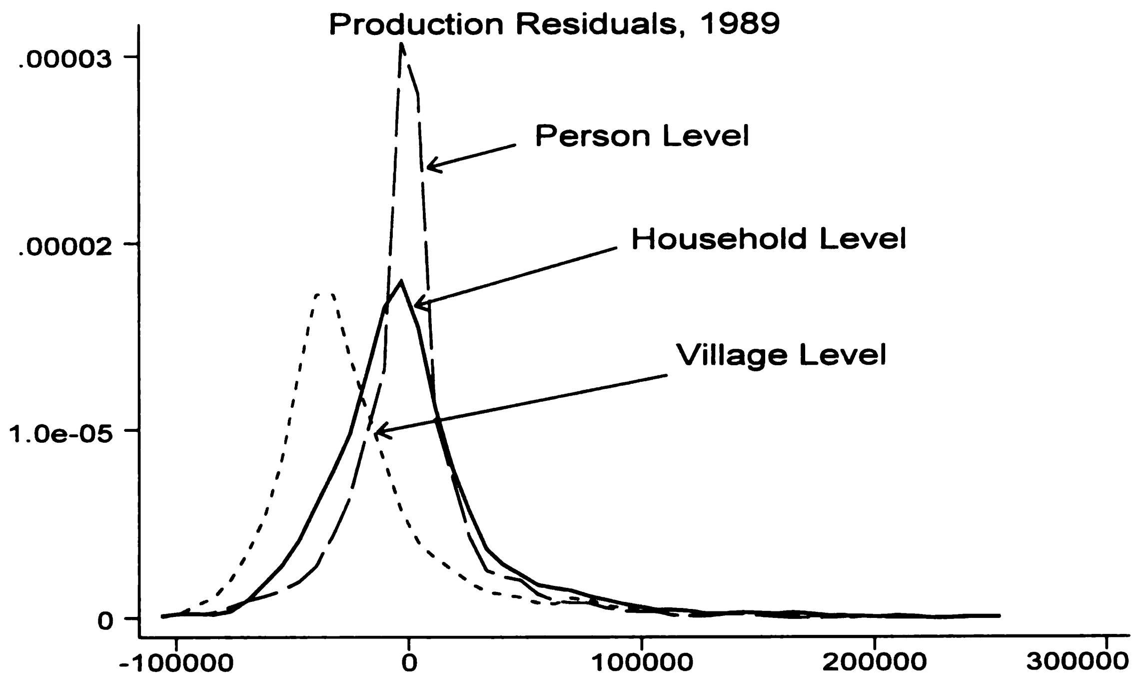
The kernel density uses the locus of points located around each point in the distribution to estimate a separate density for every x along the x-axis. The points used in each estimation are known as a band width and their weight in the function is based on their closeness to the particular x being estimated. These band widths are similar to the bins depicted in the histogram but minimize the potential bias that results from a static representation of data. For further discussion, see Deaton (1997) pp 170-179.

It is more difficult to compare the error distributions of the household-crop effect and the village-crop effect because of the skewness in the latter, but the test statistic allows us to reject the hypothesis that the household (v_h) and village (v_v) effects are similar for all households residing within a particular village. The test statistic is distributed as F(180, 1399)=1.7 and has a p-value=0.0. Thus, less dispersion occurs in yields within the same household than occurs in yields across different households within the same village.

These tests reinforce the notion that household allocation of productive resources across plots are inefficient and the magnitude of the distortion is significant even when compared to the potential misalignment of productive factors at the village level. Although the underlying inefficiency caused by the dimension of gender in factor allocation is costly in terms of the potential output that is not realized, other forces may be at work. The statistical comparison within and across households considers all possible sources of factor misallocation and thus is more general than the one used to determine whether inefficiencies exist on the basis of gender.

Figure 2 compares results of yield dispersions from predicted yields across different plots managed by individuals within a particular household, across different individuals within a particular household, and across different households in 1990. From the figure it appears that the error term of the household level distribution is more diffuse than the one corresponding to the distribution of the individual-crop effect residual. However, based on the test we cannot reject the hypothesis that these two distributions are similar. Therefore, there is little difference between the dispersion of yields across plots controlled by an individual and across plots controlled by different individuals within household.



Production Residuals, 1989
Person Level
Household Level
Village Level
.00003
.00002
1.0e-05
0
-100000
0
100000
200000
300000

