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Journal of economics and political economy

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Reference: Kundu, Amit/Das, Sangita (2019). Gender wage gap in the agricultural labor market of India : an empirical analysis. In: Journal of economics and political economy 6 (2), S. 122 - 142.
doi:10.1453/jepe.v6i2.1872.

This Version is available at:

<http://hdl.handle.net/11159/4193>

Kontakt/Contact

ZBW – Leibniz-Informationszentrum Wirtschaft/Leibniz Information Centre for Economics
Düsternbrooker Weg 120
24105 Kiel (Germany)
E-Mail: [rights\[at\]zbw.eu](mailto:rights[at]zbw.eu)
<https://www.zbw.eu/econis-archiv/>

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Journal of
Economics and Political Economy

www.kspjournals.org

Volume 6

June 2019

Issue 2

**Gender wage gap in the agricultural labor market
of India: An empirical analysis**

By Amit KUNDU ^a
& Sangita DAS ^{b†}

Abstract. The gender wage gap in the agricultural labor market is observed in all the states of India. This paper will try to identify possible policies which can reduce this gender wise wage discrimination in agricultural labor market. We consider the period between 2010-11 to 2015-16 and 18 major states of India. The possible factors which can create an impact on gender wage gap are the expansion of MGNREGP, Self Help Group, primary education among rural women, expenditure on the social sector as a percentage of Net state domestic products and the cropping intensity. It initially assumes that Cropping Intensity of a state in a specific time is very much dependent on the net irrigated area of that state in that time. Our endogeneity test supports our claim. So, Instrumental variable method is applied in our Fixed Effect panel regression. The result shows that expansion of primary education among women, the number of self-help groups in the state and enhancement of cropping intensity through improving irrigation facility can play a significant role to reduce the male and female wage discrimination in the agricultural labor market in India. But participation of women in MGNREGP and social sector expenditure as a percentage of NSDP fails to create any impact on the gender wage gap.

Keywords. Agricultural labor market, Gender wage gap, Panel data, Instrumental variable.
JEL. C23, C26, J16, J43.

1. Introduction

The gender wage gap, the difference between male and female average wage rate has long been noted and debated in the Indian agricultural labor market. It is observed that the female agricultural laborers do not enjoy an equal or equivalent wage rate for the same or equivalent work as compared to the male agricultural laborers. In 1976, the Equal Remuneration Act was adopted for equal pay both of male and female agricultural laborers for the "same work or work of a similar nature" to protect the rights of the female laborers against unfair wage practices. Still, it is observed that the female wage rates are not yet equal or equivalent to the male wage rates. Instead, an absolute gender wage disparity has been observed over time. As per census 2011, among the total rural workforce,

^a Department of Economics, Jadavpur University, Kolkata, 700032, West Bengal, India.

✉. +91 983 050 5312 ✉. akundu1970@gmail.com

^{b†} Department of Economics, Jadavpur University, Kolkata, 700032, West Bengal, India.

✉. +91 983 050 5312 ✉. dassangita844@gmail.com

female laborers classified as farm laborers is 38.9 percent compared to the 20.8 percent male agricultural laborers. Mencher & Saradamoni (1982) have observed that the female laborers, mainly among the landless (or marginal farmer) households contribute more than half (or close to half) of the total family income and most importantly without the women's income; these households might not be able to fulfill their basic needs¹. Despite performing similar work under the same working condition, the female laborers are mostly unorganized and unaware of their constitutional rights. Therefore, more than 90 percent of the rural females are treated as a cheap and secondary source of laborers (Javeed & Manuhaar, 2013).

