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The Feminization of Agriculture with Chinese Characteristics

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ABSTRACT

The objectives of this paper are to help build a picture of the role of women in China's agriculture, to assess whether or not agricultural feminization has been occurring, and if so, to measure its impact on productivity. To meet these goals, we rely on three datasets that allow us to explore who is working on China's farms and the effects of the labor allocation decisions of rural households on productivity. We find that since 2000, the role of women has increased both in the supply of farm labor and in the duties that women take on in the management of farms. While this expansion is important, we further demonstrate that when women do a majority of farm work or manage the farm, their farms are equally as efficient as farms managed by men.

Keywords: agricultural feminization, labor supply, rural China, rural development

JEL codes: J22, J71

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1. INTRODUCTION

Increasing participation by women in farming has been documented in many countries (IFAD 1999; Ganguly 2003; Deere 2005). This phenomenon raises the question: Does the feminization of agriculture affect (either positively or negatively) agricultural productivity?

The concern is that women may face multiple limitations in their participation, thus also limiting overall agricultural production. For example, when women manage agricultural production, they often have less access to all types of inputs—physical inputs such as fertilizers or improved seeds; high-quality or irrigated land; human capital; or even social and political capital, including social networks (Peterman, Behrman, and Quisumbing 2010). As a result, production on plots controlled by women is often lower than on plots controlled by men, even within households (Udry 1996). Profits are also lower (for example, in the context of Ghana, as described by Goldstein and Udry 2008). These differences can usually—although not always—be explained by understanding either the context or the control of inputs (Quisumbing 1996; Peterman, Behrman, and Quisumbing 2010). Needless to say, if the proportion of land controlled by women or the amount of farm work performed by women is increasing, and if women are less productive than men due to limited access to inputs, overall agricultural production may be in danger of stagnating or even declining, with potential consequences for food security within the country (UNDP 2003).

Beyond concerns about agricultural productivity (and the related issues of domestic food prices and food security), scholars are also concerned about the potential effects that agricultural feminization can have on women's welfare. Women might be forced to work more hours and take on increased responsibilities in addition to traditional roles, which in many cases would be expected to reduce their welfare. Furthermore, the feminization of agricultural labor could have negative effects on women's income, especially since women have less access to resources, such as high-quality land and credit (Katz 2003). If women are denied opportunities to participate in the off-farm sector (where returns to labor are higher) and are relegated to working on the farm without access to modern inputs, the indirect link between effort and income from farm activities may also reduce their status.

For the same reasons discussed in the international literature, agricultural feminization has been an important issue in discussions about China's drive for modernization in recent years. The absence of much empirical literature on the topic means that even basic facts are not clear. There is disagreement about whether or not feminization is even occurring in Chinese farming. On the one hand, several published and unpublished studies of the role of gender in China's agriculture have argued that agricultural feminization began in the 1990s (Song and Jiggins 2000; Song and Zhang 2004). Jacka (1997) quoted county officials in Sichuan as stating that agriculture is being feminized. Rawski and Mead (1998) produced aggregate provincial trends suggesting that women are taking over farm work in China. More recently, Chang, MacPhail, and Dong (2011) and Mu and van de Walle (2011) both showed evidence of greater female participation in farming during the first decade of the 2000s. On the other hand, de Brauw et al. (2008) demonstrated that, while women's participation in China's farming sector was high (measured as a share of the total labor input into farming), during the 1990s there was not a systematic movement of women into farming; in other words, the share of the total labor input into farming by women was nearly unchanged. Differences in timing and approaches in the studies may help explain discrepancies in the findings.

As elsewhere in the world, there also is a debate on the effect of agricultural feminization in China—on the women themselves, on their households, and on the national food supply. One set of scholars has been concerned that when women are left to tend the fields and have poor access to off-farm employment, they earn less than men for their on-farm work and have lower welfare (Song and Jiggins 2000). Alternatively, if overall production stagnates, there could be negative effects on food security. However, given the sustained increase in agricultural yields and total factor productivity during the 1990s and the period 2000–2009 (Jin et al. 2002; Jin et al. 2009), it is difficult to believe that agricultural feminization—if it is happening—could be having a negative effect on productivity in China.

The overall goals of this paper are to contribute to the ongoing discussion on the changing status of women in China's rural labor markets; to understand how the feminization of agriculture may have changed, particularly in the past decade; and to measure whether feminization is influencing agricultural productivity. To be specific, the paper has two primary objectives. First, we seek to answer the question: Is agriculture in China being feminized? Second, we attempt to quantify correlates with feminization—variables that may be associated with causes and effects, if any, that agricultural feminization has on the way farming is carried out, the wealth of female-headed households, and the productivity of women-managed farms.

Before we can study this question, we must define agricultural feminization. In this paper, we define agricultural feminization in two ways. First, the feminisation of agricultural labour is assumed to occur when the proportion of farm work done by women increases on a specific farm. Second, the feminization of farm management occurs when women begin to make decisions about farm production, such as what crops to produce, the amount of inputs to use, and how much produce to sell. The latter concept is more difficult to measure, so here we define managerial feminisation as occurring when the household is headed by a female.

Our ambitious objectives are tempered by several data limitations. First, the findings in the paper are either descriptive or should be interpreted as conditional correlations, rather than as causal. We lack instruments to identify female headship, and clearly there may be unobservable factors associated with female farm management that might also affect grain yields. We are unable to fully control for such unobservable. Second, although we examine many aspects of agricultural feminization in this paper, we cannot address all of them for all parts of China. For example, we do not seek to analyze changes in relative wages between men and women in this paper, in part because we do not have the necessary data. Our analysis of the impact on welfare of households' turning from male-headed households to female-headed households is also limited by the fact that we have data only on one admittedly narrow measure of welfare, household assets. Finally, though the coverage of the data sets we use cover broad parts of China, they are relatively small and this fact must be taken into consideration in interpreting the results.

In spite of these limitations, in this study we draw on multiple datasets to show that agricultural labor has become increasingly feminized, in terms of both the proportion of women who farm and the number of hours that they farm. Controlling for key variables such as location and the nature of the farming resources, female-headed households are equally as efficient as male-headed households in agricultural production. Moreover, after careful analysis of where women-headed households are emerging (there are increasingly more in percentage terms in poor rural areas, areas that have relatively poorer agricultural resources), women appear to have equal access to inputs such as fertilizer and land. Finally, we find that when households switch from male headed to female headed their asset levels do not fall.

2. DATA

We use three data sources for this study. The first dataset was collected in two waves, one in 2000 and the other in 2008. Both waves were collected by the authors in a randomly selected, nearly nationally representative sample of 60 villages in 6 provinces (Hebei, Liaoning, Shaanxi, Zhejiang, Hubei, and Sichuan) of rural China; the first wave was collected in November and December of 2000 (henceforth, the China National Rural Survey–2000, or CNRS-2000), and the second wave was collected in early 2009 to cover 2008 (CNRS-2008). To ensure broad coverage within each province, 1 county was randomly selected from within each income quintile for the provinces in 2000; 2 villages were then randomly selected within each county.