Figure 1

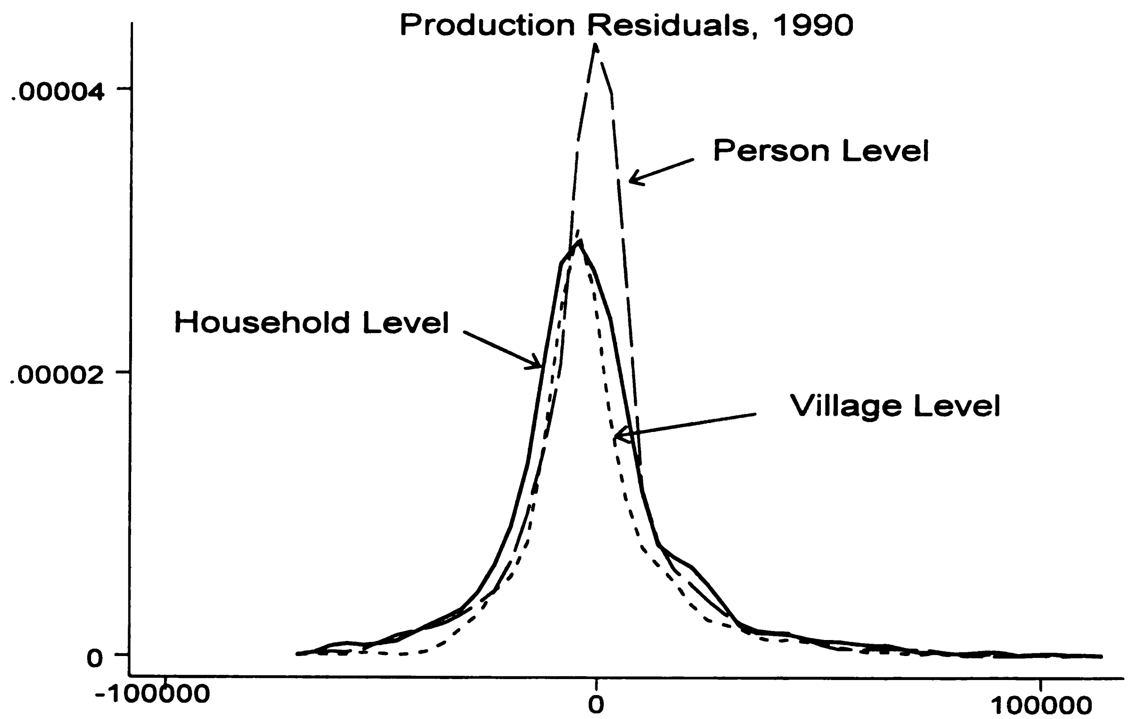

Production Residuals, 1990
.00004
.00002
0
-100000
0
100000
Person Level
Household Level
Village Level

Figure 2

In contrast to 1989, the greatest variability in yields occurs across different households. The results depicted in figure 2 suggest that yields are more diffuse within households, but statistically the hypothesis that similarity exists between the household-crop effect and village-crop effect for every house in a particular village is rejected. The test statistic is distributed as F(138, 1044)=2.4 and has a p-value=(0.0). Therefore, more dispersion occurs in yields across households than across plots within the same household. Factor misallocation across households may be attributed partially to the nonexistence of village factor markets or to an environment in which these markets do not function well. While more problematic for obtaining optimal yield outcomes than household inefficiencies, it does not diminish the significance of the results presented above that productive resources within the household are allocated based on the gender of the plot manager. As was noted, this test examines all possible sources of inefficiencies and should be considered less powerful when compared to the more specific finding of gender-based inefficiencies.

IMPLICATIONS

Kelley (et al, 1996) concluded that household yields in Senegal are differentiated by the household's access to and use of better soils in which to plant crops, household labor (both human and animal), and cash to purchase more and better inputs. The results presented here have demonstrated empirically that the differentiation in access to agricultural inputs is further transmitted to individuals within households. Resource decisions within the household are being made on the basis of gender. Although one might argue that in an environment where resource constraints are particularly critical and some field managers within a household are allocated inferior land and less inputs per hectare because there isn't enough to accommodate all household needs, should these decisions be made *systematically* on the basis of gender?

Evidence suggests that a systematic allocation of plots on the basis of gender would be inefficient. Both male and female cultivators apply exceedingly low quantities of fertilizer and manure on their fields. Thus, to compensate for the deleterious effects of soil nutrient depletion these households should be practicing crop rotation and fallow agricultural techniques that replenish the nutrient content of the soil. Crop rotation can improve soil structure, enhance permeability, and increase biological activity, water and nutrient storage capacity, and the amount of organic matter (Gebremedhim and Schwab, 1998). In Senegal, the planting of peanuts, which are nitrogen-producing, should occur on land formerly under cereal production. Millet and sorghum are nitrogen-absorbing crops.

Female cultivators farming peanuts should be allocated different parcels of land across time to spread the benefits associated with the production of nitrogen in household land. If, for example, we find that women, on average, are allocated the relatively inferior household plots within a given year, then we should expect to find women being allocated relatively better household land during the following year. In a system of cereal-peanut crop rotation practiced by households, it is conceivable that land reserved by the household head for communal cereal production in a given year could be reallocated in subsequent years to peanut cultivation. Therefore, in an efficient setting, we would expect the assignment of land to be based on the particular crop grown. In a household where the availability of good soil is limited, the household head should be rotating crop production to achieve maximum yield. The gender of the plot manager should not factor into the land allocation decision.

Other inputs could be heterogeneous. Another omission that is suggestive of this data is managerial ability. It is possible that women are inferior plot managers compared to men.

If this scenario were true, gender-based differences in yields could result from technical inefficiency. I suggested above that the limited use of animal traction on women's fields could delay the timing of input applications or other events that negatively affect yield outcomes on women's plots. If household heads were aware of the differences in ability existing between female and male cultivators within the household, they could allocate resources on the basis of this difference. In contrast to a gender-based allocation scheme, resource differences that occur because of heterogeneous ability could be considered efficient. The household head could be minimizing potential productivity losses by reallocating resources away from inferior plot managers.

If this is so, why would the practice of multiple plot managers be sustained? If women are systematically weak managers, wouldn't it make sense to use their talents elsewhere? Women could serve as a pool of labor for household fields and be remunerated for their services. Men, the superior plot managers, would make better use of women's labor. In exchange women could be compensated for their time. Thus, if significant and systematic differences existed between the genders in plot management activities, the utilization of women as managers would be allocatively inefficient.

The relatively high incidence of polygyny occurring within Senegalese households suggests that the marginal contribution of women's labor is high. Jacoby (1995) disentangles the wealth effects from the shadow price effects associated with the demand for wives in the Ivory Coast. The shadow price of a wife is defined as the marginal value of investment in physical capital foregone to pay for the bride price of an additional wife combined with the cost of retaining that wife, but offset by the marginal productivity of her labor on farm. He finds that, conditional on wealth, men marry more wives when female labor contributes to a larger share of agricultural income. In Senegal, women contribute to the household food supply with the production and market sale of an important cash crop, peanuts.

Women's labor is demanded but labor markets are non-existent. Thus, the family internalizes the absence of this market. The prevalence of polygyny suggests that men vie for women's labor through the marriage market. This bids up the cost, or bride-price, of women and increases inequality among men. The ratio of available women to available men in the marriage market is often cited as a factor that contributes to a woman's relative bargaining power within the household.[27] [28] Thus, some of the negotiation for household resources between men and women may occur as part of a marriage contract. Wealthier household heads bid away women with the promise of access to land, a productive asset that generates a personal stream of income.

Farming a separate parcel of land and selling that output in the market offers women more autonomy then if women were paid for their labor. Money is fungible. Less inclined to contribute to other household expenditures, men may deduct the earnings paid to women for their labor from other promised household transfer payments. In a farming situation, men don't really know what a wife makes from her sales and effort. They would be less able to make these types of deductions.