In Indian agricultural labor market, it is believed that female agricultural laborers cannot do heavy work due to their low muscle strength and malnutrition². It is often argued that the male laborers due to their greater physical strength and energy are more productive and efficient than the female laborers and hence from the point of view of the employer; the male laborers deserve to have better wage rates and more person-days compared to the female laborers even for the same agricultural task (Kundu, 2013). It is observed in every state of India that the female agricultural laborers are not employed during the time of ploughing. Even for the gender-neutral tasks such as weeding, sowing, transplanting, and harvesting, the female laborers are still largely discriminated from the male laborers in terms of wage rates. In this background, we shall try to understand the trends in the wage gap between the male and female agricultural laborers during 2010-11 to 2015-16 and identify the possible factors which are mainly responsible for this gender-related wage discrimination in the agricultural labor market of India. Besides that, we want to identify some policies which can reduce or remove this gap among the hired laborers in the farm sector.

2. Literature review

There has already been a substantial amount of research studies on various dimensions of agricultural laborers since the first Agricultural Census initiated by the Government of India in 1970-71. Unni (1988) has tried to capture the trends in employment and wages for agricultural laborers across 14 major states in India. The paper has explained how the fluctuations in real wages and agricultural output have adversely reflected on the living standards of the laborers over the years. Although the annual money and real wage earnings for female laborers have been increasing at a faster rate than that of the male laborers, average female earnings have remained much lower than that of the male laborers during the period between 1956-57 and 1977-78. Chavan & Bedamatta (2006) have analyzed that the long-term trends of the real agricultural wages of male and female laborers based on secondary data from agricultural wages of India (AWI) and Rural Labor Enquiry (RLE) across 17 major states in India during the period between 1964-65 and 1999-2000. By deflating money wage series into real wage series using both the retail price index of cereals and Consumer Price Index of Agricultural Laborer, their study has found that

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the real wages of male laborers have been increasing at a much faster rate than that of the female laborers.

Consequently, male-female gender wage disparity has widened across states between 1987-88 and 1993-94. Furthermore, the paper has also compared the male and female real agricultural wage rate with the statutory minimum wage rate and concluded that the male agricultural wage rate exceeds the minimum wage rate whereas the female agricultural wage rate is far below the statutory minimum wage rate. Using two data sets - Agricultural wages in India (AWI) and Wage Rate in Rural India (WRI), Usami (2011) has compared the patterns of the wage differential between agricultural laborers and the rural non-farm laborers. She has also captured the regional variation of the real wage rates and identified the states with higher wage rates (Rs. 40 and above) are Kerala, J&K, HP, Punjab, and Haryana while, states with lower wage rates (Rs. 15 and less) are M.P, Bihar, Orissa, UP and Karnataka. Jose (2013) has tried to capture the fluctuations in both the male and female wages in monetary and real terms across different states in India based on the various rounds of NSSO data during 1999-2000 and 2009-10. His study has measured the gender wage disparity by calculating the ratio of women's wage to that of men's. It was shown that the concentration of gender wage disparity (threshold is above 75 percent) is high in the southern states such as Kerala, A.P, Karnataka and Tamil Nadu, whereas, the states with low gender wage disparity (below 75 percent) are Haryana, Punjab, and Rajasthan.

Inter-state comparison of agricultural wages between male and female laborers at an aggregate level is not easily amenable during a specific time frame as the states are experiencing various agro-climatic conditions and crop cultural practices. It is better to understand some of the explanatory factors subject to the wage variation at a state level which can explain the observed gender wage inequality in agriculture (Jose, 1988; 2013). In this field, Acharya (1989) has attempted to analyze the disaggregated wage series of male and female separately over 320 districts in the country during 1970-85 and used the semi-logarithmic regression equation to determine the growth and trend in the agricultural wage rate. He has shown that migration, distribution of land asset and occupational diversifications have driven the farming wage rate to reduce regional wage variation. Several empirical studies have observed that the MGNREGA impacts positively on women workers in the rural labor market (Chandrasekhar & Ghosh, 2011). Using data from 2004-05 NSSO survey, Dasgupta & Sudarshan (2011) have also found that that women's participation in the MGNREGA has been increasing over the years and is negatively correlated with the existing gender wage gap in the unskilled agricultural labor market. This relationship can be explained adequately if we consider at least six financial years. But that is absent in the above analysis. To identify the impact of MGNREGP on the labor force participation, Azam (2012) has examined two additional factors such as public works participation and casual real wages on the gender wage gap based on the NSSO data during 1983-2004.