In 2000, a total of 1,199 households in 60 villages were surveyed. The survey form gathered information on household demographics, labor allocation, agricultural production, and nonfarm activities. Several parts of the survey were designed to learn about the household's participation in labor markets over time. Most pertinent to this study, the CNRS-2000 collected detailed information about each household member's on-farm work in the previous twelve months. After asking whether or not he or she worked on farm, each household member was asked about the number of weeks they worked on the farm during busy and slack seasons, the number of days they worked in each season, and the hours spent working on the farm on a typical day in each season. By adding up the number of hours they worked overall in the busy and slack seasons, we can estimate the number of hours each individual in the household worked on the farm.

The CNRS also collected detailed information about each household member's on-farm work in 2000. After asking whether or not the person worked on-farm, the survey then asked each household member about the number of weeks he or she worked on the farm during busy and slack seasons, the number of days worked in each season, and the hours spent working on the farm on a typical day in each season. By adding up the number of hours worked overall in the busy and slack seasons, we can estimate the number of hours each individual in the household worked on the farm.

To collect the CNRS-2008, enumerators returned to 58 of the original 60 villages and attempted to interview all of the households included in the CNRS-2000.[1] When households were no longer living in the village, they were tracked by telephone to their current location. The same module was used to collect information about time spent working on the farm. We use information on the 1,071 households that were still present in the villages for our analysis; a total of 1,160 households were surveyed.

Second, we use the China Health and Nutrition Survey (CHNS) to track agricultural labor trends. The CHNS was conducted by researchers at the University of North Carolina at Chapel Hill and their Chinese collaborators in 1991, 1993, 1997, 2000, 2004, 2006, and 2009.[2] The data we use were collected in more than 2,000 households in rural areas of 7 provinces: Guangxi, Guizhou, Henan, Hubei, Hunan, Jiangsu, and Shandong.[3] Although the data include a household-level panel, we work with the repeated cross-section data to avoid biases related to attrition and cohort as the panel ages over time. Regarding effort expended in the agricultural sector, the CHNS asked how many hours per day, days per week, and months per year each individual worked in the garden (vegetable plots near the house), on the farm, on livestock activities, and in fishing. The advantage of using the CHNS is that it asked exactly the same

[1] The 2000 survey included 60 villages. Unfortunately, 2 villages were in the Sichuan earthquake zone and were damaged so heavily that a year after the earthquake most of the households had not returned to their normal lives in the village. Therefore 40 households from these 2 villages were omitted from the 2008 survey.

[2] The CHNS was also conducted in 1989, but the questions about agricultural labor were constructed differently, so we omit them from this analysis.

[3] The CHNS is conducted in both rural and urban areas. In the subsample we study, we include data from villages in the counties considered rural as well as suburban areas or counties considered urban. Whereas a large majority of households in suburban villages farmed in 1991, very few did by 2009. As a result, we present average hours of farm work conditional on doing any farm work. Because the CHNS also covers a large cross-section of China's provinces, it is somewhat representative of farm conditions more generally in China, as is the CNRS.

questions about farm labor in each survey round in the same set of villages, so the data illustrate in a consistent manner how farm labor allocations have changed over time.

Although the CNRS-2000 and CNRS-2008 both asked about what was grown on major plots held by each household, it did not ask about plot-specific inputs. Therefore we also use a third source of data, the Fujian Rice Survey (FRS), to control for plot-level inputs. In 2010, the authors undertook a rice input and output production survey. This survey was conducted in 124 households in Shunchang and Youxi counties in Fujian. Although the number of households is small and concentrated in the rice-producing region of a single province, we believe the results from the efficiency analysis are still comparable to the analysis from 2000 because the FRS instrument asked almost the same set of questions of the respondents as the CNRS-2000 survey, with more detail on specific plots. Because some farmers planted 2 plots, the survey included a total of 168 rice plots.

3. IS FEMINIZATION OF AGRICULTURE OCCURRING IN CHINA?

The tremendous push of labor into the off-farm market—which, as Rozelle et al. (1999) found, it was mostly composed of men. In the early years, it was one of the motivating forces behind the rise of concerns about agricultural feminization. Cai, Du, and Wang (2009) estimated that by 2007, the migrant labor force included 136 million people. When such significant numbers of people are observed moving out of rural communities, a natural question arises: Who is doing the work on the farm? Since the time endowment of a household or an individual is fixed, if an individual is spending more (less) time off the farm, ceteris paribus, he or she will spend less (more) time on the farm, holding the time allocated to work over leisure fixed.[4]

Complicating the matter, the impacts also vary by age cohort in addition to gender. In studies using the CNRS-2000, de Brauw et al. (2002) and Zhang, de Brauw, and Rozelle (2004) found that in the 1990s and early 2000s, both men and women in the youngest cohort in the labor force (16 to 20 years old) were moving rapidly into the off-farm sector at comparable rates. At the same time, women between the ages of 36 and 50 tended to remain both in rural source communities and working on the farm, whereas men did not (Zhang, de Brauw, and Rozelle 2004). Therefore, these authors concluded that women who are middle aged or older are taking over more farm work, though not the younger or older generations.

One of the most important trends that appear in the CHNS is that *total* hours spent per household on farming activities fell sharply between 1991 and 2009 (Table 3.1). Furthermore, we condition the averages on farm participation, which also drops. According to the CHNS, among households allocating labor to farming, the average total hours spent per household on the farm fell from more than 3,500 hours in 1991 to a little more than 2,000 hours in 2000 (Table 3.1, row 1). Between 2000 and 2009, the hours spent farming continued to fall, to about 1,400 hours in 2009, or a further 30 percent decline from 2000. Meanwhile, the proportion of households reporting spending any time on the farm dropped from almost 89 percent in 1991 to 75 percent in 2000 and 65 percent in 2009 (row 2). These declines—which occurred at the same time that off-farm employment increased rapidly—are consistent with the findings of de Brauw et al. (2004) and Jin et al. (2002), who found that hours spent on the farm fell during the 1980s and 1990s as reforms allowed rural households increasing access to off-farm work. It is with this backdrop of overall decreasing participation in farm labor that we now turn to consider trends in gender and age composition of farm labor from 1990 to 2009.

Table 3.1—Participation in farm work by men and women, 1991–2009

	Year						
	1991	**1993**	**1997**	**2000**	**2004**	**2006**	**2009**
Average total reported hours of farm work, household, conditional on positive farm work	3,528 (174.3)	2,743 (133.1)	2,356 (127.4)	1,976 (145.6)	1,756 (145.2)	1,557 (120.3)	1,399 (126.3)
Share of households reporting positive hours of farm work	89	87	81	75	70	65	65
Average hours of farm work done by women, conditional on farm work done by household	1,943 (96.7)	1,431 (69.2)	1,192 (63.7)	1,058 (76.4)	927 (75.7)	867 (63.5)	748 (63.7)
Average share of farm work done by women	0.53	0.55	0.53	0.55	0.57	0.60	0.59
Number of obs.	2,290	2,236	2,393	2,389	2,338	2,355	2,385

Source: CHNS, 1991–2009.

Notes: Standard deviations in parentheses. Year refers to the year survey was completed. Farm work is defined to include time spent "gardening" and "cropping," and omits time spent tending livestock or fishing.

[4] Capital can also substitute for labor in farming. The proportion of households in the CNRS using some mechanized services rose between 2000 and 2008.

