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DISCUSSION PAPER SERIES

IZA DP No. 17250

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Gautam Hazarika
The University of Texas Rio Grande Valley and IZA

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IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

The Cultural Role of Rice Cultivation in Female Workforce Participation in India

Rice and wheat are India's staple cereal crops and there is significant regional variation in the suitability to the cultivation of each. Both are so-called 'plough-positive' crops, whose cultivation is benefited by ploughing. It has previously been argued that the ancient adoption of the plough, a heavy implement better suited to handling by men, was a factor in the evolution of cultural norms prescribing a domestic role for women in society (Boserup, 1970). This study contends that rice is an anomalous plough-positive crop in that its cultivation, highly labor-intensive, has traditionally required much female labor. This, it is argued, may have led to a local loosening of plough culture's strictures against work by Indian women proportional to the local relative, to wheat, suitability to rice cultivation. To distinguish between a cultural effect and the technical effect of the labor-intensivity of rice cultivation, this study considers the workforce participation of urban women, spatially removed from agricultural operations. It is found that the district urban female workforce participation rates in both the 2001 and 2011 Censuses of India significantly increase in the district relative suitability to rice cultivation. Further, the increase in the district urban female workforce participation rate between 2001 and 2011 was significantly more pronounced in districts potentially better suited to growing rice than wheat. In addition, analysis of microdata from the 1999-2000 National Sample Survey of Employment and Unemployment reveals that the urban female propensity to work significantly increases in the district relative suitability to rice cultivation, though, tellingly, only so in the case of natives of the district, those whose culture will have been shaped by the local agro-ecology. Finally, urban females principally engaged in domestic duties are likelier to report that they are required to be so occupied, the compulsion probably cultural in nature, the less relatively suitable the district is to rice cultivation, with this effect too confined to natives of the district. Taken together, these findings suggest that rice cultivation has played a cultural role in Indian women's workforce participation.

JEL Classification: Z1

Keywords: deep roots of culture, female labor force participation, India

Corresponding author:
Gautam Hazarika
Department of Economics
The University of Texas Rio Grande Valley
One West University Blvd.
Brownsville, TX 78520
USA

E-mail: gautam.hazarika@utrgv.edu

1. Introduction

This study proposes that rice cultivation, traditionally employing much female labor owing to its labor-intensivity, has played a cultural role in Indian women's workforce participation. This participation, low in comparison to that in India's economic peers by per capita GDP, lower even than in its South Asian neighbors, has been the subject of some policy disquiet. Since there is indication that cultural norms significantly hinder Indian women's workforce participation, policy-making may benefit from an understanding of these norms' origins. It is hypothesized that the traditionally high contribution of female labor to rice cultivation supplies a cultural impetus to female workforce participation, one unrelated to the current labor requirements of cultivation, whose strength increases in the local relative suitability to growing rice. This thesis is supported by the empirical finding that the district *urban* female workforce participation rate, little related to the current dictates of cultivation since agricultural operations are mostly spatially distant, is positively related to the district suitability to the cultivation of rice relative to suitability to the cultivation of wheat, India's other staple cereal crop.

There is a growing body of research upon the role of culture in comparative economic development, and, in turn, upon the agricultural origins of cultural traits. For example, Galor and Ozak (2016) hold that the historical caloric yield of a people's ancestral lands is a factor in their current levels of patience. Alesina, Giuliano, and Nunn (2013) supply rigorous proof of Boseup's (1970) thesis that the ancestral use of the plough gave rise to cultural norms upholding a domestic role for women in society. Hansen, Jensen, and Skovsgaard (2015) ascribe such norms instead to the timing of the Neolithic Revolution, with women's relegation to the domestic sphere being more pronounced in countries with longer histories of agriculture. Hazarika, Jha, and Sarangi (2019) contend that that population sex-ratios are more skewed against women today in regions whose habitants' ancestors suffered greater agro-ecological resource stress. In attributing to rice cultivation a cultural role in Indian women's labor force participation, this study aims to contribute to this burgeoning literature.

By the International Labor Organization (ILO), India's female labor force participation rate, the percentage of the economically active among females ages 15 and older, was 20.71 percent in 2018. Figure 1

illustrates that this was markedly lower than in India's economic peers by per capita GDP.

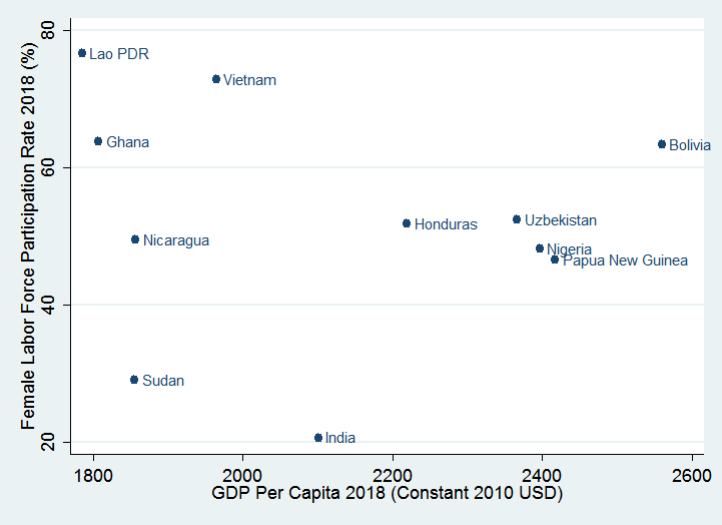

Figure 1 (data source: ILO & World Bank)

Figure 2 indicates that this was low as well by the standards of the member states of the South Asian Association for Regional Cooperation (SAARC). Besides, not only is women's participation in economic activity low, Figure 3, based on analysis by Himanshu (2011) of data from the quinquennial rounds of India's National Sample Survey (NSS), indicates that this participation has stagnated in urban India while decreasing

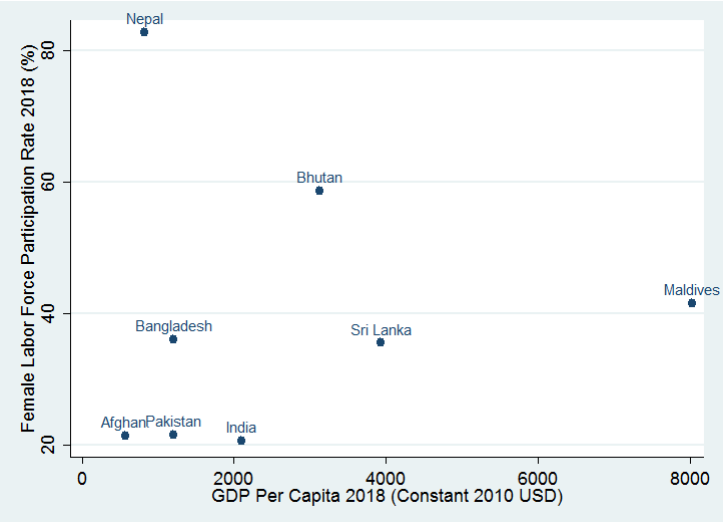

Figure 2 (data source: ILO & World Bank)

in rural India despite declining fertility, rising women's educational attainment, and economic development.