By applying the difference-in-difference method, the paper has observed that the female wage rate is 8% higher in the districts where MGNREGA has been implemented than the districts where it is yet to be functioning. MGNREGP that pay the minimum wage, targeting women during post rainy season can help to reduce the gender wage gap in the agricultural labor market. Narayan (2008) based on her research in rural Tamil Nadu observed that this public work program has benefitted rural women. Mahajan (2017) explained that cultural restriction on female labor supply and influence of non-farm employment opportunities among male laborers in the rural area is the reason behind the gender wage gap in the agricultural labor market. Their study identified 55% on gender wage differential among the northern and southern states of India, and they got 45% variation as unexplained. In another critical study, Jose (2013) has recognized several possible variables such as growth rate of NSDP (Net State Domestic Product) per capita, demographic dividend and migration, MGNREGA and social spending as determinants of the rural wages, which can explain the differential growth rates of wages over time. But no specific study has yet to be done to determine the possible factors due to which in some states the gap is wider and in some states, it is not so wide. Here, we have considered some of the potential factors such as female's employment participation in MGNREGA, female education along with three additional factors namely the land use cropping intensity, the total number of self-help group in the state and social expenditure as a percentage of NSDP in order to investigate whether these can play a significant role in explaining the variations of the gender wage discrimination across Indian states.

3. Research objectives

In this paper initially, we want to investigate the nature of variations of the money wage gap between male and female agricultural laborers across 18 major states in India over the period between 2010-11 and 2015-16.

Secondly, we shall try to identify the possible factors which can reduce this gender-based wage discrimination among the agricultural laborers in India.

3.1. Variations of the gender wage gap: Inter-state comparison

This investigation is based on the secondary data available in 'Agricultural wage income (AWI) in India, which is provided by the Directorate of Economics and Statistics (DES), Government of India. The longitudinal data for 18 major states at six-time points (2010-11 to 2015-16) is considered here³. To understand the changing scenario of the gender wage discrimination of agricultural laborers during the mentioned period, two indicators –ranking of states based on average daily money wage and absolute gender wage gap are initially considered.

Initially, the average money wage rate of the agricultural laborers (both male and female) in 18 major Indian states in the concerned periods are considered. Then, the rank of 18 major states in India on average money

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wages has separately been constructed for male and female agricultural laborers over 2010-11 to 2015-16.

Table 1. *Ranking of Indian States by Average Daily Money Wage of Male and Female Agricultural Laborers*

State	2010-11		2011-12		2012-13		2013-14		2014-15		2015-16	
	M	F	M	F	M	F	M	F	M	F	M	F
Andhra Pradesh	4	6	5	6	5	7	5	9	6	7	5	11
Assam	13	12	11	13	11	11	9	11	9	10	10	10
Bihar	10	8	12	12	8	5	12	10	12	8	13	9
Chhattisgarh	18	18	17	18	17	18	17	17	16	17	16	17
Gujarat	12	10	13	9	16	13	15	13	15	13	17	15
Haryana	2	2	2	2	2	2	2	2	2	2	2	2
Himachal Pradesh	6	4	7	5	7	4	10	5	8	4	7	3
Jharkhand	14	11	18	14	18	17	16	14	17	14	15	14
Karnataka	8	5	8	4	9	6	7	4	5	3	8	5
Kerala	1	1	1	1	1	1	1	1	1	1	1	1
Madhya Pradesh	15	13	14	11	14	12	13	12	14	12	14	12
Maharashtra	17	16	16	17	13	14	18	18	18	18	18	18
Orissa	16	17	15	16	15	15	14	15	13	15	12	13
Rajasthan	7	14	6	10	6	8	6	6	7	5	4	4
Tamil Nadu	5	15	4	15	4	16	4	16	3	16	3	16
Tripura	3	3	3	3	3	3	3	3	4	6	6	6
Uttar Pradesh	11	7	10	8	10	9	11	8	11	9	11	8
West Bengal	9	9	9	7	12	10	8	7	10	11	9	7

Source: Calculated by authors.