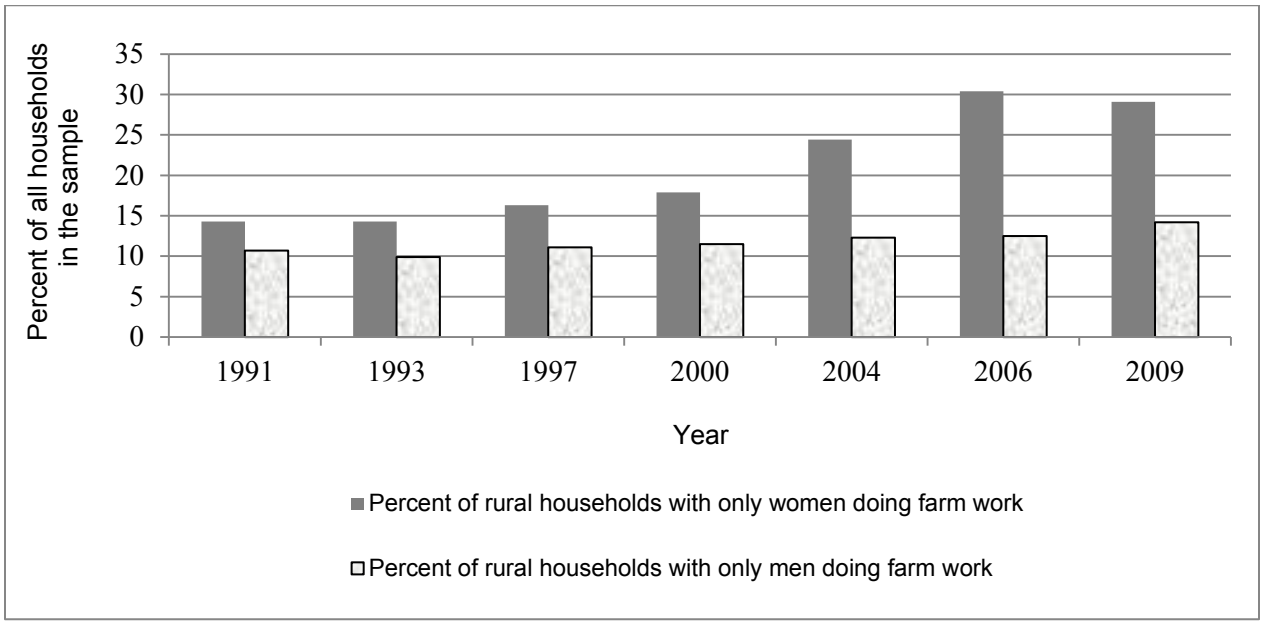
Evidence of Feminization

To learn whether feminization of agricultural labor is occurring as less labor is put into farming, we examine two measures of labor feminization. First, we aggregate the total number of annual hours each household reports working on the farm and then do the same for women. Second, we measure the proportion of households who report all of the household farm labor being completed either by men or by women. Both measures show that after the 1997 survey round, the feminization of agricultural labor appears to have begun.

Among CHNS households, we observe little change in the share of hours spent on the farm by women between 1991 and 1997 (Table 3.1, row 3). The average number of hours worked by women surveyed in the CHNS fell at a slightly faster rate than the number of hours worked per household (row 3). In 1991 women worked an average of 1,943 hours on the farm, which fell to 1,192 hours in 1997. Since the total hours fell more for women between 1991 and 1997 (39 percent) than for the farm household in general (33 percent), there is no overall trend of women's taking over more work on the farm.

We also measure the proportion of households in which either women or men do *all of the farm work*. During the early 1990s (1991 to 1997), the percentage of households in which women did all of the farm work rose slightly faster than the percentage of households in which men did all of the farm work (Figure 3.1). The households in which women were the only ones working on-farm rose from 14 percent in 1991 to 16 percent in 1997, while the percentage of households in which men did all the farm work remained constant at 11 percent during this period. Importantly, we cannot reject the hypothesis that the 2 percentage point rise in the share of women who do the entire farm work is different from zero. Therefore, it is worth noting that between 1991 and 1997, both measures are in conflict with the work of other researchers in the 1990s who expressed concerns about the rapid rate of feminization of agriculture in China during the 1990s (for example Jacka 1997; Song and Jiggins 2000).

Figure 3.1—Increase in households with farmers with one gender reporting farm work, 1991–2009



Source: CHNS, 1991–2009.

After the 1997 survey round, however, the trends change. The hours spent in agriculture among farming households continued to fall between 1997 and 2009 (Table 3.1, row 1). While the average number of hours spent by women on the farm declined from 1,192 hours per year in 1997 to 748 hours per year in 2009, the total hours worked by the household declined faster. As a result, the average share of farm work performed by women increased from 53 percent in 1997 to 59 percent in 2009.

We next look at the demographic composition of the agricultural labor force using the CNRS (Table 3.2). In 2000, men were more likely to do farm work than women (70 percent of men did at least some farm work; only 65 percent of women did—rows 6 and 12), yet there were differences by demographic cohort (panel A). For example, among the youngest members of the household labor force, both males and females were much less likely than others to perform farm tasks, and they worked fewer hours when they did work on the farm. Women between 16 and 25 were less likely to work on the farm than men in the same age cohort. Only 32.8 percent of 16- to 25-year-old women did any farm work, whereas 39.5 percent of 16- to 25-year-old men did (rows 1 and 7). Likewise, women in the older age groups (46–55 and > 55) participated less in farming (86.0 and 40.4 percent, respectively) than men in the same age groups (90.3 and 69.2 percent, respectively).

In contrast, women of prime working ages (26–35 and 36–45 years old) participated in farming at higher rates than men (Table 3.2, panel A, column 1, rows 2–3 and 8–9). For example, 36- to 45-year-old women participated at rates that were somewhat higher than men in the same age group. Significantly, the on-farm participation rates were highly correlated to the gaps among the cohorts in the off-farm labor trends. When men participated in the off-farm labor market at a higher level than women, women were likely to participate more on the farm. The reverse was true for the younger groups. As also shown by Pang, de Brauw, and Rozelle (2004), in the oldest groups, the participation rate among women fell faster than the participation rate among men.

Table 3.2—Farm hours worked and percent of people working on farm, by gender and by age categories, 2000 and 2008

Demographic group	Percent working on farm	Mean hours worked	Standard deviation
Panel A: CNRS-2000			
Men aged:			
16–25	39.5	551	524
26–35	76.5	793	677
36–45	86.7	861	696
46–55	90.3	892	697
> 55	69.2	833	666
All men	70	803	672
Women aged:			
16–25	32.8	544	534
26–35	81.2	849	685
36–45	91.2	944	699
46–55	86.0	911	689
> 55	40.4	575	503
All women, 2000	65	827	674

Table 3.2—Continued

Demographic group	Percent working on farm	Mean hours worked	Standard deviation
Panel B: CNRS-2008			
Men aged:			
16–25	14.2	955	742
26–35	31.9	826	803
36–45	69.0	955	804
46–55	80.2	1,139	868
> 55	71.5	994	781
All men, 2008	54.2	1,008	816
Women aged:			
16–25	13.5	731	573
26–35	47.9	820	748
36–45	79.4	1,137	872
46–55	80.8	1,121	843
> 55	59.5	1,001	792
All women, 2008	57.2	1,044	824

Source: CNRS-2000 and CNRS-2008.

Notes: Means and standard deviations are measured only among individuals working on-farm. Sample size is 3,794 in 2000 and 3,426 in 2008.