Men may also benefit from an arrangement in which the responsibility of plot

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McElroy (in Haddad, et al, 1997) refers to these factors as extrahousehold environmental parameters (EEP's), "threat-point shifters" that indirectly affect an individual's share of income within the household through the individual's relative position of power.

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Goldman and Pebley (in Lesthaeghe, 1989) discuss three factors that determine the available sex ratio in marriage: the incidence of polygyny, the average gap in the marriage age between men and women, and the rate at which widows remarry.

management is shared with women and other household males. The household head may use multiple plot managers as a risk management strategy. In exchange for labor provided on communal fields, the household head allocates land to household members for their own production. But he passes the associated costs of agricultural risk on to them as well. In the event of a bad harvest season, plot managers absorb the losses from low yields. However, if these individuals were compensated for their labor on the household head's fields with wages, they would still expect to be paid. Plot managers bear the costs of risk in a way that paid laborers do not.

CONCLUSION

In a setting in which household members bargain for personal control over resources, the systematic allocation of productive inputs on the basis of gender implicitly determines income distribution within the family and may drive household yields away from its production possibility frontier. Hence, production decisions within the household calculated to influence the relative share of consumption accruing to household members are not separable. Evidence from this research suggests that households are willing to sacrifice potential efficiency so as to be able to alter the internal resource allocation process.

This research has provided evidence that Senegalese households have been unable to achieve allocative efficiency in farm production and provided further empirical support to the findings of Udry (1996) and Jones (1983). The failure to meet this criteria suggests that neither the unitary model nor the more general collective bargaining model sufficiently describe the household resource allocation process in West Africa.

APPENDIX A

Table A1
1989 Plot-level Revenue per Hectare with Household and Crop Effects

	All Crops		Peanut		Millet/Sorghum	
	(1)	(2)	(1)	(2)	(1)	(2)
Gender	-12372.18	-24104.07	-18046.31	-27217.71	-10680.4	-26395.54
	(4.53)	(8.09)	(3.80)	(4.88)	(2.62)	(6.12)
Nonhead	-7479.73	-13776.86	-10605.51	-15264.53	-10826.18	19590.41
(1 if Male Nonhead)	(4.71)	4.71	(2.13)	(2.99)	(2.99)	(5.21)
Plot size:						
2nd quintile		-16876.66		-21397.82		-17982.94
		(5.01)		(3.34)		(3.66)
3rd quintile		-19965.92		-21257.99		-28733.41
		(5.62)		(2.97)		(5.94)
4th quintile		-27943.02		-25351.33		-34434.19
		(7.39)		(3.41)		(6.94)
5th quintile		-37381.41		-32612.74		-43099.3
		(9.14)		(4.08)		(8.23)
Constant	30565.16	74790.58	92799.96	130071.70	12718.07	64581.61
	(1.12)	(2.79)	(2.21)	(3.07)	(0.44)	(2.35)
Mean of Ag						
F- Statistics						
HH Dummies	1.90 [0.00]	1.86 [0.00]	1.84[0.00]	1.87 [0.00]	2.54[0.00]	2.15 [0.00]
Plot Dummies		21.84 [0.00]		4.67 [0.00]		18.07 [0.00]
R^2	.36	.40	.40	.42	.53	.59
Number of Fields	1579	1579	627	627	623	623

Table A2
1990 Plot-level Revenue per Hectare with Household and Crop Effects

	All Crops		Peanut		Millet/Sorghum	
	(1)	(2)	(1)	(2)	(1)	(2)
Gender	-8889.54	-12017.15	-8410.42	-7822.22	-16614.37	-17982.6
	(4.51)	(5.46)	(3.77)	(2.78)	(5.05)	(5.11)
Nonhead	-5927.23	-7432.29	-4015.701	-3491.913	-6769.69	-8593.97
(1if Male Nonhead)	(2.89)	3.52	(1.68)	(1.33)	(2.48)	(3.05)
Plot size:						
2nd quintile		-2443.94		2623.36		5579.98
		(1.02)		(0.87)		(1.74)
3rd quintile		-3293 .01		332.69		7088.81
		(1.17)		(0.09)		(1.94)
4th quintile		-5542.77		1690.82		2186.54
		(2.08)		(0.52)		(0.621)
5th quintile		-9160.8		2735.78		-970.24
		(3.14)		(0.73)		(0.26)
Constant	33287.81	37624.97	15185.84	13413.71	56466.67	51828.99
	(2.90)	(3.22)	(1.34)	(1.13)	(4.77)	(4.26)
Mean of Ag						
F- Statistics						
HH Dummies	5.31 [0.00]	5.33 [0.00]	12.30[0.00]	12.15 [0.00]	2.61[0.00]	2.73 [0.00]
Plot Dummies		15.32 [0.00]		0.32 [0.87]		2.44 [0.05]
R^2	.58	.58	.83	.83	.55	.57
Number of Fields	1178	1178	450	450	464	464

APPENDIX B

Table B1
OLS Fixed Effects of Labor Input Intensities
1989–All Fields (Household and Crop Effects)