Table 1 shows the ranking of average money wage rate (both male and female) of 18 major states of India between 2010-11 to 2015-16. Due to substantial variations of the money wage rate, it is quite difficult to observe any definite trends of ranking across states over the years. As for male agricultural wage rate, among the eighteen states, only in three top-ranking states- Kerala, Haryana and Tripura and the three bottom-ranking states- Chhattisgarh, Maharashtra, and Jharkhand have invariably shown their same ranking position throughout the period. The ranking of the above states as reported by female wage rate is also shown a similar pattern that of male laborers.

3.2. Gender disparities in Average money wage rate:

Now the gender wise wage gap in the agricultural sector in our concerned periods (between 2010-11 to 2015-16) in 18 major states of India is considered. It is presented in Table 2. The gender wage gap in absolute magnitude is calculated as the difference between male and female average money wage rate. It is calculated as the difference between average money wage rate of the male agricultural worker in a state in any particular time and the average money wage rate of the female agricultural laborer of that state in that period. Here we have considered the money wage rate instead of the real wage rate because the farming laborers are suffering from money illusion due to their illiteracy and ignorance about the real purchasing power of commodity bundle. So during the time of wage determination, both male and female agricultural laborers give more importance to money wage rate (Kundu, 2006). This measurement is also

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better because, during the time of comparing gender wage gap of different states in a particular time or same state in different periods, this gender-based wage gap in monetary terms can be utilized as an indicator in a much better way.

Table 2. *Gender Wage Gap in The Agricultural Sector in the 18 Major States of India in Different Years (in Terms of Rupees)*

State	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Andhra Pradesh	38.29	53.02	68.12	66.78	82	95.53
Assam	22.33	28.8	39.15	42.95	52	44.83
Bihar	17.39	25.31	18.37	20.11	10	12.4
Chhattisgarh	18.76	29.75	36.69	45.68	52	46.84
Gujarat	11.85	14.25	15.72	16.9	24	20.3
Haryana	39.89	51.58	46.63	49.22	64	66.72
Himachal Pradesh	30.13	28.92	25.08	20.19	19	23.83
Jharkhand	6.15	4.5	8.75	14.08	16.72	11.9
Karnataka	5.01	18.58	19.59	22.2	44	27.36
Kerala	70.04	81.14	96.86	111	130	149.44
Madhya Pradesh	11.37	14.62	17.97	22.53	25	29.34
Maharashtra	20	28.12	50	25.46	52	60
Orissa	22.72	30.67	33.31	43.63	47	51.2
Rajasthan	58.11	65.25	51.89	48.91	58	53.01
Tamil Nadu	77.01	98.21	133.4	130.57	173	192.66
Tripura	47.3	62.86	72.63	70.87	68	62.94
Uttar Pradesh	8.3	19.53	25.49	22.87	35	22.3
West Bengal	19.9	25.52	29.74	32.91	45	40.22
All India	32.89	45.03	49.14	50.3	64	63.56

Source: Calculated by the authors.

Table 2 shows gradual enhancement of the male-female wage gap among the agricultural laborers in the states like Kerala, Tamil Nadu, Andhra Pradesh. In Jharkhand, Gujarat, Bihar, and Uttar Pradesh, the absolute gender wage gap is observed low over the years. Out of the eighteen states considered here, only in three states, i.e. in Bihar, Himachal Pradesh, and Rajasthan, the absolute gender wage gap has shown a declining trend over 2010-11 to 2015-16. The most obvious fact from the Table-2 is that there is no clear, definite trend towards an increase or decrease of wage disparity in absolute monetary terms showing the prevalence of substantial variations of gender wage gap across states during our period of analysis. To explain this paradoxical situation of gender wage gap, Chen (1989) has examined the variation of female labor force participation rate based on six agro-ecological conditions in India and observed that female labor force participation rate is higher in the rice-growing belt of the eastern and southern states compared to wheat growing belt of the North-Western states. The structural constraints of each specific state such as gender biases and caste linked social barrier restrict the women's employment participation in the agricultural labor market especially in rain-fed paddy growing states such as West Bengal, Orissa, and Bihar. Agarwal (1984, 1986) has also shown that female labor force participation rate is higher in high productive paddy growing states like Andhra Pradesh.