Low and, in rural areas, declining female workforce participation has been concerning for the

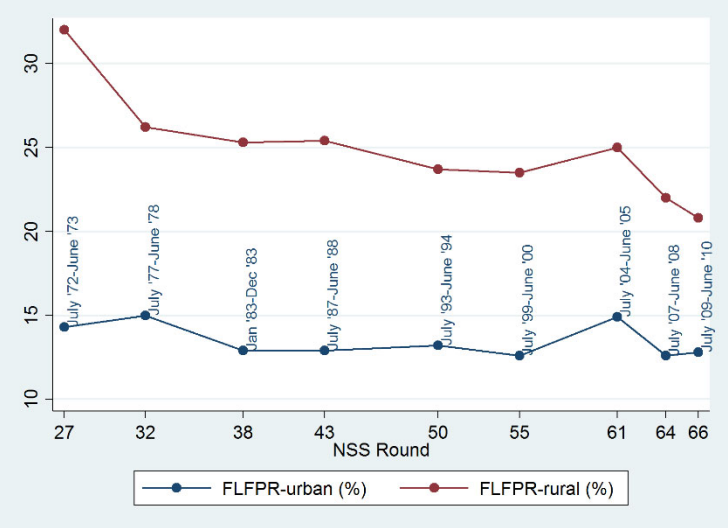

Figure 3 (data source: National Sample Survey)

following reasons. First, the fuller utilization of the resource of female labor would bode well for economic growth. Next, work by women raises their economic worth, as well the economic worth of girls based on their prospect of work as adults, and this may improve female well-being. Indeed, their very lives may depend on it. For example, Carranza (2014) finds that the rural sex-ratio among 0 to 6 year olds is less skewed against girls in the districts of India whose soil was composed of a greater fraction of clayey soils relative to the fraction of loamy soils. Clayey soils, unyielding when dry and sticky when wet, don't permit deep tillage, that is, plowing to a substantial depth. Deep tillage better severs the roots of weeds, so that there is less weeding to be done, and less need for the transplanting of crops, a technique aimed at easing weed pressure by decreasing crops' time in the ground. Besides, by promoting root development, enhancing the soil's ability to absorb and retain water, and permitting root access to deeper water and nutrient reservoirs, deep tillage so fosters healthy plant growth that there is less need for fertilizer. Weeding, transplanting, and fertilizing are all labor-intensive tasks typically falling to women. Hence, there is more demand for female labor in districts endowed with a greater fraction of deep tillage prohibiting clayey soils relative to the fraction of loamy soils. This, Carranza (2014) argues, raises the value of daughters, so that the child sex-ratio turns less skewed against them. Rise in the value of female labor boosts the survival of daughters in neighboring China as well. Qian (2008) finds that, following a hike in the price of tea consequent to agricultural reforms in the late 1970s, there was greater improvement in the survival of girls in the counties of China producing more tea, a

crop in whose delicate harvesting women hold a comparative advantage. Finally, work by women may benefit children of both genders. For example, Qian (2008) finds that the above rise in the value of Chinese women's labor lifted children's educational attainment, and Afridi, Mukhopadhyay, and Sahoo (2016) determine that work by women under the auspices of India's National Rural Employment Guarantee Scheme led to their children spending more time at school whose benefit was speedier grade progression.

There is indication that cultural norms, those concerning the division of labor between the genders in particular, constitute a major impediment to Indian women's workforce participation. By data in the National Sample Survey (NSS), over 90 percent of Indian women primarily occupied in household domestic work report that they are so under compulsion, the proportion only slightly decreasing in women's education, and, disturbingly, slightly increasing over the period 1999 – 2011 at every level of women's education (Afridi, Bishnu, and Mahajan, 2019). Further, a survey of couples in the Central Indian state of Madhya Pradesh reveals that men's fear of contravening social norms, whose disapproval of women's market work they severely overestimate, is a compelling factor in their wives' confinement to the home (Bernhardt et al., 2018).

Boserup (1970) observed that the cloistering of women at home, their rare veiled appearance in the village street, was particular to 'plough culture', being "seemingly unknown in the regions of shifting cultivation where women do most of the agricultural toil." Thus, she alluded to cultural norms that upheld domesticity in women taking root in regions in which the plough was employed in agriculture since ploughing greatly reduced the need for female agricultural labor. First, the plough is a heavy implement drawn by powerful, strenuous to control, draft animals. Next, ploughing isn't an activity conducive to frequent and unexpected interruption, whereas women must frequently halt to attend to their children. Besides, the plough can imperil small children in the vicinity of its operation. Finally, by severing the roots of weeds, ploughing reduces the need for weeding, a task in the domain of women. Boserup's thesis that use of the plough led to a gendered division of labor whereby women specialized in home-bound tasks, and that this division of labor was gradually enshrined in culture, has lately been rigorously tested by Alesina, Giuliano, and Nunn (2013), who find that present female labor force participation, female ownership of businesses, and female

representation in parliament is lower in countries in which a higher fraction of the population is descended from ethnicities who took up the plough.

What led a society to take up the plough? While Boserup (1970) argued that the adoption of the plough was a consequence of the population pressure led intensification of cultivation, Pryor (1985) held that it was instead driven by the ecological suitability to crops whose cultivation is benefited by ploughing. These 'plough-positive' crops include wheat, barley, rye, buckwheat, teff, and, notably, wetland rice. In some cases, the land needing extensive preparation before sowing, the plough is labor saving. In other cases, the caloric yield being low, more land than can be easily prepared by the hoe is needed to satisfy caloric needs. In yet other cases, as with wetland rice, ploughing allows the land to be prepared sufficiently rapidly to meet the narrow schedule of multiple-cropping.

Wetland rice poses a caveat to Boserup's (1970) thesis, in that it is testament to the fact that the plough didn't universally decimate female labor in agriculture. Its cultivation remains labor-intensive enough to employ significant female labor, making it an anomaly among 'plough-positive' crops. It is conceivable, therefore, that in regions of wetland rice cultivation, cultural norms are less insistent upon a domestic role for women than in regions suited to the other 'plough-positive' staples. This possibility calls into question a certain robustness-check employed by Alesina, Giuliano, and Nunn (2013) in their testing of Boseup's (1970) thesis. In the course of bolstering the credibility of their estimated negative association between ancestral plough use and women's present participation in economic and public life, the authors investigate the reduced-form relationship between this participation and the ecological suitability to 'plough-positive' crops, the precondition, by Pryor (1985), for plough use, to find that women's present participation in economic and public life is significantly lower in countries whose habitants' ancestral lands are more suited to 'plough-positive' crops (Alesina, Giuliano, and Nunn, 2013, pp. 516-517). However, the particular 'plough-positive' crops considered are barley, rye, and wheat, that is, the authors inexplicably exclude wetland rice, despite the fact that rice, whose world supply is largely wetland rice[2], supplies mankind more calories than any other

[2] Rice varieties are of two broad types, wetland or lowland, grown in standing water, and dryland or upland, grown on steeply sloped hillsides. According to http://ricepedia.org/rice-as-a-crop/where-is-rice-grown, accessed on October 25, 2020, dryland rice makes up less than 4 percent of world rice output.

cereal crop (Elert, 2014). It cannot but be speculated that the relation between the suitability of ancestral lands to 'plough-positive' crops and women's present participation in economic and public life wouldn't have been as strongly negative as Alesina, Giuliano, and Nunn (2013) estimate had they considered wetland rice 'plough-positive'. After all, in Cambodia, the world's second-largest per capita producer of rice in 2018, the female labor force participation rate that year was 76.28 percent, slightly higher than in Angola, whose staple crops are the 'plough-negative' cassava, corn, and sweet potato in whose cultivation hoe-wielding women customarily played a paramount role. Similarly, in Laos, the world's third-largest per capita producer of rice, the female labor force participation rate was 76.68 percent, slightly higher than in Togo, whose staple crops are the 'plough-negative' cassava, yam, corn, sorghum, and millet. Two other major rice producers whose female labor force participation rates exceed that in Sub-Saharan Africa as a whole, locus of the cultivation of 'plough-negative' crops, are Vietnam and Nepal.

The high labor requirements of rice cultivation are well documented. For example, Jabbar and Faruque (1978) note that it took between 62 and 105 man-days per acre to grow traditional (low-yielding) varieties of wetland rice in Bangladesh, whereas the corresponding figure for wheat was 29. That this has generally resulted in much higher women's participation in rice farming than in wheat farming is long established. Buck (1937) observed that female labor made up but 9 percent of total farm labor in the northern Chinese regions of wheat production, though 29 percent of farm labor in the regions of southern China in which rice is double-cropped. While communism and collectivization increased female farm labor across China, female labor as a fraction of total agricultural labor remained highest, at 33 percent, in rice growing southern China (Croll, 1979). In general, the tasks of transplanting, weeding, and harvesting in Asian rice farming are assumed by women. Rarely did women supply less than a third of the total labor in rice farming in Asia. The fraction was highest, at half, in Nepal and India. It was about a third in Southeast Asia, and women's share of labor in rice farming didn't diminish with economic development, remaining at 30 to 40 percent in Malaysia, South Korea, and Japan (IRRI, 1983). This paper argues that such high levels of women's agricultural labor in the regions of India relatively better suited to growing rice may have served to locally loosen the cultural strictures against work by women that are, by Boserup (1970), typical of societies that

adopted the plough. If such a loosening occurred, even women presumably unconnected with farming ought to be likelier to work in the regions of India relatively better suited to growing rice. This, then, is the study's testable proposition.