	Female Labor per Hectare		Male Labor per Hectare		Child Labor per Hectare		Animal Traction per Hectare	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	89.40	71.49	-68.02	-123.77	-7.47	-41.65	-10.32	-28.59
	(8.84)	(6.37)	(6.08)	(10.30)	(0.74)	(3.74)	(2.46)	(6.28)
Nonhead	1.64	-5.36	-21.67	-49.83		-26.58	-9.50	-18.68
(1 if Male Nonhead)	(0.15)	(0.49)	(1.82)	(4.23)		(2.43)	(2.12)	(4.18)
Plot size:								
2^{nd} quintile		-57.34		-90.04		-79.81		-32.18
		(4.52)		(6.62)		(6.34)		(6.25)
3^{rd} quintile		-74.53		-121.80		-93.45		-44.44
		(5.57)		(8.50)		(7.04)		(8.19)
4^{th} quintile		-80.70		-150.58		-103.77		-49.84
		(5.67)		(9.88)		(7.35)		(8.64)
5^{th} quintile		-65.58		-179.35		-123.11		-60.97
		(4.26)		(10.87)		(8.06)		(9.76)
Constant	4.59	77.90	105.84	316.75	63.96	206.13	69.24	140.53
	(0.05)	(0.77)	(0.95)	(2.92)	(0.63)	(2.05)	(1.65)	(3.42)
Mean of labor hrs	56.9	56.9	138.1	138.1	84.2	84.2	47.6	47.6
F- Statistics								
HH Dummies	2.07[0.00]	2.12[0.00]	2.25[0.00]	2.22[0.00]	2.58[0.00]	2.62[0.00]	2.29[0.00]	2.36[0.00]
Plot Dummies		10.0[0.00]		33.3[0.00]		19.27[0.00]		26.97[0.0]
R^2	.32	.34	.28	.35	.28	.32	.27	.32
Number of Fields	1579	1579	1579	1579	1579	1579	1579	1579

Table B2
OLS Fixed Effects Estimates of Labor Input Intensities
1989–Millet and Sorghum Fields (Household Effects)

	Female Labor per Hectare		Male Labor per Hectare		Child Labor per Hectare		Animal Traction per Hectare	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	60.93	44.01	-62.21	-153.57	-25.47	-87.67	-25.42	-54.95
	(5.46)	(3.52)	(2.54)	(5.97)	(1.43)	(4.67)	(2.71)	(5.44)
Nonhead (1 if Male Nonhead)	-15.91 (1.56)	-23.05 (2.12)	-66.88 (2.98)	-113.05 (5.04)	-53.67 (3.30)	-84.69 (5.17)	-28.49 (3.32)	-43.71 (4.97)
Plot size:								
2^{nd} quintile		-37.53		-145.51		-109.71		-43.50
		(2.64)		(4.97)		(5.13)		(3.79)
3^{rd} quintile		-48.65		-198.65		-138.89		-65.66
		(3.47)		(6.89)		(6.60)		(5.80)
4^{th} quintile		-50.06		-228.77		-157.84		-71.16
		(3.48)		(7.72)		(7.30)		(6.12)
5^{th} quintile		-55.46		-267.27		-187.02		-87.18
		(3.66)		(8.56)		(8.20)		(7.11)
Constant	15.91	78.51	123.63	437.07	87.73	305.76	62.54	164.95
	(0.20)	(0.99)	(0.72)	(2.67)	(0.70)	(2.56)	(0.95)	(2.57)
Mean of labor hrs	36.0	36.0	136.5	136.5	78.3	78.3	48.2	48.2
F- Statistics								
HH Dummies	1.80[0.00]	1.72[0.00]	1.65[0.00]	1.68[0.00]	1.50[0.00]	1.48[0.00]	1.27[0.00]	1.32[0.01]
Plot Dummies		3.94[0.00]		19.65[0.00]		17.82[0.0]		13.54[0.0]
R^2	.47	.49	.42	.51	.39	.47	.36	.43
Number of Fields	623	623	623	623	623	623	623	623

Table B3
OLS Fixed Effects Estimates of Labor Input Intensities
1989–Peanut Fields (Household Effects)

	Female Labor per Hectare		Male Labor per Hectare		Child Labor per Hectare		Animal Traction per Hectare	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	58.16	43.59	-79.33	-116.76	-26.44	-63.41	-10.04	-23.86
	(5.94)	(3.77)	(4.99)	(6.94)	(1.44)	(2.95)	(2.17)	(4.43)
Plot size:								
2nd quintile		-28.75		-40.03		-87.44		-10.77
		(2.16)		(2.07)		(3.54)		(1.74)
3rd quintile		-40.04		-66.29		-92.25		-23.05
		(2.70)		(3.07)		(3.35)		(3.33)
4th quintile		-46.70		-97.29		-108.00		-27.40
		(3.03)		(4.34)		(3.77)		(3.81)
5th quintile		-46.94		-118.39		-131.20		-36.05
		(2.83)		(4.91)		(4.26)		(4.66)
Nonhead	-5.11	-11.72	-8.61	-28.54	4.36	-14.12	-3.35	-9.62
(1 if Male Nonhead)	(0.50)	(1.11)	(0.57)	(1.85)	(0.23)	(0.72)	(0.69)	(1.95)
Constant	5.11	58.66	143.53	281.85	88.24	237.90	95.94	138.25
	(0.59)	(0.67)	(1.21)	(2.20)	(0.54)	(1.46)	(2.35)	(3.37)
Mean of labor hrs	48.1	48.1	130.3	130.3	86.0	86.0	46.9	46.9
F- Statistics								
HH Dummies	2.29[0.00]	2.21[0.00]	2.25[0.00]	2.15[0.00]	2.13[0.00]	2.19[0.00]	3.06[0.00]	3.07[0.00]
Plot Dummies		2.70[0.03]		6.97[0.00]		5.22[0.00]		5.42[0.00]
R^2	.51	.52	.47	.50	.43	.45	.52	.55
Number of Fields	627	627	627	627	627	627	627	627

Table B4
OLS Fixed Effects Estimates of Non-Labor Input Intensities
1989–All Fields (Household and Crop Effects)