In these circumstances, there is a need to examine the possible factors

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which are responsible for gender wage discrimination in the Indian agricultural labor market. Panel data regression is applied here to evaluate the influence of different factors possibly responsible for reducing the gender wage gap in agriculture.

Before going for this investigation, we initially calculate the Gender Wage Gap Index (GWPI) of each state in each period in the Agricultural Labor Market⁴. This is used here as an explained variable in this investigation. Gender Wage Gap Index of the i^{th} state in the t^{th} period this measured in the following way:

$$GWPI_{it} = \frac{\text{Mean Male Agricultural Wage Rate}_{it} - \text{Mean Female Agricultural Wage Rate}_{it}}{\text{Mean Male Agricultural Wage Rate}_{it}} \times 100$$

The higher value of GWPI indicates more gender-based wage disparity in the agricultural labor market. Now to identify the possible factors which can reduce this disparity over time, we have taken the help of Panel data regression. The chosen explanatory variables in our investigation and the theoretical justifications behind choosing these explanatory variables are given below:

1. Percentage of the female population (Age group 15-49 years) by the level of primary education in India (priedu): The main aim of the National Policy on Education, 1968 was to promote the women's education at a minimum direct cost which would bring social justice and help to accelerate social transformation. National policy on Education, 1986 has further stressed on reducing the gender disparity by providing the basic education to women as literacy is the instrument of their empowerment and self-awareness and living standard. Recently we observe the expansion of Sarva Shiksha Abhiyan and implementation of the right to education act. It is therefore hypothesized that the higher percentage of primary education for a female would have a positive impact on agricultural wage of the female labor force. Better educational attainment may help the women to get better bargaining power which is expected to reduce gender disparity in terms of wage.
2. Percentage of women's participation in MGNREGP (wpermgnrp): An important aspect of Mahatma Gandhi National Rural Employment Guarantee Programme (MGNREGP) is equal wage to both male and female participant in any state or region in any particular period. Percentage of women's participation in MGNREGP in a state in a year is calculated by dividing the total number of days of employment participation of women of that state in that financial year by the total number of person-days generated in MGNREGP in that state in that particular financial year. In most of the states, MGNREGP wage rate is determined at least above the market wages for the female agricultural worker (Jose, 2013). Figure stated in Table-5 in Appendix shows that the states such as Assam (2010-11), Chhattisgarh (2010-16), Jharkhand (2010-12 and 2014-15), Madhya Pradesh (2010-11), Maharashtra (2010-11) and Orissa (2010-16) are experiencing wage rate in MGNREGP which is in

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between the female and the male agricultural wage rates. MGNREGP wage rate creates a little impact on the wage rate of the farm laborers in West Bengal (Kundu 2016). But no proper investigation has yet done to investigate whether the expansion of MGNREGP among unskilled female labor can reduce the gender wage gap in the agricultural labor market. The agricultural wage of female farm laborers may be directly affected because through participation in MGNREGP, a female laborer gets alternative employment opportunity and due to a decrease of female labor supply, the wage rate of the female laborer in the agricultural sector may be enhanced. Therefore, it is investigated whether a higher percentage of women's participation in MGNREGP can play an important role to reduce the gender wage gap in agriculture?