In 2008, among a general decline in farm participation consistent with the CHNS, we find a slight change in the pattern of participation and average hours for each age–gender group (Table 2, panel B). Specifically, we find that women aged 36 to 45 were 10 percentage points more likely to be working on the farm than men in the same age group. Furthermore, there was an even larger difference among 26- to 35-year-olds—47 percent of 26- to 35-year-old women worked on the farm, whereas only 31 percent of 26- to 35-year-old men did. Although most women aged 26 to 35 did not work on the farm in 2008, women in that age group were much more likely to work on the farm than men in the same group.

We also find an increase in participation among older women, at least in relative terms. Whereas 46- to 55-year-old women were less likely to work on the farm in 2000 than men in the same age group, in 2008 they were equally as likely. Women more than 55 years old, who worked on the farm in 2008, had a higher percentage (59 percent) than, the percentage found in 2000 (40 percent).[5]

There is one further interesting difference when examining changes in average hours of farm work completed by demographic group (Table 3.2). Comparing panels A and B, we find that although participation has declined, the average hours worked among those who are farming increased among almost all demographic groups.[6] This observation is consistent with specialization of labor tasks within households. If a household continued to farm in 2008, it was less likely that every able-bodied household member was doing farm work than it was in 2000 or earlier. Instead, by 2008 households were more likely to have one person specializing in farm work, and both datasets suggest that the individual who was specializing in farming was more likely than not to be female.

[5] This change could be related to the aging of the sample; since the dataset is truly a panel, most members found in both rounds aged 8 years between surveys.

[6] Chang, MacPhail, and Dong (2011) showed that even though the share of farm work and off-farm work are rising for women, between 1991 and 2006 the total number of hours worked per day (including on-farm, off-farm, and domestic work) actually fell. This is another finding that would support the conclusion that with higher wages, higher assets, more management responsibilities, and fewer hours, women were better-off by late in the first decade of the present century than they were in the 1990s.

4. THE FEMINIZATION OF FARM MANAGEMENT: CORRELATES, CAUSES, AND EFFECTS

Given this feminization of agricultural labor and the fact that women are more likely to do all of the farm work in a significant proportion of households, it follows that much of the work of managing a farm is now also the responsibility of women. In this section, we want to begin to understand the consequences of managerial feminization. For the purposes of most of this section, we define female-managed farms or female-headed households as households in which either the household named a female as the head, or the male head had migrated and was away from the household for six months or more.[7]

In doing so, we have three specific objectives. First, we want to understand more about the nature of the female-managed farms and women's access to inputs. Second, we examine the relative efficiency of female-headed and male-headed households in farming. Third, we identify the impact on the welfare of the household when women manage farms rather than men.

Access to Means of Production: Do Women Have Access to Inputs?

According to the CNRS datasets, women and men have equal access to land regardless of whether farming activities of households are headed by men or women (Table 4.1). In fact, access to land is one of the defining characteristics of China's farming sector.[8] In 2000, literally 100 percent of all male- and female-headed households had access to land (row 1). In 2008, the rates were almost the same—97.3 percent of male-headed households and 97.1 percent of female-headed households. In both years of the survey, male-headed and female-headed households also had access to equal numbers of plots (row 2).

However, at least in terms of point estimates, gaps in farm size and allocations have widened slightly over time. Male-headed households were allocated more land (at least in recent years) than female-headed households (Table 4.1, row 3). In 2000, male-headed households were allocated 4.22 mou on average, while female-headed households were allocated only 3.81 mou. However, this difference is not statistically significant. By 2008, the gap widened and the difference in means became statistically significant. Male-headed households reported being allocated 6.36 mou; female-headed households reported allocations of only 3.33 mou. Landholdings per capita and total landholdings (allocated land plus rented-in land) showed the same trends: There were differences between men and women, and those differences have widened over time (rows 4 and 5).

Female-headed households also own less farm equipment than their male-headed counterparts in terms of several metrics (Table 4.1, rows 6 to 8). Perhaps in part related to the fact that female-headed households had less land, female-headed households owned less farm equipment than male-headed households (row 6), and the value of that equipment was also lower (row 7). A larger share of female-headed households also owned no farm equipment (row 8). Interestingly, in the cases of all three metrics (number of pieces of farm equipment, value of farm equipment, and share of households with no equipment) the gap between male- and female-headed households has widened somewhat over time.

Just as there are differences in access to land and farm equipment, by 2008 female-headed households also appeared to use less chemical fertilizer than male-headed households (Table 4.1). In 2000, female-headed households purchased fertilizer at similar rates (at the 5 percent level of significance) and used similar volumes of chemical fertilizer as male-headed households (columns 1–3, rows 9–10). In 2008, however, gaps appeared (columns 4–6). When examining both the share of

[7] In most cases, the male was gone for either 11 or 12 months when gone for at least 6 months. We unfortunately cannot observe households in which females made all or most of the decisions about farm management, so we use this definition to isolate the group of households in which farm decisions were most likely being made by females.

[8] In China, all land is officially owned by the collective. All members of an administrative village with a residency permit (or *hukou*) in the village are members of the collective, by definition. The collective's interests are represented by a village leadership committee that is partly elected and partly appointed. Households are allocated land with 30-year use rights from the village leadership committee.

households that purchased fertilizer (row 9) and the value of fertilizer used (row 10), in 2008 female-headed households were using less chemical fertilizer than male-headed households.[9]

Table 4.1—Landholdings by male-, female-headed households, 2000 and 2008

	2000			2008		
	Male-headed	Female-headed	p-value	Male-headed	Female-headed	p-value
Land						
Household has access to land	99%	100%	-	97.3%	97.1%	0.893
Number of plots held	6.34	6.1	0.729	5.13	5.57	0.416
	(0.36)	(0.68)		(0.35)	(0.73)	
Total amount of allocated land	4.22	3.81	0.269	6.36	3.33	0.0001
	(0.19)	(0.39)		(0.72)	(0.24)	
Landholdings per capita	2.56	1.54	0.0002	2.20	1.27	0.0002
	(0.24)	(0.18)		(0.23)	(0.11)	
Total landholdings	8.57	5.19	0.0001	7.91	4.89	0.0001
	(0.71)	(0.63)		(0.65)	(0.40)	
Capital						
Number of major farm implements owned	1.184	0.809	0.001	1.118	0.608	< 0.0001
	(0.068)	(0.117)		(0.084)	(0.077)	
Value of farm implements owned (nominal)	1162.5	557.1	0.0001	1281.1	330.8	< 0.0001
	(101.1)	(108.3)		(218.7)	(79.5)	
Percent of HHs, no farm implements	34%	47%	0.006	41%	58%	0.0003
Fertilizer						
Percentage purchasing fertilizer	92%	86%	0.078	86%	67%	0.330
Value of fertilizer purchased/mou	74	71	0.553	85	64	0.037
	(4.0)	(4.9)		(6.6)	(10.6)	

Sources: CNRS-2000 and CNRS-2008.
Notes: "Total" landholdings include privately held land, land allocated by the village, land contracted from the village, and any land rented in by the household.

In sum, according to the descriptive statistics, women managing farms appear to have (slightly) less access to land, capital, and fertilizer. However, it is not yet clear whether these differences affect farm productivity. We next explore whether managerial feminization is associated with lower farm earnings. After discussing farm productivity, we will return to discussing apparent differences in access to land, capital, and fertilizer inputs.

Effect of Managerial Feminization: Are Women as Productive?