The remainder of the paper is organized as follows. Section 2 discusses the empirical strategy and describes the utilized data. Section 3 presents the empirical findings, and Section 4 a brief conclusion.

2. Empirical Strategy and Data

The empirical strategy is two-pronged. First, district-level analyses are conducted upon data from the 2001 and 2011 Censuses of India[3]. The period between these censuses saw the creation of new districts. To ensure comparability between the two censuses, new districts in 2011 are, when they were created by simply dividing original districts, recombined into the original districts. It is not possible to reconstitute an original district when a portion of it was combined with portions of other original districts to form a new district. Such new districts, of which there are but few, are kept out of the investigation.

The district urban female workforce participation rate obtained from each census is separately regressed against, among other variables, the district suitability to rice cultivation relative to wheat cultivation. The Census of India classifies an individual as a main worker if he or she worked for 6 or more months in the previous year, work including part-time work and unpaid work in a family agricultural or other enterprise. Individuals who worked for less than 6 months are termed marginal workers. A district's urban female workforce participation rate is calculated as the percentage of its urban female population consisting of main and marginal workers.

A district's relative suitability to rice cultivation is measured in two alternate ways. First, it is gauged as the difference between the district *potential* caloric yield per hectare of rice less that of wheat. These are based on potential crop yields obtained from the Global Agro-Ecological Zones (GAEZ) project of the United Nations Food and Agricultural Organization (FAO). The GAEZ project reports two types of potential crop yields: the Agro-Climatically Attainable Yield and the Total Production Capacity. The Agro-

[3] The 2021 Census has been delayed by the COVID-19 Pandemic and India's elections cycle.

Climatically Attainable Yield is based solely on the climate, that is, the temperature, radiation, and moisture. The Total Production Capacity takes soil and slope distributions into account as well, besides fallow period requirements. This study uses the latter measure for two reasons. First, wetland rice, making up some 96 percent of world rice output, must be sown in fields flooded with water to a depth of 10 to 12 centimeters. Therefore, it is important that the fields be level. In other words, the terrain slope is an important factor in the potential yield of rice. Second, deep fertile clayey or loamy soils capable of being readily puddled into mud, and which develop cracks upon drying, are considered ideal for growing rice. In sum, besides the climate, the terrain slope and the soil are important considerations in the cultivation of rice. The GAEZ project's potential crop yield data are differentiated according to whether the source of moisture is rainfall or irrigation, and whether inputs are at low, medium, or high levels. To better extrapolate to the past when culture was formed, the study employs potential crop yield data based on rainfed and low input conditions. These data, whose units of observation are 5 arc-minute by 5 arc-minute (about 10 kilometer by 10 kilometer) grid cells, are aggregated to the level of the districts of India. The district potential yields of rice and wheat in tonnes per hectare are then multiplied by crop-specific energy conversion factors, supplied by the USDA Nutrient Database for Standard Reference, to obtain their caloric equivalents. A second manner of gauging district relative suitability to rice cultivation is the district *current* caloric yield per hectare of rice less that of wheat, based on crop yield data procured from the Crop Production Statistics Information System of the Directorate of Economics and Statistics, Ministry of Agriculture and Farmers' Welfare, Government of India. Since this measure may be endogenous on account of, say, higher yields in regions in which women's greater propensity to work permits more intensive cultivation, it is instrumented by the aforementioned difference between the district *potential* caloric yield per hectare of rice less that of wheat.

In sum, two regression equations are considered. The first, estimated by 2SLS, is

$$\textit{urban female workforce participation rate}_i = a_1 + a_2 \,.\, (\textit{current caloric yield of rice} - \textit{current caloric yield of wheat})_i + \boldsymbol{X_i'a_3} + e_{1i}, \quad (1)$$

where the subscript i denotes individual districts of India, $\boldsymbol{X}$ is a vector of control variables, and e signifies the regression error, and the second, estimated by OLS, is

$$\textit{urban female workforce participation rate}_i = b_1 + b_2 \,.\, (\textit{potential caloric yield of rice} - \textit{potential caloric yield of wheat})_i + \boldsymbol{X_i'b_3} + e_{2i}. \quad (2)$$

Given Carranza's (2014) finding that agriculture employs more female labor when the soil is clayey rather than loamy, vector $\boldsymbol{X}$ above includes the fraction of district land area composed of clayey soils less the fraction composed of loamy soils, these fractions computed from data supplied by *Soils of India,* National Bureau of Soil Survey and Land Use Planning (NBSS&LUP), Indian Council of Agricultural Research. This inclusion will test whether the effect of soil type on women's traditional toil in agriculture too has had a cultural effect upon women's propensity to work. Also included in $\boldsymbol{X}$ is the log of district urban median per capita expenditure, this representing per capita income since the latter is unreported at the level of India's districts. District ethno-religious diversity is controlled for by inclusion in $\boldsymbol{X}$ of the fractions of the urban population consisting of Muslims, Christians, Sikhs, Buddhists, and Jains, as well as the fractions making up Scheduled Castes and Scheduled Tribes[4]. Following Klasen and Pieters (2015), the availability of suitable or attractive jobs for women is controlled for by inclusion in $\boldsymbol{X}$ of the urban sectoral distribution of *male* employment, since, the dependent variable being the female workforce participation rate, the sectoral distribution of total employment, being that it includes female employment, may be endogenous. Even though it is potentially endogenous, education often tailing prospects of employment, female educational attainment, as measured by the shares of urban women in three educational categories, is controlled for. Levels of urbanization are controlled for in the belief that more urbanized districts are pervaded by a more progressive ethos. A version of (2) also includes as regressors a variety of aspects of district geography.

Having obtained data from two consecutive censuses, this study also considers the effect of the district relative suitability to rice cultivation upon the evolution of the district urban female workforce participation rate between 2001 and 2011. Two regression equations are estimated. The first is

$$\textit{urban female workforce participation rate}_{it} = c_1 + c_2 \,.\, Q_{1i} \,.\, Year_{2011,t} + c_3 \,.\, Q_{2i} \,.\, Year_{2011,t} + c_4 \,.\, Q_{3i} \,.\, Year_{2011,t}$$

[4] socio-economically disadvantaged castes and tribes listed in the Constitution of India

$$+ c_5 \,.\, Year_{2011,t} + district\ fixed\text{-}effects + e_{3it}\,, \qquad (3)$$

where subscript *i* continues to denote individual districts of India, subscript *t* identifies the census year, variable Q_1 indicates whether the district potential caloric yield of rice less that of wheat lies between the 1st and 2nd quartiles of its distribution, variable Q_2 indicates whether this lies between the 2nd and 3rd quartiles of its distribution, while variable Q_3 indicates whether this exceeds the 3rd quartile of its distribution, with $Year_{2001}$ indicating whether the census year is 2011 and *e* denoting the regression error. The second equation is

$$urban\ female\ workforce\ participation\ rate_{it} = d_1 + d_2 \,.\, rice_i \,.\, Year_{2011,t} + d_3 \,.\, Year_{2011,t}$$
$$+ district\ fixed\text{-}effects + e_{4it}\,, \qquad (4)$$

where *rice* indicates whether the district potential caloric yield of rice exceeds that of wheat. These equations will uncover whether the increase in the district urban female workforce participation rate between 2001 and 2011 was positively related to the district relative suitability to rice cultivation.