3. **Cropping intensity (cropint):** In agriculture, higher cropping intensity⁵ is one of the possible demands inducing factors of labor. An increase in cropping intensity through multiple cropping leads to higher demand for both male and female laborers. In a male-dominated village community, the unskilled male laborers always have alternative employment opportunities in the private non-farm sector or MGNREGP or through migrating to other areas. Due to cultural and other family-related factors, female members have little alternative opportunity mainly outside the native village. So, when the farmer has to hire labor for agricultural production, he has to employ female laborers besides male laborer mostly during the time of harvesting or threshing. The higher demand for female labor is expected to push up the wage rate of the female agricultural laborers which may be negatively associated with the gender wage gap in the farm labor market.
4. **A total number of Self-help groups in the state (shg):** Microcredit system has already established itself an instrument of income generation among village women. Besides that, it plays a significant role to enhance the empowerment of participating women. Expansion of the microfinance system indicates more participation of village women mainly married in different types of economic activity which help them to enhance their earnings. In India, the microfinance system is operating under the joint liability credit contract mainly through the formation of Self-Help Groups. More involvement of rural women in the microfinance system will reduce female labor supply in the agricultural labor market. Besides that, it enhances empowerment among the participating women. Based on labor market function, reduction of female labor supply during the time of agricultural production can enhance the female wage rate. At unchanged male wage rate, this may reduce gender discrimination in the labor market.
5. **Total social expenditure as a percentage of Net State Domestic Product (socialexp).** Due to spending on the social sector by the state government through spending on healthcare, shelter, civic amenities, the capability of the poor rural households have increased. Better capability can reduce

the multi-dimensional poverty of rural households. This may discourage the female members of the households from joining in the unskilled labor force. So the female labor supply in the agricultural labor market will be decreased which can enhance the wage rate of the female agricultural laborer and reduce gender wise wage gap.

6. Net land irrigated area (netlandirr): Cropping intensity of a state in any particular time depends on 'Net irrigated area⁶' of that state in that period. It is expected that, if major parts of the cultivatable land of a state are irrigated, the farmers of that state may move towards multiple cropping which means better cropping intensity of that state. It is assumed that better irrigation facility may not directly create any impact on the male-female wage gap in the agricultural labor market but can influence through enhancing cropping intensity. Here, this is treated as an instrumental variable of cropping intensity.

There are several other factors like labor force participation rate of rural women in private non-farm sector, the participation of family labor force (mainly the female member of the farmer household) during the time of agricultural production may influence gender-based wage disparity in the agricultural labor market. But due to lack of availability of the state-wise data of those factors in our concerned period, the factors as mentioned earlier cannot be incorporated in our investigation model⁷.

4. Sources of data

In this investigation, we consider 18 major states of India and six-time points: from 2010-11 to 2015-16. The variables which will be considered in our study are already explained. Theoretical justifications behind consideration of those variables have also given. Now we mention the details of our data source which are as follows:

- (i). Data related to male and female agricultural wages of the 18 states of India are taken from various rounds of Agricultural Wages of India (AWI), published by Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India.
- (ii). Data on the percentage of the female population (Age group 15-49 years) by the level of primary education in 18 states of India are taken from the Annual reports of Ministry of Home Affairs, Government of India.
- (iii). Percentage of female's participation in MGNREGP in terms of person days is calculated from various Annual Report of 2010-11, 2011-12, 2012-13, 2014-15 and 2015-16, published by the Ministry of Rural Development, Government of India.
- (iv). Data related to Cropping intensity of different states in different periods are taken from the various reports (from 2010-11 to 2015-16) published by the Ministry of Agriculture and farmers welfare, Government of India.
- (v). Information on State-wise total number of Self-Help groups (in lakhs)

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in India in different time periods are available from Lok Sabha Unstirred Question Number 3749, dated on 27.04.202, Question Number 322, dated on 23.11.2012, Question Number 947, Dated on 04.12.2015, Question Number 487, dated on 26.02.2016, Question Number 5044, Dated on 31.03.2017, Question Number 2434, Dated on 09.03. 2018⁸.

- (vi). Information related to state wise expenditure on social sector in the different financial year and Net State Domestic Product of a particular state in a specific financial year is taken from the 'Handbook of Statistics on State Government Finances-2010' and various issues of 'State Finances: A Study of Budgets', Reserve Bank of India.
- (vii). Information related to the net irrigated area of different states of India in different periods are compiled from the various reports (during 2010-11 to 2015-16) of Ministry of Agriculture and Farmers welfare, Government of India.