	Plot	Seed (Kg per Hectare)		Manure (1 if used)		Fertilizer (1 if used)		Fungicide (1 if used)	
	(1)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	-0.11	-2.12	-12.19	-0.04	-0.02	-0.01	0.00	-0.186	-0.10
	(3.43)	(0.87)	(4.57)	(2.79)	(1.05)	(1.75)	(0.01)	(9.29)	(4.58)
Nonhead	-0.11	2.61	-2.61	-.03	-0.02	-.01	-0.00	-0.11	-0.06
(1 if Male Nonhead)	(3.52)	(1.00)	(1.00)	(2.00)	(1.25)	(1.46)	(0.50)	(5.13)	(2.80)
Plot size:									
2nd quintile			-20.26		0.05		0.01		0.04
			(6.71)		(2.69)		(1.45)		(1.76)
3rd quintile			-21.82		0.03		0.01		0.07
			(6.86)		(1.88)		(1.31)		(2.83)
4th quintile			-28.64		0.09		0.02		0.13
			(8.47)		(4.47)		(2.48)		(4.74)
5th quintile			-34.26		0.06		0.03		0.25
			(9.36)		(3.00)		(3.45)		(8.15)
Constant	0.12	-5.78	34.25	-0.06	-0.02	0.02	-0.03	0.115	0.19
	(0.42)	(0.24)	(1.42)	(0.41)	(0.13)	(0.24)	(0.39)	(0.59)	(0.96)
Mean of input Use	.84	46.5	46.5	.05	.05	.01	.01	.19	.19
F- Statistics									
HH Dummies	2.41[0.00]	2.19[0.00]	2.20[0.00]	2.59[0.00]	2.67[0.00]	1.34[0.00]	1.33[0.00]	6.63[0.00]	6.38[0.00]
Plot Dummies			24.56[0.00]		5.44		3.34 [0.01]		19.76[0.00]
R^2	.40	.66	.68	.35	.36	.54	.54	.54	.57
Number of Fields	1579	1579	1579	1579	1579	1579	1579	1579	1579

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Table B5
OLS Fixed Effects Estimates of Non-Labor Input Intensities
1989–Millet and Sorghum (Household Effects)

	Plot	Seed (Kg per Hectare)		Manure (1 if used)		Fertilizer (1 if used)		Fungicide (1 if used)	
	(1)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	–0.89	-0.83	-5.26	-0.15	-0.12	-0.01	-0.01	-0.12	-0.09
	(8.87)	(0.60)	(3.62)	(4.57)	(3.27)	(1.21)	(0.37)	(3.86)	(2.59)
Nonhead	-0.19	-1.7	-3.83	-0.09	-0.08	-0.02	-0.01	-0.15	-0.13
(1 if Male Nonhead)	(8.87)	(1.34)	(3.02)	(2.85)	(2.29)	(1.69)	(1.01)	(5.35)	(4.19)
Plot size:									
2^{nd} quintile			-8.34		0.02		0.00		-0.00
			(5.04)		(0.44)		(0.18)		(0.02)
3^{rd} quintile			-10.99		0.02		0.01		-0.02
			(6.74)		(0.56)		(0.85)		(0.44)
4^{th} quintile			-11.44		0.11		0.01		0.02
			(6.83)		(2.52)		(0.78)		(0.56)
5^{th} quintile			-13.98		0.04		0.02		0.05
			(7.91)		(0.77)		(1.51)		(1.23)
Constant	2.61	7.09	23.21	-0.09	0.04	-0..02	-0.01	0.15	0.08
	(3.70)	(0.74)	(2.51)	(0.37)	(0.17)	(0.22)	(0.15)	(0.70)	(0.34)
Mean of input Use	1.04	5.6	5.6	.07	.07	.01	.01	.12	.12
F- Statistics									
HH Dummies	2.05[0.00]	1.52[0.00]	1.54[0.00]	1.90[0.00]	1.89[0.00]	3.34[0.00]	3.30[0.00]	4.99[0.00]	4.88 [0.00]
Plot Dummies			16.74[0.00		2.67[0.03]		0.77[0.55]		1.12[0.35]
R^2	.51	.38	.47	.44	.45	.58	.58	.68	.69
Number of Fields	623	623	623	623	623	623	623	623	623

Table B6
OLS Fixed Effects Estimates of Non-Labor Input Intensities
1989–Peanut Fields (Household Effects)

	Plot Area (Hectares)	Seed (Kg per Hectare)		Manure (1 if used)		Fungicide (1 if used)	
	(1)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	-0.88	-6.55	-28.32	-0.01	-0.01	-0.25	-0.03
	(11.84)	(1.21)	(4.68)	(0.73)	(0.68)	(6.50)	(0.72)
Nonhead	-0.49	3.43	-7.33	-0.16	-0.02	-0.13	-0.03
(1 if Male Nonhead)	(6.30)	(0.61)	(1.32)	(1.6)	(1.59)	(3.3)	(0.85)
Plot size:							
2nd quintile			-38.04		0.01		0.16
			(5.47)		(0.66)		(3.26)
3rd quintile			-44.65		0.01		0.26
			(5.76)		(1.00)		(4.94)
4th quintile			-51.28		0.01		0.40
			(6.36)		(0.83)		(7.10)
5th quintile			-70.02		0.00		0.57
			(8.07)		(0.12)		(9.57)
Constant	2.38	70.64	151.42	-0.01	0.02	1.13	0.46
	(3.63)	(148)	(3.29)	(0.10)	(0.17)	(3.33)	(1.45)
Mean of Input Use	.82	92.2	92.2	.01	.01	.34	.34
F- Statistics							
HH Dummies	1.46[0.00]	1.84[0.00]	1.85[0.00]	1.60[0.00]	1.60[0.00]	4.51[0.00]	4.66[0.00]
Plot Dummies			16.91[0.00]		0.44[0.78]		25.45[0.00]
R^2	.45	.39	.47	.36	.36	.63	.69
Number of Fields	627	627	627	627	627	627	627

APPENDIX C

Table C1
OLS Fixed Effects Estimates of Labor Input Intensities
1990–All Fields (Household and Crop Effects)