Since a migrant's culture may have roots in the agro-ecology of a different region, inter-regional migration may weaken the correlation between observed culture at a location and local agro-ecological conditions. However, Indians are highly geographically immobile. This has been noted by, for example, Topalova (2010) and Anderson (2011). By the 2001 Census of India, 91.05 percent of males and 84.34 percent of females in India as a whole were born in the districts, akin to counties in the United States, in which they were enumerated. Urban Indians were somewhat more mobile, in that 77.83 percent of urban males and 74.84 percent of urban females were born in the districts in which they were enumerated. The especially high immobility of males, attributable to the custom of patrilocal exogamy, by which only women depart their natal families upon marriage, favors the study's empirical design since men's antipathy to women's work, as well as women's perception of this antipathy, may be greater impediments to women's workforce participation than their own feelings in the matter (Bernhardt et al., 2018). It might be mentioned additionally that, in light of Zelinksy's (1973) Doctrine of First Effective Settlement[5], even migrants' culture

[5] The cultural geographer Wilbur Zelinsky argued that "Whenever an empty territory undergoes settlement or an earlier population is dislodged by invaders, the specific characteristics of the first group able to effect a viable, self-perpetuating society are of crucial significance for the later social and cultural geography of the area, no matter how tiny the initial band of settlers may have been."

may become influenced by local norms. Nevertheless, the fact that aggregative district-level analysis cannot distinguish between natives and migrants is its weakness.

Thus, the second prong of this study's empirical strategy consists of the analysis of individual-level data which permit a modicum of distinction between urban females native to a district and migrants from outside it. The Government of India's National Sample Survey Office (NSSO) conducts a quinquennial national survey of employment and unemployment. This study utilizes data from the 55th (July 1999 – June 2000) round of the Survey, conducted shortly before the 2001 Census. An urban female is considered to have worked over the past year if work was either her principal or subsidiary activity or if she at all engaged in job search. The Survey queried each respondent about whether her place of enumeration was different from her last usual place of residence. If the respondent affirmed that it was, the Survey ascertained whether her last location lay within the district. Hence, an individual who affirmed that her place of enumeration was the same as her last usual place of residence, or, if the two were different, that her last location lay within the district, is considered native to the district. It is acceded that this would be inaccurate if, say, the individual originally migrated from outside the district to her previous location within it. However, besides being impossible to improve upon given the limitations of the data, this means of identifying females native to a district is defensible considering Indians' low geographical mobility. The equation

$$work_{ij} = \beta_1 + \beta_2 \,.\, (\text{potential caloric yield of rice} - \text{potential caloric yield of wheat})_j$$

$$+ \beta_3 \,.\, (\text{potential caloric yield of rice} - \text{potential caloric yield of wheat})_j \times native_{ij} + \boldsymbol{Z}_{ij}'\boldsymbol{\beta}_4 + e_{5ij}\,, \quad (5)$$

where $work_{ij}$ indicates whether individual i in district j worked during the past year, $native_{ij}$ indicates whether individual i is native to district j, $\boldsymbol{Z}$ is a vector of control variables, describing aspects of both the individual and her district, and e signifies the normally distributed regression error, is estimated by probit ML. It will uncover whether the district relative suitability to rice cultivation has a greater effect upon the propensity to work of those whose inherited culture will have been shaped by the local agro-ecology.

Even though it is reasonable to argue that an effect of agricultural conditions, *extrapolated to the past when culture was formed*, upon the workforce participation of *urban* women, spatially removed from agricultural operations, must be in the nature of a cultural effect, the argument would undoubtedly be strengthened by

the finding of an effect of these agricultural conditions upon a facet of culture intimately tied with female workforce participation. The Survey inquired of females principally engaged in domestic duties over the past year whether they were *required* to be so occupied. This type of compulsion is typically cultural in nature, stemming from norms of gender roles, and may be among the principal impediments to female workforce participation, at least in societies with a legacy of plough use of which India is squarely a part. Hence, the equation

$$required_{ij} = \delta_1 + \delta_2 \,.\, (\text{potential caloric yield of rice} - \text{potential caloric yield of wheat})_j$$
$$+ \delta_3 \,.\, (\text{potential caloric yield of rice} - \text{potential caloric yield of wheat})_j \times native_{ij} + \boldsymbol{Z_{ij}'\,\delta_4} + e_{6ij}\,, \quad (6)$$

where $required_{ij}$ is an indicator of whether individual i in district j, principally engaged in domestic duties over the past year, was required to be so engaged, and e signifies the normally distributed regression error, is estimated by probit ML.

3. Empirical Results

Figure 4 presents two choropleth maps of which one details the spatial distribution of the district potential caloric yield of rice less that of wheat and the other the district urban female workforce participation rate by the 2001 Census of India. It may be seen that regions to which a darker shade is applied in the map detailing the spatial distribution of the potential caloric yield differential, that is, regions in which the potential caloric yield difference between rice and wheat is greater, are often also those to which a darker shade is applied in the map describing the spatial distribution of the urban female workforce participation rate, that is, those in which a higher fraction of urban women were main and marginal workers.

Table 1 presents results obtained from estimation of (1) and (2) upon data from the 2001 Census of India. The coefficient of correlation between 'district *current* caloric yield of rice less that of wheat' in (1) and its identifying instrument, 'district *potential* caloric yield of rice less that of wheat', is, happily, 0.59 and statistically significant at the 1% level. It may be seen that the district urban female workforce participation rate significantly increases in the district relative suitability to rice cultivation as measured both by the difference between the district current rice caloric yield and current wheat caloric yield and the difference

between the district potential rice caloric yield and potential wheat caloric yield. As argued, since urban women are spatially removed from agricultural operations, it is not unreasonable that the positive effect of the district relative suitability to rice cultivation upon urban women's workforce participation should be a cultural effect as opposed to one driven by the dictates of cultivation. In a version of (2), whose coefficient estimates are reported in column 5 of the table, the potential caloric yield of rice and that of wheat are, less restrictedly, separate regressors. It may be seen that the potential caloric yield of rice exerts a statistically significant positive effect upon urban female workforce participation, the effect of the potential caloric yield of wheat being statistically insignificant. By the coefficient estimate of 'district potential caloric yield of rice less that from wheat' in column 4 of the table, an increase in the value of this regressor from its minimum value of -2.35 million kcal/hectare to the 1st quartile of its distribution, 0.63 million kcal/hectare, is predicted to increase the district urban female workforce participation rate by 2.09 percentage points, a considerable magnitude in light of India's low levels of female workforce participation. Put differently, an increase of one standard deviation in 'district potential caloric yield of rice less that of wheat' is predicted to increase the district urban female workforce participation rate by 1.07 percentage points. While Alesina, Giuliano, and Nunn (2013) find that the female labor force participation rate in a country peopled by the descendants of ethnic groups who adopted the plough as an agricultural implement is, on average, 12.93 percentage points lower than in a country inhabited by the descendants of ethnic groups who did not adopt the implement (Alesina, Giuliano, and Nunn, 2013: col. 2 of Table IV, pg. 494), the authors demonstrate that there is nonetheless substantial variation in female labor force participation among countries with a legacy of plough-use (Alesina, Giuliano, and Nunn, 2013: Figure III(a), pg. 490). The present study suggests that this variation is partly tied to nations' relative suitability to rice cultivation. Indeed, Alesina, Giuliano, and Nunn's (2013) Figure III(a) illustrates that, of the countries whose populations are almost wholly descended from plough adopters, East Asian rice produces like Cambodia (ISO code KHM) have among the highest rates of female labor force participation.

By Table 2, a positive effect of the district relative suitability to rice cultivation upon the district urban female workforce participation rate is to be found as well in data from the 2011 Census of India. The

standard errors reported in Table 1 and Table 2 are clustered at the level of the state/union territory, 35 of which constituted the Republic of India in 2001. Cluster-robust standard errors may be downward-biased when the number of clusters is too few (Cameron and Miller, 2015). Since 35 unbalanced clusters may well be considered too few, Wild cluster bootstrapping is implemented. With the method yielding a p-values of 0.0891 for the test of significance of the coefficient of 'district potential caloric yield of rice less that of wheat' in the regression to which column 4 of Table 1 pertains, and a p-value of 0.0781 for the test of significance of the variable in the regression to which column 4 of Table 2 pertains, the statistical significance of this measure of the district relative suitability to rice cultivation is not in doubt.