From the international literature on women in agriculture, there is ample evidence that female-headed households and women-cultivated plots have produced lower yields and revenues (World Bank 2001). Beyond the access to inputs (discussed in the subsection above), women can be less efficient producers for a variety of reasons. Women also must do other work, such as child rearing and housework, burdens not borne by men (see, for example, Peterman, Behrman, and Quisumbing 2010). If we find that the

[9] A further concern might be that female-headed households have less access to credit. Although we did not ask about credit in 2008, in 2000 we found no difference in credit access.

feminization of farm management is associated with lower output in China, then some of the gains women have received in the off-farm sector may be offset by lower earnings in the farm sector.

We first want to know whether or not female-headed households are as productive on the farm as male-headed households before controlling for inputs. Because one might expect women to be less efficient due to greater involvement in child rearing or housework than men, such findings would not be surprising.

To answer the question of whether female-headed households are more, less, or equally efficient in cropping, we initially set out to test whether yields of similar crops planted by women and men are different. To control for differential cropping patterns, we first identify all of the plots that were planted in the most frequently planted grain crop in the village. We then explore whether grain yields are systematically lower among female-headed households than male-headed households. Therefore we measure whether women are as productive as men, conditional on planting the most frequently planted grain in the village. We do so both within each cross-section and by constructing a panel between the two years.

One question is whether or not these plots are representative of the farming activity of the villages in the CNRS. In fact, in 2000, 91 percent of all farming households grew the primary (or most commonly produced) grain in the village. This figure dropped to 74 percent in 2008, indicating that conditions changed between the two surveys. Some of this change was at the village level; several villages in the dataset had specialized in growing specific crops. In 2008, sample households from one village were exclusively growing cotton; in another village, very few households were growing anything other than nuts. Finally, in the richest two villages in the sample, there were very few farming households by the 2008 survey, and the modal crop in both villages was also vegetables. If we eliminate these four villages, we find that 77 percent of households that were farming in 2008 were growing the primary grain in the village, which is slightly more comparable to the average from 2000.

To estimate yield determinants in the cross-section for the 2000 and 2008 data, we separately estimate a model of the form

$$\ln(y_{ihv}) = \alpha_v + F_{hv}\gamma + \mathbf{P_{ihv}}\eta + \varepsilon_{ihv}, \quad (1)$$

where y_{ihv} represents the yield for plot i farmed by household h in village v, which is regressed on the female-headed household dummy variable, F_{hv}, and a vector of plot-level characteristics P_{ihv}.[10] Our null hypothesis is that the coefficient on the female-managed farm variable, γ, equals zero, or that yields are no different on farms run by women than on farms run by men. We initially estimate the regression suggested by equation (1) separately for 2000 and 2008, whether or not we hold plot characteristics constant.

When we estimate whether the logarithms of primary grain yields are different between male- and female-headed households, without holding plot-level covariates constant (Table 4.2, columns 1 and 3), we find results that are generally at odds with the results from other parts of the world (for example, World Bank 2001; Peterman, Behrman, and Quisumbing 2010). In both years, we find that we cannot reject the null hypothesis that $\gamma = 0$. Moreover, we estimate positive coefficients on the female-headed household indicator variable. This finding implies either that female-headed households have the same yields, on average, as male-headed households have in both survey rounds, or that they have higher yields. These findings do not change when we control for plot-level characteristics (Table 4.2, columns 2 and 4). Hence, according to this empirical exercise, it appears that female-headed households produce grain crops with yields that are no different than those of male-headed households.

[10] Plot-level characteristics include whether or not the grain was single cropped, topography, whether or not a shock occurred on the plot, irrigation status, and farmer-reported quality of the plot.

Table 4.2—Relationship between female headship and logarithm of yields on plots growing primary grain crop, 2000 and 2008

Variable	2000		2008	
	(1)	(2)	(3)	(4)
Constant	6.353	6.333	6.586	6.557
	(0.003)	(0.027)	(0.004)	(0.037)
Female head	0.034	0.035	0.017	0.017
	(0.033)	(0.033)	(0.037)	(0.032)
Plot characteristics				
Single crop		-0.060		0.037
		(0.059)		(0.049)
Hilly plot		-0.026		-0.033
		(0.022)		(0.038)
Terraced plot		-0.134		-0.011
		(0.047)		(0.061)
Reported a shock on plot		-0.167		-0.157
		(0.030)		(0.035)
Irrigated plot		0.135		0.034
		(0.062)		(0.030)
Reported high-quality plot		0.106		0.068
		(0.017)		(0.025)
Village fixed effects?	yes	yes	yes	yes
N	2,819	2,819	2,002	2,002

Sources: CNRS-2000 and CNRS-2008.

Notes: Standard errors clustered at the village level in parentheses.

Robustness Checks

In this section we seek to shed more light on the impact of agricultural feminization on productivity and household welfare. To do so, we complete several empirical exercises to better allow the data to demonstrate what is happening.

Yields and Shifting from Male-Headed to Female-Headed Households

One of the ways that the process of agricultural feminization occurs is that women take over primary management responsibilities of the farm. Between 2000 and 2008, some households switched from being male-headed households to being female-headed households. In this part of the analysis we assume that managerial feminization occurred for those households. Since we have data on these households from both before and after the shift from male headed to female headed, we can study the impact of feminization on this group of households.

The core question that we are interested in is whether or not productivity in primary grains declined for the household as the household shifted from male headed to female headed. The regressions in Table 4.2 did not detect any change in productivity, potentially because we did not pool the data across the two rounds to study how productivity changed.

To examine the impact of agricultural feminization (from the viewpoint of the shift of households from male headed to female headed), we pool our datasets from the two years. When doing so, we can estimate the following regression:

$$\ln(y_{ihvt}) = \alpha_h + \beta_1 D_t + \beta_2 F_{hvt} + \beta_3 D_t \cdot F_{hvt} + \mathbf{P}_{\mathbf{ihv}t} + \varepsilon_{ihv\mathbf{t}}, \quad (2)$$

where t now indexes time. In equation (2) we now include household fixed effects (α_h) to control for fixed unobservable at the household level. To control for differences over time in equation (2), we now include individual explanatory variables for the survey round (D_t), an indicator for female-headed households indexed over time (F_{hvt}), and the interaction between the two ($D_t F_{hvt}$). The coefficient β_2 represents the difference in yield between female-headed and male-headed households in the CNRS-2000, and β_3 represents the change in difference of the yields between female-headed and male-headed households between the CNRS-2000 and the CNRS-2008. In this regression, the average difference in yields between female- and male-headed households in the CNRS-2008, then, is the sum of the coefficients on female head, the interaction term, $\beta_2 + \beta_3$. The null hypothesis we want to test is that there is no change in the difference between female- and male-headed households between 2000 and 2008, or that $\beta_2 + \beta_3 = 0$. If we reject the null hypothesis, we will be able to conclude that female-headed households have different (or lower) yields in 2008 than male-headed households.

We estimate equation (2) and find that there is still a positive coefficient on the female-headed household indicator variable (Table 4.3, columns 1 and 2). However, we find a negative coefficient on the interaction term, indicating that yields did not grow as quickly among female-headed households. The point estimate for the estimate of $\beta_2 + \beta_3$ implies that yields among female-headed households are 6.4 percent. This is lower than among male-headed households, controlling for other plot characteristics (column 2). Despite the negative sum of the coefficients, we cannot reject the hypothesis that the coefficients add to zero. Therefore, our initial interpretation is that women-managed farms in 2008 are still equally as efficient as farms managed by men.