5. The econometric investigation

Before moving towards our investigation; initially one should look at the summary statistics of the explanatory variables considered here. That is presented in Table 3.

Table 3. Summary Statistics of the explanatory variables which can explain the Gender Wage Gap Index in the agricultural labor market in India

Year	2010-11				2011-12			
Variables	Max	Min	Mean	S. D	Max	Min	Mean	S. D
GWPI	48.04	3.84	19.18	11.10	50.19	4.34	20.93	11.28
priedu (%)	17.30	8.00	12.54	2.75	17.30	8.70	12.64	2.65
wpermgnrp (%)	93.23	14.74	44.90	19.62	92.91	17.16	45.84	19.05
shg (number)	2.676	0.013	0.352	0.647	8.445	.058	2.163	2.105
cropint (%)	184.90	115.10	138.91	21.58	184.70	113	139.16	21.90
socialexp (%)	14.975	4.608	8.488	2.75	15.443	5.447	8.85	2.76
	2012-13				2013-14			
GWPI	54.36	7.34	20.68	11.28	51.57	9.10	19.47	10.62
priedu (%)	16.70	8.00	12.36	2.62	17.80	7.10	12.96	2.91
wpermgnrp (%)	92.62	18.76	46.01	20.22	92.59	20.75	47.31	18.60
shg (number)	14.214	0.104	3.974	3.628	14.18	.0914	4.05	3.716
cropint (%)	181.70	113.00	138.96	22.47	185.00	115	141.69	21.85
socialexp (%)	15.22	5.91	9.32	2.88	15.78	5.76	9.91	3.145
	2014-15				2015-16			
GWPI	57.10	9.10	19.47	10.62	57.60	5.77	19.84	12.80
priedu (%)	17.80	6.10	12.99	2.97	18.00	6.20	13.25	3.00
wpermgnrp (%)	92.16	24.77	48.92	18.29	91.32	29.28	50.53	17.16
shg (number)	9.872	0.0828	3.90.091	3.13	9.62	0.42	4.0	3.21
cropint (%)	185.97	114.67	142.62	22.16	188.13	114.30	143.55	22.59
socialexp (%)	22.81	6.629	11.53	4.12	25.82	7.312	14.24	5.808

Source: Calculated by authors

Table 3 shows that the mean value of all regressors has increased from 2010-11 to 2015-16. Among the five variables considered here, Standard Deviation (SD) of 'priedu' is the lowest.

We consider the following Panel Econometric model:

$$GWPI_{it} = f(priedu_{it}, wpermgnrp_{it}, shg_{it}, socialexp_{it}, cropint_{it}, a_i, u_{it}) \quad (1)$$

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$$\text{cropint}_{it} = f(\text{netlandirr}_{it}, v_{it}) \quad (2)$$

Here $i = 1, \dots, 18$, and $t = 1, \dots, 6$.

Here GWPI_{it} indicates gender wise agricultural wage gap Index of the i^{th} state in the t^{th} period. Similarly, priedu_{it} , wpermgnrp_{it} , shg_{it} , socialexp_{it} , and cropint_{it} represents, percentage of female population got primary education, percentage of women's participation in MGNREGP in terms of man-days, total number of Self-Help groups, percentage of Net state domestic product spent on social sector and Cropping intensity of the i^{th} state in the t^{th} time period. It is assumed that the cropping intensity of the i^{th} state in the t^{th} period is endogenous⁹ and very much dependent on net cropped area¹⁰ of that particular state for that specific period. Here ' a_i ' shows the unobserved effect of the i^{th} state which does not change over time. In Equation (1) priedu_{it} , wpermgnrp_{it} , shg_{it} and priedu_{it} , wpermgnrp_{it} , socialexp_{it} and shg_{it} can be treated as policy variables which are correlated with a_i which can be considered as the state-specific socio-economic condition of the rural people. It is assumed that a_i is time-invariant in our concerned time-period¹¹. Besides that, we consider 18 major states of India which cannot be considered as random in nature. As the cross-sectional unit is here stated (a large geographical unit) we should apply Fixed effect estimation method of our balanced panel data without going for Hausman test¹². Initially, we allow explanatory variable here cropint_{it} mentioned in Equation (1) to be correlated with the u_{it} . To allow for correlation between the regressor and the idiosyncratic error, we consider the existence of netlandirr_{it} which is strictly exogenous. Here netlandirr_{it} should be uncorrelated with u_{it} . Since Fixed Effect estimate involves time dimension, we have found both cropint_{it} and netlandirr_{it} , are time varying.