Since unobserved characteristics of the state or union territory to which a district belongs may be subsumed within its regression error, regression errors may be correlated within states or union territories. For that reason, Table 1 and Table 2 report cluster-robust standard errors. However, the coefficient estimates in columns 2, 4, and 5 of these tables result from the inclusion as regressors of state/union territory dummy variables. By accounting for all the, observed and unobserved, characteristics of states and union territories, might these cluster fixed-effects obviate the need for cluster-robust standard errors? Cameron and Miller (2015) aren't sufficiently clear on the matter. For example, they write that "While cluster-specific effects will control for part of the within-cluster correlation of the error, in general they will not completely control for within-cluster error correlation", but this appears contradicted by "in a state-year panel there may be clustering both within years and within states. If the within-year clustering is due to shocks that are the same across all observations in a given year, then including year fixed effects as regressors will absorb within-year clustering, and inference then need only control for clustering on state" (Cameron and Miller, 2015). Abadie et al. (2023), whose arguments concern the specific case of a binary treatment, write that, once cluster fixed-effects are included, "the cluster standard errors may be unnecessarily large". In an earlier version of their paper, Abadie et al. (2017) write that, with the inclusion of cluster fixed-effects, "heterogeneity in the treatment effect is now a requirement for clustering adjustments to be necessary", which implies that the adjustments may not be required when the effect of the binary treatment is homogeneous, that is, its coefficient is a scaler, a common assumption in non-experimental settings. Even though the present study's

treatment variable, the district relative suitability to rice cultivation, isn't binary, the above justifies the reporting of cluster-*unadjusted* standard errors in cases of the inclusion of state/union territory dummy variables. This reportage is undertaken in Table 3.

Could the estimated positive effect of the district relative suitability to rice cultivation upon the district urban female workforce participation rate be an artifact of selection on unobservables, i.e., of correlation between the former and omitted variables? By Table 4, there is considerable selection on observables in that 'district potential caloric yield of rice less that of wheat' is statistically significantly correlated with several of the other regressors. Therefore, might not there be substantial selection on unobservables as well, capable of biasing the results? Such questions have lately been settled by Oster's (2019) test of robustness. Its test statistic, 'Delta', is the ratio of selection on unobservables to selection on observables necessary to drive the estimated effect of the key explanatory variable to zero upon inclusion in the analysis of all omitted variables. The effect of the key regressor is considered robust when Delta > 1. Since the observables, the included explanatory variables, will have been chosen precisely because they are potential confounders, that is, likely strongly correlated with the key explanatory variable, selection on observables is routinely so high that its eclipsing by selection on unobservables is unlikely. In other words, it is unlikely for the ratio of selection on unobservables to selection on observables to exceed 1. Therefore, if Oster's test yielded a Delta greater than 1, that is, if it were found that the inclusion as regressors of all unobservables would drive the estimated effect of the key regressor to zero only if the ratio of selection on unobservables to selection on observables were greater than 1, it would be surmisable that the estimated effect of the key regressor is unlikely to be driven to zero by the inclusion of all omitted variables. The application of the test to the regression to which column 4 of Table 1 pertain yields 1.9 as the value of Delta, and its application to the regression to which column 4 of Table 2 pertain yields 3.2 as the value of Delta, the test statistic based on state fixed-effects as unrelated controls and 1 as the value of R-squared in a hypothetical regression that includes all observables and unobservables. Consequently, the estimated positive effect of the district relative suitability to rice cultivation upon the district urban female workforce participation rate may be considered robust.

Table 5 presents estimates relating to (3) and (4). By those in column 1, the increase in the district urban female workforce participation rate between 2001 and 2011 was significantly greater in districts in which the potential caloric yield of rice less that of wheat lay between the 1st and 3rd quartiles of its distribution than in districts within the bottom quartile. The estimates in column 2 indicate that this increase was significantly greater in districts better suited to growing rice than wheat. Hence, besides supplying a static boost to urban Indian women's workforce participation, the district relative suitability to rice cultivation apparently supplies a dynamic boost as well. The regressions to which the estimates in columns 4 of Table 1 and Table 2 pertain are, next, augmented by several measures of district geography: the average daily temperature in Celsius, the average daily rainfall in millimeters, nitrogen in the topsoil in parts per million, phosphorous in the topsoil in parts per million, potassium in the topsoil in parts per million, and categories of soil acidity. The ensuing estimates, presented in Table 6, corroborate a positive relationship between 'district potential caloric yield from rice less that from wheat' and the district urban female workforce participation rate. In sum, the results presented in Table 1 – Table 6 indicate that urban female workforce participation is granted a boost by the local relative suitability to growing rice. Again, since urban women are spatially distant from agricultural operations, this effect may not be explained by the labor-intensivity of rice cultivation. Therefore, the conclusion that the effect operates through culture is a reasonable one.

Table 7 reports results ensuing from probit estimation of (5) upon a sample of urban females obtained from the 55th (July 1999 – June 2000) round of the National Sample Survey of Employment and Unemployment. They indicate that the propensity to work of urban females increases, at a decreasing rate, in age, and that male earnings inhibit this propensity, presumably through an income effect. Importantly, they indicate that the impetus to urban females' propensity to work from the local relative suitability to rice cultivation is felt only by those native to the district, consistent with the shaping of their culture by the local agro-ecology. Table 8 presents the results from probit estimation of (6) upon a sub-sample of urban females principally engaged in household domestic work. They indicate that the probability of an urban female principally engaged in household domestic work being *required* to be so engaged significantly decreases in her district's relative suitability to rice cultivation provided that she is a native of the district. This suggests that

cultural norms are less insistent on a domestic role for women in regions of greater relative suitability to rice cultivation. In sum, a cultural boost to female workforce participation proportional to the local relative suitability to rice cultivation may be inferred as well from individual-level data.

4. Conclusion

This study presents evidence of a cultural stimulus to Indian women's workforce participation from rice cultivation. The Danish agricultural economist Esther Boserup had intimated that the advent of the plough, a heavy implement better suited to use by men, so reduced the need for female labor in agriculture that norms upholding a domestic role for women in society persist in plough cultures to this day (Boserup, 1970). This paper points out that wetland rice, consisting of some 94% of world rice output, is an anomaly among 'plough positive' crops in continuing to employ significant female labor on account of its labor-intensivity. It is argued that this may have served to loosen the strictures upon women's work typical of plough cultures, making women in India's districts relatively better suited to growing rice more apt to work.

To untangle rice cultivation's cultural impetus to female workforce participation from its technical impetus, that arising simply from the high labor demands of rice cultivation, this study focuses on the workforce participation of urban women, spatially removed from agriculture. It is found that, even once district per capita income as measured by median per capita expenditure, district soil composition, district ethno-religious composition, district sectoral composition of jobs, district female educational attainment, district urbanization, a variety of aspects of district geography, and state fixed-effects are controlled for, district urban female workforce participation is statistically significantly positively related to the district relative suitability to rice cultivation in data both from the 2001 and 2011 Censuses of India. This positive effect is discernible as well in microdata drawn from the 55th (July 1999 – June 2000) round of the National Sample Survey of Employment and Unemployment. Importantly, these individual-level data reveal that an urban female's propensity to work is positively related to her district's relative suitability to rice cultivation *provided* that she is a native of the district. They also indicate that, of women primarily engaged in household domestic work, those native to districts with greater relative suitability to rice cultivation are less likely to have

been required to be so engaged. Since it is often culture that relegates women to household work, this may be taken as evidence of a weakening of cultural norms insistent upon a domestic role for women in regions of greater relative suitability to rice cultivation.