Table 4.3—Relationship between female headship and logarithm of yields on plots growing primary grain crop, controlling for household fixed effects in panel regression, 2000 and 2008

Variable	All villages		Poor villages only	
	(1)	(2)	(3)	(4)
Round (2008 = 1)	0.297	0.253	0.345	0.304
	(0.074)**	(0.058)**	(0.097)**	(0.076)**
Female head?	0.057	0.048	0.080	0.086
	(0.090)	(0.083)	(0.118)	(0.108)
Round–female head interaction	-0.176	-0.112	-0.227	-0.168
	(0.115)	(0.101)	(0.141)	(0.123)
Plot characteristics				
Single season		-0.043		-0.098
		(0.068)		(0.100)
Hilly plot		0.017		-0.005
		(0.036)		(0.044)
Terraced plot		-0.155		-0.241
		(0.095)		(0.132)
Reported a shock on plot		-0.284		-0.301
		(0.056)**		(0.063)**
Irrigated plot		0.194		0.212
		(0.067)**		(0.075)**
Reported high-quality plot		0.076		0.098
		(0.020)**		(0.026)**
Household fixed effects?	yes	yes	yes	yes
Combined female head effect, 2008	-0.119	-0.064	-0.146	-0.082
	(0.075)	(0.071)	(0.071)**	(0.095)
N	4,821	4,821	3,298	3,298

Sources: CNRS-2000 and CNRS-2008.
Notes: Standard errors accounting for village level clustering in parentheses.

The Location of Female-Headed Households and Access to Agricultural Inputs

Although we do not find differences in productivity between male- and female-headed households, it is important to return to the issue of access. If male-headed households have systematically better access to land and inputs than female-headed households, as shown by the analysis in the previous section, the welfare of female-headed households could trail that of male-headed households. In the following empirical exercise, we seek to offer an explanation about why we may be observing differences in access to inputs between male-headed and female-headed households.

One explanation of the observed differences in access to inputs could be that there are systematic differences between types of households that are male headed and the types of households that are female headed in the sample. One source of such heterogeneity might be that female-headed households are more common in certain types of villages and male-headed households are more common in other types of villages. In this paper, we define *types of villages* as villages that have fundamentally different economies, terrains, or geographies. For example, it might be that female-headed households are more commonly found in relatively poor villages. If the quality of land in these villages is systematically lower, then this would be one explanation of why women are using systematically lower levels of fertilizer. If this were the case, then, in fact, this would not be an access problem at all. It would be consistent with rational use of resources: If female-headed households are more common in poor areas that have more fragile cultivated land, we would expect rational farmers to be using fewer inputs.

Are there indeed more female-headed households in poor areas? To answer this question, we first need to define *poor areas*. We define the richer areas in our sample as the households in Zhejiang Province and in the richest county of each other province.[11] Poor areas are then defined as all other counties in the sample. We find that in 2000, there were fewer female-headed households in poor areas (8 percent) than in richer areas (10 percent). However, between 2000 and 2008, more households changed from male- to female-headed in poor areas (8 percentage points) than in richer areas (5 percentage points), and as a result by 2008 there were more female-headed households in poor areas (17 percent) than in richer areas (15 percent). Clearly, if farmers in poor areas have relatively fragile land—which is almost certainly true—then their relatively low levels of fertilizer use can be explained. Therefore, it is important to control for the nature of the village economies when comparing the differences between male- and female-headed households.

After eliminating rich households from the sample and re-estimating equation (2), we find that the combination of estimates of β_2 and β_3 remains negative (8.7 percent when controlling for plot characteristics, Table 4.3, column 4). The difference is statistically significant when we do not include plot characteristics in the regression (column 3), but statistically insignificant once we do so (column 4). Even if households in poor areas that have become female headed between survey rounds have lower yields, on average, for primary grains, the difference appears to be generated by differences in plot characteristics. In these areas, women may be using lower-quality plots on average in these households than men.

The next question, therefore, is to understand why women might be farming lower-quality plots than men on average. It could be that women have less access to high-quality plots than men. Alternatively, female-headed households could rent out their better land and keep their lower-quality plots for themselves to cultivate. As a result, yields might be lower if one does not control for plot characteristics. We next explore what women do with their land in more detail.

Inequalities in Access to Land

In Table 4.1 (see above), we defined land available to the household as the sum of all private holdings, land allocated by the village, land contracted from the village, and all other land rented in by the household. We first explore whether alternative definitions of land access affect the gap between male

[11] de Brauw and Rozelle (2008) use the same split of poor and nonpoor villages in studying the relationship between migration and household investment using the CNRS-2000.

and female landholdings (Appendix Table A.1, rows 1–4). We can produce an alternative definition of landholding by not including land that households lease directly from the village (*chengbao tien*).[12] When we do so, we find that the difference between the landholding of the average male-headed and the average female-headed household declines by 18 percent, but the two averages remain significantly different (row 2). On a per capita basis (female-headed households are smaller than male-headed households), removing contracted land from averages actually makes the difference between male- and female-headed households significant only at the 10 percent level (row 4). From the household perspective, the decision to contract in land appears to be more easily done by male-headed than female-headed households. One of the reasons that landholdings appear so unequal is that more men choose or are allowed to choose, to expand landholdings by contracting land from the village, at least relative to women.

The gap in landholdings between male-headed and female-headed households is also because female-headed households are more likely to rent their land out than male-headed households (Appendix Table A.1, rows 5–6). Overall, 15 percent of female-headed households rent out all of their land. An additional 23 percent of female-headed households rent out some of their land. In total, nearly 40 percent of all female-headed households rent some or all of their land out. Why does such a large proportion of women rent land out? There may be several reasons, but one possible explanation is that there are fewer dependents in female-headed households. Women may rent out land to ensure that the value of the marginal product of their effort on the farm remains high, given the human capital endowments of the household. In sum, female-headed households may be renting land out to balance their landholdings with available labor, which might help explain why they farm less land than male-headed households.

Other differences between male- and female-headed households could also help explain the difference between their landholdings. If female-headed households are more likely to exist in places where land is scarce (as is the case in poor areas), then we would expect to find differences in landholdings between male and female households. Therefore, we next control for location through province- and village-level indicators in a regression framework (Appendix Table A.2). When we initially regress land per capita on a dummy variable for female-headed households (row 1), we observe the negative coefficient we would expect from descriptive statistics (that is, female-headed households have access to less land). The sign and significance of the coefficient do not change when we control for the age of the household head (row 2). However, once we control for either province- or village-level indicators (in addition to age—rows 3 and 4), the difference between landholdings in female- and male-headed households is no longer statistically significant. As a result, we can conclude that a large portion of the measured difference in average landholdings between male- and female-headed households is due to the location of female-headed households.

Efficiency in 2010

Because of the changes between 2000 and 2008 in access to land and other inputs—for example, farm equipment, custom services, and fertilizer—of male-headed and female-headed households (see discussion in the introduction), we also examine the relative efficiency of male- and female-headed households using the Fujian Rice Survey. In this dataset, the farmers are all from the same several villages and are growing rice.