	Female Labor per Hectare		Male Labor per Hectare		Child Labor per Hectare		Animal Traction per Hectare	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	39.68	32.87	-36.68	-53.02	-11.84	-21.95	-7.10	-14.44
	(10.10)	(7.55)	(5.18)	(6.80)	(2.15)	(3.59)	(2.37)	(4.38)
Nonhead (1 if Male Nonhead)	-2.37	-4.03	-23.01	-29.49	-11.62	-15.87	-8.8	-11.37
	(0.58)	(0.96)	(3.13)	(3.94)	(2.03)	(2.70)	(2.84)	(3.59)
Plot size:								
2^{nd} quintile		-17.79		-39.27		-19.59		-14.47
		(3.76)		(4.64)		(2.94)		(4.04)
3^{rd} quintile		-21.89		-36.17		-19.22		-15.74
		(3.94)		(3.64)		(2.46)		(3.74)
4^{th} quintile		-21.83		-43.66		-24.40		-19.86
		(4.13)		(4.61)		(3.28)		(4.96)
5^{th} quintile		-25.79		-63.72		-36.63		-25.64
		(4.47)		(6.17)		(4.51)		(5.87)
Constant	51.83	74.29	83.79	126.66	145.68	237.90	43.16	61.33
	(2.27)	(3.21)	(2.03)	(3.06)	(4.54)	(1.46)	(2.48)	(3.50)
Mean of labor hrs	27.6	27.6	104.6	104.6	65.3	65.3	42.7	42.7
F- Statistics								
HH Dummies	7.09[0.00]	7.11[0.00]	4.12[0.00]	3.89[0.00]	7.18[0.00]	6.88[0.00]	3.67[0.00]	3.45[0.00]
Plot Dummies		6.09[0.00]		10.13[0.0]		5.25[0.00]		9.27[0.00]
R^2	.58	.59	.46	.48	.54	.55	.39	.41
Number of Fields	1178	1178	1178	1178	1178	1178	1178	1178

Table C2
OLS Fixed Effects Estimates of Labor Input Intensities
1990–Millet and Sorghum Fields (Household Effects)

	Female Labor per Hectare		Male Labor per Hectare		Child Labor per Hectare		Animal Traction per Hectare	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	13.05	12.73	-45.35	-66.56	-32.63	-39.83	-15.67	-27.07
	(1.85)	(1.67)	(2.57)	(3.58)	(2.30)	(2.62)	(2.01)	(3.32)
Nonhead	-10.75	-12.81	-28.83	-42.96	-30.06	-37.59	-12.95	-19.26
(1 if Male Nonhead)	(1.83)	(2.10)	(1.97)	(2.89)	(2.56)	(3.09)	(2.00)	(2.94)
Plot size:								
2nd quintile		-5.41		-52.86		-23.99		-24.94
		(0.78)		(3.12)		(1.73)		(3.35)
3rd quintile		5.99		-31.99		-1.91		-23.42
		(0.76)		(1.66)		(0.12)		(2.76)
4th quintile		-1.88		-64.58		-22.01		-32.63
		(0.25)		(3.47)		(1.45)		(3.99)
5th quintile		-6.92		-80.76		-36.05		-40.44
		(0.87)		(4.15)		(2.27)		(4.73)
Constant	109.57	110.45	100.21	148.49	219.58	231.54	57.50	85.52
	(4.13)	(4.19)	(1.58)	(2.31)	(4.30)	(4.41)	(2.05)	(3.03)
Mean of labor hrs	20.7	20.7	105.2	105.2	69.6	69.6	44.3	44.3
F- Statistics								
HH Dummies	3.22[0.00]	3.13[0.00]	3.07[0.00]	2.80[0.00]	2.58[0.00]	2.46[0.00]	1.73[0.00]	1.63[0.00]
Plot Dummies		1.06[0.38]		5.15[0.00]		2.16[0.07]		5.90[0.00]
R^2	.59	.60	.58	.60	.53	.55	.43	.47
Number of Fields	464	464	464	464	464	464	464	464

Table C3
OLS Fixed Effects Estimates of Labor Input Intensities
1990–Peanut Fields (Household Effects)

	Female Labor per Hectare		Male Labor per Hectare		Child Labor per Hectare		Animal Traction per Hectare	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	40.879	31.830	-17.704	-14.716	2.852	0.811	-0.935	-1.295
	(8.72)	(5.49)	(3.13)	(2.06)	(0.44)	(0.10)	(0.41)	(0.45)
Nonhead	1.77	-0.887	-8.93	-7.378	-1.299	-1.922	-2.560	-2.761
(1 if Male Nonhead)	(0.35)	(0.16)	(1.48)	(1.11)	(0.19)	(0.25)	(1.04)	(1.02)
Plot size:								
2nd quintile		-0.604		-6.342		-9.327		-4.365
		(0.10)		(0.83)		(1.06)		(1.40)
3rd quintile		-10.400		-5.307		-6.228		-2.366
		(1.38)		(0.58)		(0.59)		(0.63)
4th quintile		-19.453		0.323		-10.574		-3.236
		(2.88)		(0.04)		(1.11)		(0.96)
5th quintile		-15.776		0.896		-9.367		-3.441
		(2.04)		(0.09)		(0.86)		(0.89)
Constant	-20.440	-10.413	58.817	63.148	62.324	237.904	26.664	30.210
	(8.72)	(0.43)	(2.04)	(2.10)	(1.88)	(1.46)	(2.28)	(2.47)
Mean of labor hrs	24.9	24.9	82.2	82.2	61.8	61.8	27.4	27.4
F- Statistics								
HH Dummies	2.21[0.00]	2.11[0.00]	4.71[0.00]	4.49[0.00]	4.02[0.00]	3.72[0.00]	7.24[0.00]	3.15[0.00]
Plot Dummies		3.29[0.01]		0.39[0.82]		0.39[0.82]		0.35[0.84]
R^2	.60	.61	.66	.66	.61	.62	.59	.59
Number of Fields	450	450	450	450	450	450	450	450

Table C4
OLS Fixed Effects Estimates of Non-Labor Input Intensities
1990–All Fields (Household and Crop Effects)