Krishnapriya (2016) suggests that Indian women's workforce participation may be raised by the means of the following four policy measures. First, women ought to be better prepared for work by investments in their human capital: their formal education and job training. Next, workplace gender discrimination must be stamped out. Further, workplace infrastructure, physical and legal, ought to be made friendlier to women. Such improvement includes the provision of workplace toilets, a safe work environment, and maternity support and childcare. Finally, inimical cultural attitudes to work by women must be transformed. By the findings of this study, these measures may prove more successful in the regions of India relatively better suited to growing rice.

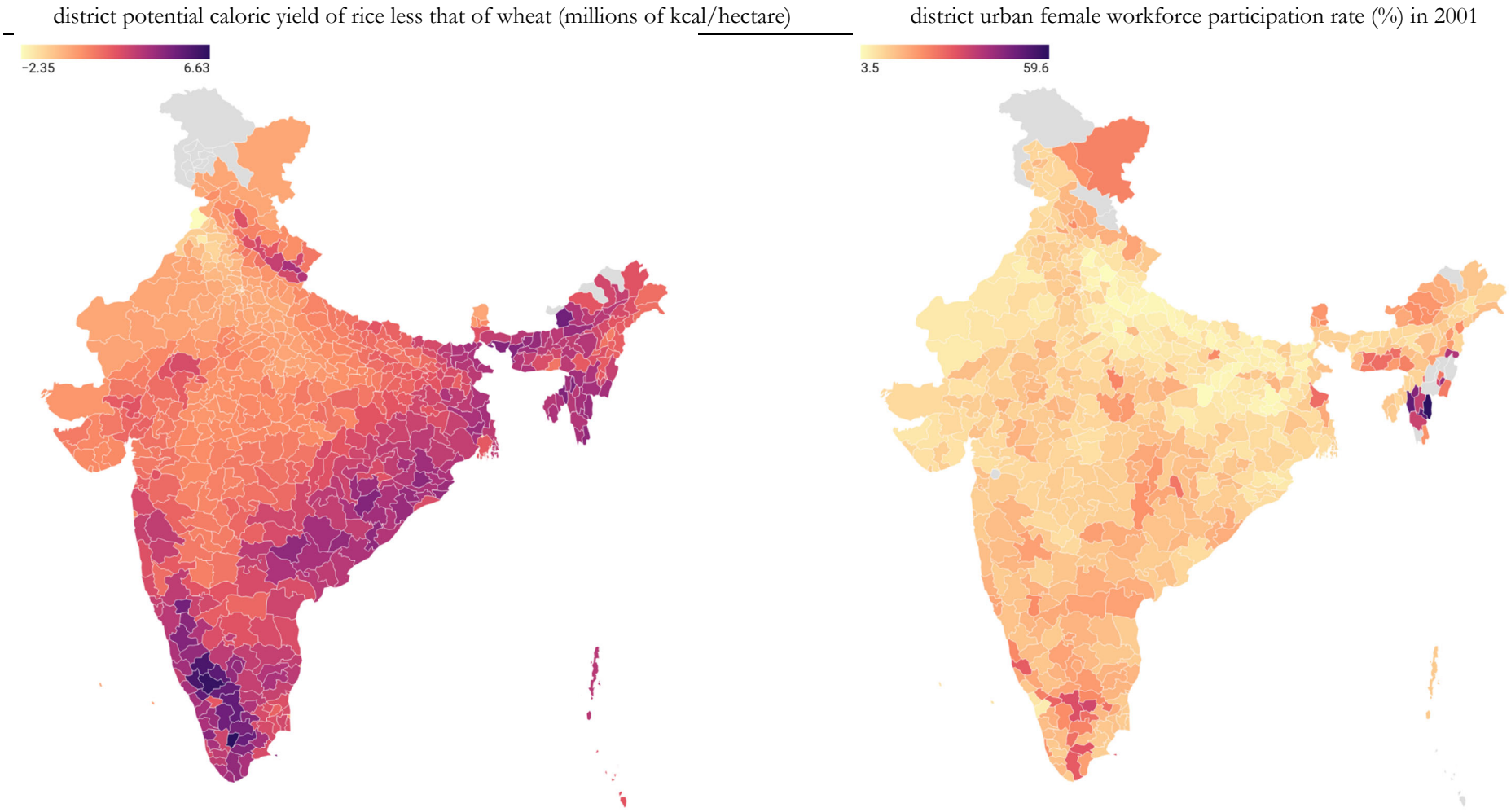

Figure 4 (GAEZ project of the FAO; 2001 Census of India)

Table 1
District Urban Female Workforce Participation in 2001 and the Relative Suitability to Rice Cultivation
Dependent Variable = District Urban Female Workforce Participation Rate (%) in 2001

Variable	Coefficient Estimates				
	(1)	(2)	(3)	(4)	(5)
	(2SLS)	(2SLS)	(OLS)	(OLS)	(OLS)
constant	94.452	29.288	93.227	-13.047	-11.215
	(67.082)	(97.534)	(56.222)	(66.642)	(66.686)
district current caloric yield of rice less that of wheat (millions of kcal/hectare) – instrumented by its analogous potential value	**0.650*** (0.151)**	**1.066** (0.488)**			
district potential caloric yield of rice less that of wheat (millions of kcal/hectare) – obtained from the GAEZ project of the FAO			**1.033*** (0.242)**	**0.701* (0.352)**	
district potential caloric yield of rice (millions of kcal/hectare) – obtained from the GAEZ project of the FAO					**0.682* (0.349)**
district potential caloric yield of wheat (millions of kcal/hectare) – obtained from the GAEZ project of the FAO					**-0.367 (0.484)**
ln(district urban median per capital monthly expenditure in 2001-2002) - obtained from the 57th Round of the National Sample Survey)	-24.763	-3.931	-25.720	11.952	11.284
	(20.576)	(31.416)	(17.286)	(21.567)	(21.590)
square of ln(district urban median real per capital monthly expenditure)	1.918	0.325	1.999	-0.888	-0.841
	(1.570)	(2.395)	(1.329)	(1.659)	(1.661)
% of district land area made up of clayey soils less that made up of loamy soils	-0.005	0.000	-0.011**	-0.004	-0.004
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
district rural female workforce participation rate in 2001	yes	yes	yes	yes	yes
district urban population shares of ethno-religious groups in 2001	yes	yes	yes	yes	yes
district urban sectoral distribution of male employment in 2001	yes	yes	yes	yes	yes
district urban female educational attainment in 2001	yes	yes	yes	yes	yes
district urbanization in 2001	yes	yes	yes	yes	yes
state fixed-effects		yes		yes	yes
Adjusted R-squared	0.65	0.67	0.66	0.77	0.77
N	514	514	514	514	514

Notes: standard errors clustered at state/union territory level in parentheses; * significant at 10%, ** significant at 5%, *** significant at 1%

Table 2
District Urban Female Workforce Participation in 2011 and the Relative Suitability to Rice Cultivation
Dependent Variable = District Urban Female Workforce Participation Rate (%) in 2011

Variable	Coefficient Estimates				
	(1)	(2)	(3)	(4)	(5)
	(2SLS)	(2SLS)	(OLS)	(OLS)	(OLS)
constant	311.700	192.922	180.115	291.326*	281.534*
	(198.929)	(128.579)	(162.065)	(162.216)	(154.803)
district current caloric yield of rice less that of wheat (millions of kcal/hectare) – instrumented by its analogous potential value	**0.611*** (0.158)**	**0.840** (0.398)**			
district potential caloric yield of rice less that of wheat (millions of kcal/hectare) – obtained from the GAEZ project of the FAO			**0.933*** (0.297)**	**0.567* (0.286)**	
district potential caloric yield of rice (millions of kcal/hectare) – obtained from the GAEZ project of the FAO					**0.549* (0.287)**
district potential caloric yield of wheat (millions of kcal/hectare) – obtained from the GAEZ project of the FAO					**-0.181 (0.465)**
ln(district urban median per capital monthly expenditure in 2011-2012) - obtained from the 68th Round of the National Sample Survey)	-51.563	-30.236	-29.454	-45.336	-43.913*
	(33.186)	(21.459)	(27.026)	(26.987)	(25.822)
square of ln(district urban median real per capital monthly expenditure)	2.183	1.330	1.260	1.908*	1.852*
	(1.390)	(0.903)	(1.131)	(1.125)	(1.077)
% of district land area made up of clayey soils less that made up of loamy soils	0.003	0.007	-0.004	0.002	0.002
	(0.006)	(0.006)	(0.006)	(0.004)	(0.004)
district rural female workforce participation rate in 2011	yes	yes	yes	yes	yes
district urban population shares of ethno-religious groups in 2011	yes	yes	yes	yes	yes
district urban sectoral distribution of male employment in 2011	yes	yes	yes	yes	yes
district urban female educational attainment in 2011	yes	yes	yes	yes	yes
district urbanization in 2011	yes	yes	yes	yes	yes
state fixed-effects		yes		yes	yes
Adjusted R-squared	0.62	0.71	0.63	0.80	0.80
N	513	513	513	513	513