To estimate the efficiency impacts of having a female head in 2010, we use the modeling framework of de Brauw et al (2008), which adds household characteristics to equation (1), as was used in the analysis using the CNRS data in 2000. Here, we try two different measures of agricultural feminization (Z_{hv})—first, whether or not the household has a female head, and second, the share of household labor used in rice farming supplied by women. The dependent variable in the 2010 version of equation (1) is defined in two ways: as rice yields (in linear form) and as the natural log of rice yields.

Despite the fact that both farm size of women and input use (farm equipment, use of custom services, and fertilizer use) was lower for women than men in 2010 (in the CNRS survey), after

[12] Villages normally keep a small portion of total village land to rent to farmers who want to farm more land than they are allocated, as a revenue source. See Brandt et al. (2002) for a comprehensive description of land types and rights in China.

accounting for these inputs—as we do in equation (1)—regression results provide no evidence that women are any less efficient than men (Table 4.4 and Appendix Table A.3). According to the results, the estimated coefficient on the female-headed household indicator is not significantly different from zero, regardless of the form of the yield variable (Table 4.4, row 1). When replacing the female-headed household measure of agricultural feminization with a variable measuring the share of labor on rice farms provided by women, we also find no significant difference in the farming efficiency (Appendix Table A.3, row 1). In other words, female-headed households and male-headed households from the sample are operating at equally technically efficient points on the rice production function.

Table 4.4—OLS estimation of rice yields (and log of rice yields) in Fujian using "female-headed household–based" measure of agricultural feminization (Z_{hv}) in 2010

Variable	Yield (kg/mou)	Ln (yield)
Female household head (female = 1; male = 0)	29.879 (40.105)	0.060 (0.080)
Age of household head (years)	0.933 (0.787)	0.091 (0.074)
Education of household head (years)	0.282 (3.067)	-0.009 (0.018)
Labor inputs (hours/mou)	0.284 (0.189)	0.077 (0.033) **
NPK fertilizer (kg/mou)	0.242 (0.774)	0.005 (0.022)
Proportion of N in NPK (%)	0.533 (0.738)	-0.002 (0.002)
Proportion of K in NPK (%)	0.476 (0.714)	0.001 (0.002)
Pesticide cost (CNY/mou)	-0.082 (0.278)	-0.012 (0.010)
Machinery cost (CNY/mou)	0.103 (0.085)	0.006 (0.005)
Ratoon rice dummy	-74.904 (28.361) ***	-0.191 (0.056) ***
Middle-season rice dummy	5.999 (40.168)	0.006 (0.082)
Quality of land (1 = good; 2 = bad)	32.422 (15.585) **	0.075 (0.031) **
Plot area (mou)	1.084 (8.749)	0.020 (0.026)
County dummy	1.936 (26.411)	-0.037 (0.049)
Constant	419.737 (79.634) ***	5.621 (0.349) ***
Observations	168	168
R-square	0.314	0.358

Source: Fujian Rice Survey, 2010.

Notes: OLS = ordinary least squares. NPK = nitrogen, phosphorus, potassium. CNY = Chinese yuan.
Standard errors in parentheses. *, **, and *** represent statistically significant at 10%, 5%, and 1%, respectively.

All the evidence taken together, we discover that female- and male-headed households are actually equal in terms of access to inputs such as land and fertilizer when controlling for location. Moreover, female-headed households are equally as efficient as male-headed households after accounting for differences in inputs.

Female-Headed Households and Asset Holdings

We have established that in general female-headed households are no less efficient than male-headed households in rural China. However, we may be concerned that women may experience lower levels of welfare: They cannot participate in more productive off-farm labor when they are working on-farm, and they may have to take care of children while farming. In this section, we compare the asset holdings of female-headed and male-headed households to ascertain differences in welfare. If female-headed households have lower asset levels than male-headed households, they might be considered less well-off.

Using levels of assets as measures of welfare, we find a mixed picture. In general, welfare levels of female-headed households seem to have increased between 2000 and 2008 in the CNRS data but deteriorated relative to those of male-headed households. However, in terms of the most valuable asset—housing—female-headed households seem to be doing just as well as male-headed households.

For 2000, we count the number of *common consumer durables*—a proxy for assets and thereby of welfare—that households owned, out of six.[13] We cannot reject the hypothesis at the 5 percent level that asset levels in female-headed and male-headed households were the same (Table 4.5). Both types of households owned, on average, between 1.61 and 1.91 basket items (row 1). We also find no difference between the share of households with none of the items in the basket (a measure of asset poverty) when comparing female-headed households (24.5 percent) with male-headed households (20.0 percent). Finally, we measure the self-reported value of all consumer durables (row 2) and find virtually no difference between that of female-headed households (CNY 2,933) and that of male-headed households (CNY 2,981).

Table 4.5—Consumer durable holdings by male-, female-headed households, 2000 and 2008

	2000			2008		
	Male-headed	Female-headed	p-value	Male-headed	Female-headed	p-value
Number of common durables owned	1.91 (0.10)	1.61 (0.16)	0.0879	2.69 (0.11)	2.18 (0.14)	0.001
Total value of durables owned (nominal)	2,981 (363)	2,933 (981)	0.963	7,045 (1,440)	3,593 (526)	0.045
No common durables owned	20.0%	24.5%	0.43	12.0%	22.2%	0.000

Source: CNRS-2000 and CNRS-2008.

Notes: Common durables are the durables that were listed by approximately 50 percent of households in 2009 and include sound systems, refrigerators, washing machines, gas stoves, motorcycles, and bicycles. Total value of durables is self-reported. Standard error clustered at village level in parentheses. Computers and air conditioners were rare in 2000, and so they were not included in the survey form.

For 2008, we find that although assets had grown in real terms among female-headed households, the amount and value of consumer durable holdings had fallen behind that of male-headed households (Table 4.5, columns 3 and 4). In terms of both the number of common durable items owned and the value

[13] The six common consumer durable assets we consider are sound systems, refrigerators, washing machines, gas stoves, motorcycles, and bicycles. Each demonstrated a great deal of variation in ownership in 2000, making them a good combined welfare indicator.

of the consumer durables, female-headed households had less than male-headed households in 2008 (rows 1 and 2). Although the share of female-headed households owning none of the items in the common durables basket had fallen slightly compared with 2000, it had decreased more slowly than among male-headed households. Furthermore, all of the differences are statistically significant at the 5 percent level. As such, in terms of consumer durables, the relative position of female-headed households (versus that of male-headed households) fell between 2000 and 2008.[14]

The deteriorating position of women, however, does not appear in relation to the most valuable asset holding of households in rural China: housing (Table 4.6). In 2000, the value of housing in male-headed and female-headed households was statistically indistinguishable. In fact, in 2000 the point estimate of the reported value of the household's housing assets (columns 1 and 2, row 1) was higher for female-headed households (CNY 29,998) than for male-headed households (CNY 26,176). Although the ranking of the point estimates reversed in 2008 (the value of the housing assets for male-headed households was CNY 86,560 and the value for the female-headed households was CNY 73,340), the annual growth rates of the value of housing assets of both male-headed and female-headed households was greater than 12 percent, and the two were statistically indistinguishable (columns 3 and 4, row 1).

Because of the dominance of the housing asset in the total asset holdings of both male-headed and female-headed households, when one considers total asset holdings (housing + consumer durables), male-headed households and female-headed households are remarkably close between 2000 and 2008 (Table 4.6, row 2). The point estimates of the total asset holdings of male-headed and female-headed households in the CNRS dataset in both 2000 and 2008 are statistically indistinguishable. Hence, when considering total household assets, female-headed households are just as well-off as male-headed households.