	Plot Area (Hectares)	Seed (Kg per Hectare)		Manure (1 if used)		Fertilizer (1 if used)		Fungicide (1 if used)	
	(1)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	-0.70	-7.23	-11.79	-0.10	-0.08	-0.00	-0.01	-0.18	-0.13
	(12.98)	(0.58)	(0.84)	(5.64)	(3.86)	(0.14)	(0.59)	(7.70)	(4.85)
Nonhead	-0.43	-4.16	-5.16	-0.08	-0.08	-.01	-0.01	-0.08	-0.07
(1 if Male Nonhead)	(7.67)	(0.32)	(0.38)	(4.30)	(3.98)	(1.44)	(0.94)	(3.39)	(2.85)
Plot size:									
2nd quintile			-9.50		0.05		0.01		0.06
			(0.62)		(2.43)		(1.29)		(2.04)
3rd quintile			-12.73		0.08		0.02		0.10
			(0.71)		(3.36)		(1.31)		(3.04)
4th quintile			-14.63		0.08		0.01		0.17
			(0.86)		(3.32)		(1.07)		(5.32)
5th quintile			-15.18		0.08		0.03		0.14
			(0.81)		(3.03)		(2.35)		(4.00)
Constant	0.81	8.36	21.77	-0.04	-0.04	-0.00	-0.02	-0.12	-0.24
	(2.56)	(0.12)	(0.29)	(0.36)	(0.41)	(0.02)	(0.34)	(0.88)	(1.72)
Mean of input use	.84	57.3	57.3	.06	.06	.08	.08	.28	.28
F- Statistics									
HH Dummies	2.45[0.00]	2.26[0.00]	2.16[0.00]	1.95[0.00]	1.89[0.00]	1.79[0.00]	1.75[0.00]	10.17[0.00]	10.22[0.0]
Plot Dummies			0.22[0.93]		3.59[0.00]		1.48[0.21]		8.00[0.00]
R^2	.42	.32	.33	.30	.30	.91	.91	.67	.68
Number of Fields	1178	1178	1178	1178	1178	1178	1178	1178	1178

Table C5
OLS Fixed Effects Estimates of Non-Labor Input Intensities
1990–Sorghum and Millet Fields (Household Effects)

	Plot Area (Hectares)	Seed (Kg per Hectare)		Manure (1 if used)		Fertilizer (1 if used)		Fungicide (1 if used)	
	(1)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	-0.63	-0.78	3.99	-0.19	-0.16	-0.00	0.01	-0.06	-0.04
	(4.66)	(0.04)	(0.21)	(4.08)	(3.07)	(0.25)	(0.32)	(1.81)	(1.12)
Nonhead (1 if Male Nonhead)	0.43	-0.49	-1.37	-0.11	-0.10	-.01	-0.01	-0.12	-0.10
	(3.82)	(0.03)	(0.09)	(2.75)	(2.42)	(1.02)	(0.80)	(3.93)	(3.39)
Plot size:									
2nd quintile			17.06		0.03		0.00		0.06
			(0.98)		(0.68)		(0.30)		(1.64)
3rd quintile			34.98		0.09		0.03		0.04
			(1.77)		(1.73)		(1.87)		(1.06)
4th quintile			17.88		0.10		0.01		0.07
			(0.94)		(1.86)		(0.84)		(1.90)
5th quintile			18.70		0.08		0.02		0.08
			(0.94)		(1.40)		(1.38)		(1.94)
Constant	0.7	-10.00	-16.43	-0.00	-0.09	-0.00	-0.02	0.00	-0.06
	(1.43)	(0.16)	(0.25)	(0.00)	(0.53)	(0.00)	(0.40)	(0.00)	(0.43)
Mean of input use	.86	12.56	12.56	.09	.09	.01	.01	.19	.19
F- Statistics									
HH Dummies	2.56[0.00]	2.28[0.00]	2.25[0.00]	2.05[0.00]	2.05[0.00]	2.22[0.00]	2.23[1.31]	12.81[0.0]	12.72[0.00]
Plot Dummies			0.79[0.53]		1.23[0.30]		1.31 [0.26]		1.18 [0.32]
R^2	.55	.50	.50	.48	.49	.49	.50	.85	.85
Number of Fields	464	464	464	464	464	464	464	464	464

Table C6
OLS Fixed Effects Estimates of Non-Labor Input Intensities
1990–Peanut Fields (Household Effects)

	Plot Area (Hectares)	Seed (Kg per Hectare)		Manure (1 if used)		Fertilizer (1 if used)		Fungicide (1 if used)	
	(1)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Gender	-1.05	2.86	12.83	-0.05	-0.01	-0.01	0.00	-0.163	-0.03
	(12.97)	(0.38)	(1.36)	(2.73)	(0.46)	(1.02)	(0.27)	(4.38)	(0.67)
Nonhead	-0.72	5.11	9.32	-0.04	-0.01	.000	0.01	-0.048	0.01
(1 if Male Nonhead)	(8.32)	(0.634)	(1.06)	(1.82)	(0.65)	(0.07)	(1.03)	(1.22)	(0.15)
Plot size:									
2nd quintile			2.39		0.02		-0.00		0.14
			(0.24)		(0.97)		(0.10)		(2.96)
3rd quintile			-0.07		0.04		-0.01		0.23
			(0.01)		(1.53)		(0.29)		(4.01)
4th quintile			19.84		0.05		-0.00		0.29
			(1.80)		(1.88)		(0.26)		(5.68)
5th quintile			18.02		0.09		0.03		0.33
			(1.43)		(2.90)		(1.50)		(5.57)
Constant	1.08	111.16	105.01	-0.02	-0.03	0.01	0.00	-0.816	-0.17
	(2.63)	(2.90)	(2.64)	(0.27)	(0.31)	(0.10)	(0.03)	(0.43)	(0.91)
Mean of input use	.86	92.31	92.31	.02	.02	.01	.01	.52	.52
F- Statistics									
HH Dummies	1.79[0.00]	1.99[0.00]	1.99[0.00]	1.72[0.00]	1.74[0.00]	1.54[0.00]	1.49[0.00]	9.62[0.00]	10.25[0.00]
Plot Dummies			1.59[0.18]		2.26[0.06]		1.46[0.21]		9.92[0.00]
R^2	.54	.44	.45	.41	.43	.38	.39	.80	.82
Number of Fields	450	450	450	450	450	450	450	450	450