Notes: standard errors clustered at state/union territory level in parentheses; * significant at 10%, ** significant at 5%, *** significant at 1%

Table 3
District Urban Female Workforce Participation and the Relative Suitability to Rice Cultivation: Cluster-Unadjusted Standard Errors
Dependent Variable = District Urban Female Workforce Participation Rate (%)

Variable	Coefficient Estimates					
		2001			2011	
	(2SLS)	(OSLS)	(OSLS)	(2SLS)	(OLS)	OLS
constant	29.288	-13.047	-11.215	192.922	291.326**	281.534**
	(65.192)	(60.186)	(59.991)	(139.204)	(124.449)	(182.828)
district current caloric yield of rice less that from wheat	**1.066*** **			**0.840*** **		
(millions of kcal/hectare) – instrumented	**(0.346)**			**(0.297)**		
district potential caloric yield of rice less that from wheat		**0.701*** **			**0.567*** **	
(millions of kcal/hectare)		**(0.211)**			**(0.181)**	
district potential caloric yield of rice			**0.682*** **			**0.549*** **
(millions of kcal/hectare)			**(0.210)**			**(0.181)**
district potential caloric yield of wheat			**-0.367**			**-0.181**
(millions of kcal/hectare)			**(0.347)**			**(0.313)**
ln(district urban median per capital monthly expenditure	-3.931	11.952	11.284	-30.236	-45.336**	-43.913**
	(20.453)	(18.944)	(18.880)	(22.946)	(20.590)	(20.307)
square of ln(district urban median real per capital monthly expenditure)	0.325	-0.888	-0.841	1.330	1.908**	1.852**
	(1.556)	(1.449)	(1.444)	(0.950)	(0.853)	(0.841)
% of district land area made up of clayey soils less that made up of	0.0001	-0.004	-0.004	0.007*	0.002	0.002
loamy soils	(0.005)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)
district rural female workforce participation rate	yes	yes	yes	yes	yes	yes
district urban population shares of ethno-religious groups	yes	yes	yes	yes	yes	yes
district urban sectoral distribution of male employment	yes	yes	yes	yes	yes	yes
district urban female educational attainment	yes	yes	yes	yes	yes	yes
district urbanization	yes	yes	yes	yes	yes	yes
state fixed-effects	yes	yes	yes	yes	yes	yes
Adjusted R-squared	0.67	0.77	0.77	0.71	0.80	0.80
N	514	514	514	513	513	513

Notes: robust standard errors in parentheses; * significant at 10%, ** significant at 5%, *** significant at 1%

Table 4
Selection on Observables
Pairwise Correlations Between Key Regressor and Select Other Regressors

Correlation Between **district potential caloric yield of rice less that of wheat** and	Coefficients of Correlation (2001)	(2011)
ln(district urban median real per capital monthly expenditure)	0.0886*	0.0064
% of district land area made up of clayey soils less that made up of loamy soils	-0.0778*	-0.0676
% of Muslims in the district urban population	-0.1057*	-0.0663
% of Christians in the district urban population	0.1734*	0.1431*
% of Sikhs in the district urban population	-0.3749*	-0.3652*
% of Buddhists in the district urban population	-0.0325	-0.0288
% of Jains in the district urban population	-0.2427*	-0.0724
% of Scheduled Castes in the district urban population	-0.2327*	-0.2127*
% of Scheduled Tribes in the district urban population	0.1453*	0.1122*
% of district urban female population with some schooling though not high school diploma	0.3916*	0.3898*
% of district urban female population with high school diploma though no further education	0.1410*	0.2297*
% of district urban female population with post-secondary qualifications	-0.0915*	-0.1105*
% of district population resident in an urban area	-0.0523	-0.0481
N	514	513

Notes: * significant at the 10%, or lower, level

Table 5
The Evolution of District Urban Female Workforce Participation between 2001 and 2011 and the Relative Suitability to Rice Cultivation
Dependent Variable = District Urban Female Workforce Participation Rate

Variable	OLS Coefficient Estimates	
	(1)	(2)
constant	16.531***	11.943***
	(2.258)	(2.249)
indicator of district potential caloric yield of rice less that of wheat lying between the	1.400***	
1st and 2nd quartiles of its distribution × indicator of year = 2011	(0.399)	
indicator of district potential caloric yield of rice less that of wheat lying between the	1.028***	
2nd and 3rd quartiles of its distribution × indicator of year = 2011	(0.398)	
indicator of district potential caloric yield of rice less that of wheat exceeding the	0.454	
3rd quartile of its distribution × indicator of year = 2011	(0.404)	
indicator of district potential caloric yield of rice less that of wheat > 0 × indicator of year = 2011		1.475***
		(0.454)
indicator of year = 2011	2.119***	1.530***
	(0.282)	(0.428)
district fixed-effects	yes	yes
Adjusted R-squared	0.87	0.87
N	1027	1027

Notes: * significant at 10%, ** significant at 5%, *** significant at 1%

Table 6
District Urban Female Workforce Participation and the Relative Suitability to Rice Cultivation
Robustness: Geographical Controls
Dependent Variable = District Urban Female Workforce Participation Rate

Variable	OLS Coefficient Estimates			
	(2001)		(2011)	
	(1)	(2)	(3)	(4)
constant	-35.080	-35.080	14.211	14.211
	(78.822)	(71.028)	(85.364)	(142.384)
district potential caloric yield of rice less that of wheat	**1.028****	**1.028*****	**0.931****	**0.931*****
(millions of kcal/hectare)	**(0.468)**	**(0.235)**	**(0.339)**	**(0.212)**
ln(district urban median real per capital monthly expenditure)	19.502	19.502	0.134	0.134
	(25.033)	(21.856)	(14.693)	(23.602)
square of ln(district urban median real per capital monthly expenditure)	-1.516	-1.516	0.005	0.005
	(1.908)	(1.665)	(0.608)	(0.978)
% of district land area made up of clayey soils less that made up of loamy soils	0.002	0.002	0.002	0.002
	(0.005)	(0.004)	(0.003)	(0.004)
geographical controls (temperature, rainfall, and soil nutrient content and acidity)	**yes**	**yes**	**yes**	**yes**
district rural female workforce participation rate	yes	yes	yes	yes
district urban population shares of ethno-religious groups	yes	yes	yes	yes
district urban sectoral distribution of male employment	yes	yes	yes	yes
district urban female educational attainment	yes	yes	yes	yes
district urbanization	yes	yes	yes	yes
state fixed-effects	yes	yes	yes	yes
Adjusted R-squared	0.74	0.74	0.77	0.77
N	342	342	341	341

Notes: standard errors clustered at state level in parentheses in cols. (1) and (3); cluster-unadjusted standard errors in parentheses in cols. (2) and (4);
* significant at 10%, ** significant at 5%, *** significant at 1%

Table 7
Urban Female Propensity to Work and the Relative Suitability to Rice Cultivation:
Evidence from 1999-2000 NSS Microdata
Dependent Variable = Indicator of Work over the Preceding Year