Table 4.6—Reported value of house, house plus durables, by gender of household head, 2000 and 2008

	2000			2008		
	Male-headed	Female-headed	p-value	Male-headed	Female-headed	p-value
Reported value of house	26,176	29,998	0.465	86,560	73,340	0.512
	(2,935)	(7,073)		(24,060)	(15,040)	
Value of house + durables	29,109	32,979	0.485	93,610	76,930	0.423
	(3,211)	(7,415)		(24,540)	(15,140)	

Source: CNRS-2000 and CNRS-2008.
Notes: Values are nominal.

[14] In 2008 there also is a mixed picture when examining larger consumer durables. A greater share of male-headed households (5.8 percent) owned automobiles than female-headed households (1.7 percent). This is statistically significant. When considering computers and air conditioners, however, the share of female-headed households with ownership (8.0 percent for computers and 10.2 percent for air conditioners) is statistically indistinguishable from that of male-headed households (9.8 percent for computers and 11.6 percent for air conditioners).

5. SUMMARY, POLICY IMPLICATIONS, AND A CAUTIONARY ALTERNATIVE EXPLANATION

In this study we have shown that agricultural feminization is indeed occurring in rural China. That said, when women manage farms they have equal access to inputs and resources, perform as well in terms of efficiency, and are as well-off as men in terms of asset holdings. One possible explanation for these findings relates to China's rural market environment. Markets are so competitive, efficient, and deep (Huang, Rozelle, and Chang 2004) that they provide women with the services, inputs, markets for selling their produce, and information that they need to efficiently operate and succeed in agriculture. Moreover, the human capital levels of females in female-headed households, which are nearly (or are) equal to those of men in male-headed households (Appendix Table A.4) allow them to take equal advantage of opportunities that China's agricultural markets offer.

If these conjectures are correct, the policy implication for China (and for the rest of the world) would be to continue to do the things that have allowed China's markets to flourish. Government officials have not interfered too much in China's farming sector over the past 10 to 20 years. They have, however, invested heavily into the infrastructure that markets need to operate well: roads, communications, and accessible wholesale marketing facilities, open to all and lightly taxed. In this environment, literally thousands of traders seek out agricultural producers who are willing to sell their goods—no matter if they are rich or poor, no matter if they are young or old, and no matter if they are male or female. Too many traders exist for any one trader to have enough market power to discriminate. Equal human capital investments for men and women have almost certainly played a supplemental role.

Finally, there may be lessons for the rest of the world on what policies and institutions help make women productive when they work in agriculture and manage production in the agricultural sector. Policies that ensure equal access to land, regulations that dictate open access to credit, and economic development strategies that encourage competitive and efficient markets have all contributed to an environment in which women farmers can and appear to succeed. However, China can do more by fostering initiatives to promote agricultural extension agents who are women. Although fewer than 30 percent of extension agents in China are women overall, nearly 40 percent of young ones are. When women have access to inputs, information, and new technologies, there is no reason that they cannot produce at levels equally as efficient as those of men.

APPENDIX: SUPPLEMENTARY TABLES

Table A.1—Revisiting descriptive statistics on land, by gender of household head, CNRS, 2008

Variable	Female head	Male head	F-statistic *p-value*
Amount of landholdings (mou)			
All land (including rent-in)	4.89	7.91	19.39
	(0.40)	(0.65)	*0.0001*
All land, no contract land	4.76	7.02	12.59
	(0.40)	(0.623)	*0.0008*
Land per capita (all)	2.05	2.82	7.02
	(0.23)	(0.22)	*0.0107*
Land per capita, no contract	2.00	2.50	3.46
	(0.21)	(0.22)	*0.0684*
Land rental activity (proportion)			
All land rented	0.152	0.056	12.52
	(0.026)	(0.012)	*0.0009*
Some land rented	0.234	0.095	15.53
	(0.036)	(0.014)	*0.0002*

Source: C NRS-2008.
Notes: Standard errors in parentheses clustered at village level. Number of observations is 1,038; all households that did not grow any crops in 2008 are removed.

Table A.2—Regressions explaining variation in land per capita, 2008

	(1)	(2)	(3)	(4)
Female-headed household	-0.769	-0.782	-0.271	-0.104
	(0.294)	(0.320)	(0.264)	(0.257)
Age of head		-0.003	-0.005	0.010
		(0.009)	(0.008)	(0.008)
Fixed effects?	no	no	province	village

Source: CNRS-2008.
Notes: Standard errors accounting for village-level clustering in parentheses.

Table A.3—OLS estimation of rice yields in Fujian using "share of hours spent working on farm by women–based" measure of agricultural feminization (Z_{hv}) in 2010

Variable	Yield (kg/mou)	Ln (yield)
Share of women labor input in the family (%)	-0.133 (0.257)	-0.000 (0.001)
Age of household head (years)	0.914 (0.789)	0.088 (0.074)
Education of household head (years)	0.247 (3.073)	-0.009 (0.018)
Labor inputs (hours/mou)	0.277 (0.190)	0.076 (0.033) **
NPK fertilizer (kg/mou)	0.227 (0.775)	0.005 (0.022)
Proportion of N in NPK (%)	-0.489 (0.744)	-0.002 (0.002)
Proportion of K in NPK (%)	0.475 (0.715)	0.001 (0.002)
Pesticide cost (CNY/mou)	-0.086 (0.279)	-0.011 (0.010)
Machinery cost (CNY/mou)	0.093 (0.084)	0.006 (0.005)
Ratoon rice dummy	-78.855 (28.323) ***	-0.198 (0.056) ***
Middle-season rice dummy	2.374 (40.212)	-0.002 (0.082)
Quality of land (1 = good; 2 = bad)	32.339 (15.613) **	0.074 (0.031) **
Plot area (mou)	1.103 (8.762)	0.022 (0.026)
County dummy	0.400 (26.353)	-0.038 (0.049)
Constant	427.448 (80.061) ***	5.640 (0.350) ***
Observations	168	168
R-square	0.312	0.357

Source: Fujian Rice Survey, 2010.

Notes: OLS = ordinary least squares. NPK = nitrogen, phosphorus, potassium. CNY = Chinese yuan. Standard errors in parentheses. *, **, and *** represent statistically significant at 10%, 5%, and 1%, respectively.

Table A.4—Average years of schooling, adults aged 16–35 in household, by gender and household type, 2000 and 2008

	2000			2008		
Proportion enrolled in school	**Men**	**Women**	**p-value**	**Men**	**Women**	**p-value**
Households with male head and spouse present	8.32	7.50	0	8.84	8.80	0.819
	(0.15)	(0.17)		(0.18)	(0.20)	
Female-headed households	8.26	7.28	0.085	8.39	8.28	0.844
	(0.39)	(0.44)		(0.50)	(0.54)	
All households	8.27	7.46	0	8.71	8.61	0.630
	(0.16)	(0.17)		(0.20)	(0.24)	

Source: CNRS-2000 and CNRS-2008.

Notes: Discrepancy between total of households with both male head and spouse present, female-headed households, and all households are households headed by a male with no spouse present. Standard errors in parentheses. P-values test the null hypothesis that the mean for men is equal to the mean for women.

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