APPENDIX D

Table D1
Chow Tests for Structural Change Across 1989 & 1990

Model Specification		Test Results		
All Fields	F	Numerator Degrees of Freedom	Denominator Degrees of Freedom	P-Value
Ag Revenue				
1) Gender, Year, HH dummies	3.29	159	2388	0.00
2) Gender, Year, Plot & HH dummies	3.36	163	2380	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	3.35	163	2378	0.00
Female Labor				
1) Gender, Year & HH dummies	1.29	159	2388	0.01
2) Gender, Year, Plot & HH dummies	1.40	163	2380	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	1.26	163	2378	0.02
Male Labor				
1) Gender, Year & HH dummies	1.62	159	2388	0.00
2) Gender, Year, Plot & HH dummies	1.79	163	2380	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	1.82	163	2378	0.00
Child Labor				
1) Gender, Year, HH dummies	1.82	163	2378	0.00
2) Gender, Year, Plot & HH dummies	2.25	163	2380	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	2.27	163	2378	0.00
Own Equipment Labor				
1) Gender, Year & HH dummies	1.45	159	2388	0.00
2) Gender, Year, Plot & HH dummies	1.55	163	2380	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	1.61	163	2378	0.00
Fungicide Use				
1) Gender, Year & HH dummies	2.16	159	2388	0.00
2) Gender, Year, Plot & HH dummies	2.29	163	2380	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	2.31	163	2378	0.00

Manure Use				
1) Gender, Year & HH dummies	1.19	159	2388	0.06
2) Gender, Year, Plot & HH dummies	1.16	163	2380	0.09
3) Gender, Year, Nonhead, Plot & HH dummies	1.17	163	2378	0.07
Seed Use				
1) Gender, Year & HH dummies	2.36	159	2388	0.00
2) Gender, Year, Plot & HH dummies	2.27	163	2380	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	2.26	163	2378	0.00
Plot Size				
1) Gender, Year & HH dummies	0.78	163	2380	0.98
2) Gender, Year, Nonhead, Plot & HH dummies	0.87	159	2386	0.87

Table D2
Chow Tests for Structural Change Across 1989 & 1990

Model Specification Millet and Sorghum Fields	F	Numerator Degrees of Freedom	Denominator Degrees of Freedom	P-Value
Ag Revenue				
1) Gender, Year & HH dummies	1.78	133	764	0.00
2) Gender, Year, Plot & HH dummies	1.94	137	746	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	2.06	137	744	0.00
Ag Yield				
1) Gender, Year & HH dummies	1.67	133	764	0.00
2) Gender, Year, Plot & HH dummies	1.83	137	746	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	1.97	137	744	0.00
Female Labor				
1) Gender, Year & HH dummies	1.22	133	764	0.06
2) Gender, Year, Plot & HH dummies	1.25	137	746	0.04
3) Gender, Year, Nonhead, Plot & HH dummies	1.17	137	744	0.11
Male Labor				
1) Gender, Year & HH dummies	1.52	133	764	0.00
2) Gender, Year, Plot & HH dummies	1.61	137	746	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	1.79	137	744	0.00
Child Labor				
1) Gender, Year & HH dummies	1.08	133	764	0.27
2) Gender, Year, Plot & HH dummies	1.20	137	746	0.07
3) Gender, Year, Nonhead, Plot & HH dummies	1.38	137	744	0.00
Own Equipment Labor				
1) Gender, Year & HH dummies	0.98	133	764	0.54
2) Gender, Year, Plot & HH dummies	0.95	137	746	0.64
3) Gender, Year, Nonhead, Plot & HH dummies	1.09	137	744	0.25

Fungicide Use				
1) Gender, Year & HH dummies	1.85	133	764	0.00
2) Gender, Year, Plot & HH dummies	1.86	137	746	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	1.91	137	744	0.00
Manure Use				
1) Gender, Year & HH dummies	0.96	133	764	0.60
2) Gender, Year, Plot & HH dummies	0.97	137	746	0.59
3) Gender, Year, Nonhead, Plot & HH dummies	0.98	137	744	0.54
Seed Use				
1) Gender, Year & HH dummies	2.81	133	764	0.00
2) Gender, Year, Plot & HH dummies	2.72	137	746	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	2.71	137	744	0.00
Plot Size				
1) Gender, Year & HH dummies	1.11	137	746	0.20
2) Gender, Year, Nonhead, Plot & HH dummies	1.26	133	752	0.03

Table D3
Chow Tests for Structural Change Across 1989 & 1990

Model Specification Peanut Fields	Test Results F	Numerator Degrees of Freedom	Denominator Degrees of Freedom	P-Value
Ag Revenue				
1) Gender, Year & HH dummies	2.76	111	785	0.00
2) Gender, Year, Plot & HH dummies	2.82	115	777	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	2.91	115	775	0.00
Ag Yield				
1) Gender, Year & HH dummies	3.53	111	785	0.00
2) Gender, Year, Plot & HH dummies	3.59	115	777	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	3.68	115	775	0.00
Female Labor				
1) Gender, Year, HH dummies	1.67	111	785	0.00
2) Gender, Year, Plot & HH dummies	1.60	115	777	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	1.53	115	775	0.00
Male Labor				
1) Gender, Year, HH dummies	1.76	111	785	0.00
2) Gender, Year, Plot & HH dummies	1.92	115	777	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	1.86	115	775	0.00
Child Labor				
1) Gender, Year, HH dummies	0.58	111	785	1.00
2) Gender, Year, Plot & HH dummies	0.62	115	777	1.00
3) Gender, Year, Nonhead, Plot & HH dummies	0.60	115	775	1.00
Own Equipment Labor				
1) Gender, Year & HH dummies	2.33	111	785	0.00
2) Gender, Year, Plot & HH dummies	2.42	115	777	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	2.44	115	775	0.00

Fungicide Use				
1) Gender, Year & HH dummies	2.44	111	785	0.00
2) Gender, Year, Plot & HH dummies	2.87	115	777	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	2.85	115	775	0.00
Manure Use				
1) Gender, Year & HH dummies	2.61	111	785	0.00
2) Gender, Year, Plot & HH dummies	2.61	115	777	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	2.55	115	775	0.00
Seed Use				
1) Gender, Year & HH dummies	1.35	111	785	0.01
2) Gender, Year, Plot & HH dummies	1.54	115	777	0.00
3) Gender, Year, Nonhead, Plot & HH dummies	1.57	115	775	0.00
Plot Size				
1) Gender, Year & HH dummies	0.67	111	785	1.00
2) Gender, Year, Nonhead, Plot & HH dummies	0.88	111	783	0.80

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