Variable	Probit Coefficient Estimates		
constant	-1.283*	-1.394*	-1.340*
	(0.747)	(0.748)	(0.706)
district potential caloric yield of rice less that of wheat (millions of kcal/hectare)	**0.041*** **	**0.001**	**-0.034***
	(0.014)	**(0.017)**	**(0.020)**
district potential caloric yield of rice less that of wheat (millions of kcal/hectare) × indicator of being native to the district (last usual place of residence lies within present district)		**0.051*** **	**0.044*** **
		(0.012)	**(0.011)**
currently married	0.023	0.028	0.025
	(0.026)	(0.027)	(0.027)
age in years	0.117***	0.118***	0.119***
	(0.003)	(0.003)	(0.003)
square of age	-0.001***	-0.001***	-0.002***
	(0.00004)	(0.00004)	(0.00004)
ln(household male weekly earnings)	-0.107***	-0.106***	-0.107***
	(0.007)	(0.007)	(0.008)
square of ln(household male weekly earnings)	-0.014***	-0.014***	-0.014
	(0.001)	(0.001)	(0.001)
% of district land area made up of clayey soils less that made up of loamy soils	0.00002	0.00005	0.00001
	(0.0003)	(0.0003)	(0.0004)
educational category (completion of primary, middle, secondary, or higher secondary school, or college)	yes	yes	yes
religion	yes	yes	yes
district urban sectoral distribution of male employment per 2001 Census	yes	yes	yes
district urbanization per 2001 Census	yes	yes	yes
state fixed-effects			yes
Pseudo R-squared	0.18	0.18	0.19
Log-pseudolikelihood	-1.201×10^{8}	-1.199×10^{8}	-1.191×10^{8}
N	106,385	106,385	106,385

Notes: standard errors clustered at district level in parentheses; * significant at 10%, ** significant at 5%, *** significant at 1%

Table 8
Compulsion in Urban Female Confinement to Domestic Duties and the Relative Suitability to Rice Cultivation:
Evidence from 1999-2000 NSS Microdata
Dependent Variable = Indicator of Compulsion in Principal Activity over the Past Year being Domestic Duties

Variable	Probit Coefficient Estimates		
constant	-0.082	-0.009	-0.058
	(0.501)	(0.498)	(0.570)
district potential caloric yield of rice less that of wheat (millions of kcal/hectare)	**-0.075*** **	**-0.036**	**-0.010**
	(0.021)	**(0.024)**	**(0.031)**
district potential caloric yield of rice less that of wheat (millions of kcal/hectare) × indicator of being native to the district (last usual place of residence lies within present district)		**-0.053*** **	**-0.043*** **
		(0.015)	**(0.015)**
currently married	0.271***	0.262***	0.260***
	(0.041)	(0.041)	(0.041)
age in years	0.061***	0.061***	0.062***
	(0.006)	(0.006)	(0.006)
square of age	-0.001***	-0.001***	-0.001***
	(0.0001)	(0.0001)	(0.0001)
ln(household male weekly earnings)	-0.003	-0.005	-0.004
	(0.010)	(0.010)	(0.010)
square of ln(household male weekly earnings)	-0.0004	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
% of district land area made up of clayey soils less that made up of loamy soils	-0.001**	-0.001**	-0.001
	(0.0006)	(0.0006)	(0.001)
educational category (completion of primary, middle, secondary, or higher secondary school, or college)	yes	yes	yes
religion	yes	yes	yes
district urban sectoral distribution of male employment per 2001 Census	yes	yes	yes
district urbanization per 2001 Census	yes	yes	yes
state fixed-effects			yes
Pseudo R-squared	0.05	0.05	0.06
Log-pseudolikelihood	-47199189	-47117292	-46391052
N	47,493	47,493	47,493

Notes: standard errors clustered at district level in parentheses; * significant at 10%, ** significant at 5%, *** significant at 1%

References

Abadie, A., Athey, S., Imbens, G. W., and Wooldridge, J. M., 2017. When Should You Adjust Standard Errors for Clustering? NBER Working Paper 24003, Cambridge: National Bureau of Economic Research.

Abadie, A., Athey, S., Imbens, G. W., and Wooldridge, J. M., 2023. When Should You Adjust Standard Errors for Clustering? *The Quarterly Journal of Economics*, 138(1), pp. 1-35.

Afridi, F., Bishnu, M., and Mahajan, K., 2019. What Determines Women's Labor Supply? The Role of Home Productivity and Social Norms. *IZA Discussion Paper No. 12666*, Bonn: Institute of Labor Economics.

Afridi, F., Mukhopadhyay, A., and Sahoo, S., 2016. Female Labor Force Participation and Child Education in India: Evidence from the National Rural Employment Guarantee Scheme. *IZA Journal of Labor and Development*, 5, Article 7.

Alesina, A., Giuliano, P., and Nunn, N., 2013. On the Origin of Gender Roles: Women and the Plough. *The Quarterly Journal of Economics*, 128(2), pp. 469-530.

Anderson, S., 2011. Caste as an Impediment to Trade. *American Economic Journal: Applied Economics*, 3(1), pp. 239-263.

Bernhardt, A., Field, E., Pande, R., Rigol, N., Schaner, S., and Troyer-Moore, C., 2018. Male Social Status and Women's Work. *American Economic Association Papers and Proceedings*, 108, pp. 363-367.

Boserup, E., 1970. *Women's Role in Economic Development*. London & Sterling, VA: Earthscan.

Buck, J. L., 1937. *Land Utilization in China: Statistics*. Chicago: The University of Chicago Press.

Cameron, A. C. and Miller, D. L., 2015. A Practitioner's Guide to Cluster-Robust Inference. *The Journal of Human Resources*, 50(2), pp. 317-372.

Carranza, E., 2014. Soil Endowments, Female Labor Force Participation, and the Demographic Deficit of Women in India. *American Economic Journal: Applied Economics*, 6(4), pp. 197-225.

Croll, E., 1979. *Women in Rural Development: The People's Republic of China*. Geneva: International Labor Office.

Elert, E., 2014. Rice by the Numbers: A Good Grain. *Nature*, 514(7524): pp. S50-51.

Galor, O. and Ozak, O., 2016. The Agricultural Origins of Time Preference. *American Economic Review*, 106(10), pp. 3064-3103.

Hansen, C. W., Jensen, P. S., and Skovsgaard, C., 2015. Modern Gender Roles and Agricultural History: The Neolithic Inheritance. *Journal of Economic Growth*, 20(4), pp. 365-404.

Hazarika, G., Jha, C. K., and Sarangi, S., 2019. Ancestral Ecological Endowments and Missing Women. *Journal of Population Economics*, 32(4), pp. 1101–1123.

Himanshu, 2011. Employment Trends in India: A Re-Examination. *Economic and Political Weekly*, 46(37), pp. 43-59.

IRRI, 1983. *Women in Rice Farming*. Manila: The International Rice Research Institute.

Jabbar, M. A. and Faruque, A. K. M., 1978. Labour Requirements for Production of Major Crops in Bangladesh. *Bangladesh Journal of Agricultural Economics*, 1(1), pp. 101-113.

Klasen, S. and Pieters, J., 2015. What Explains the Stagnation of Female Labor Force Participation in Urban India? *The World Bank Economic Review*, 29(3), pp. 449-478.

Krishnapriya, P. P., 2016. How to Get More Women Working in India. *World Bank Blogs*, Feb. 17.

Oster, E. (2019). Unobservable selection and coefficient stability: Theory and evidence. *Journal of Business & Economic Statistics*, 37(2), pp. 187-204.

Qian, N., 2008. Missing Women and the Price of Tea in China: The Effect of Sex-Specific Earnings on Sex Imbalance. *The Quarterly Journal of Economics*, 123(3), pp. 1251-1285.

Topalova, P., 2010. Factor Immobility and Regional Impacts of Trade Liberalization: Evidence on Poverty from India. *American Economic Journal: Applied Economics*, 2(4), pp. 1-41.

Zelinksy, W., 1973. *The Cultural Geography of the United States*. Englewood Cliffs, New Jersey: Prentice Hall.