Initially, the test for endogeneity is required to detect whether the endogeneity as mentioned above is correct or not. If that is correct, then only we can use Instrumental variable estimation in the above panel regression.

To test the endogeneity, we have taken the help of the following two procedures:

1. We regress the endogenous variable 'cropint' on exogenous regressors of Equation (1) and the instrumental variable 'netlandirr' of Equation (2): Then the augmented equation becomes

$$\text{cropint}_{it} = \alpha_1(\text{priedu}_{it}) + \alpha_2(\text{wpermgnrp}_{it}) + \alpha_3(\text{shg}_{it}) + \alpha_4(\text{socialexp}_{it}) + \alpha_5(\text{netlandirr}_{it}) + \varepsilon_{it} \quad (3)$$

We have applied the Fixed effect model¹³.

2. Next, we have estimated the residual form of cropint_{it} using fixed effect model and get the Fixed effect residual $\widehat{\varepsilon}_{it}$.
3. After that, we estimate the following augmented equation after introducing $\widehat{\varepsilon}_{it}$ another explanatory variable in the original equation.

Then the new equation becomes:

$$GWPI_{it} = \beta_0 + \beta_1 (\text{priedu}_{it}) + \beta_2 (\text{wpermgnrp}_{it}) + \beta_3 (\text{shg}_{it}) + \beta_4 (\text{socialexp}_{it}) + \theta_1 \widehat{\varepsilon}_{it} + u_{it} \quad (4)$$

Here the Null Hypothesis is $\widehat{\theta}_1 = 0$. If we accept the Null Hypothesis, then there is no existence of endogeneity in our model. But if we reject the Null Hypothesis, then we can conclude the presence of endogeneity in our model, and we have applied the Instrumental variable estimation method in our Fixed effect Panel data regression analysis. This proves that without using Instrumental variable estimation procedure, we will get an inconsistent estimator in simple fixed effect model.

Here the parameter estimates of $\widehat{\varepsilon}_{it}$, i.e. $\widehat{\theta}$ is significant. This study rejects the null hypothesis and establishes the presence of endogeneity in our model. We, therefore, applied the instrumental variable analysis in fixed effect panel regression after considering the net irrigation area (netlandirr_{it}) as an instrumental variable of cropping intensity (cropint_{it})¹⁴.

We also have again examined Instrumental variable regression analysis through Two-stage least square (2SLS) method whether the instrumental variable is weak or strong in our study. The instrumental variable will be weak if the joint significance (effect of the endogenous variable on the instrumental and exogenous variable) of the partial F-statistic test is less than 10. Our study shows that the robustness of the F statistic is 12.36 and that is more than 10. Hence, the result indicates that the net irrigated area (netlandirr) is a strong instrumental variable for the cropping intensity (cropint) data.

Besides the endogeneity test, we have also examined the multi-collinearity test among the variables. Multi-co linearity test is used to check whether the above-mentioned explanatory variables have any correlation or not. We can calculate the Variance Inflation Factor ($VIF=1/(1-R^2)$) to examine the multi-collinearity or inter-correlations among all explanatory variables. Based on the observed VIF values, the variables can be categorized as collinear (VIF values above 4) or non-collinear (otherwise). From this test, we can conclude that all given explanatory variables are not suffering any multi-collinearity problem as their observed VIF values are less than 4.

Now we move to Fixed effect panel data regression after using Instrumental variable method to investigate the influence of any explanatory factor mentioned in Equation (1) on the gender wage gap in the agricultural labor market. Table-4 provides the result of the fixed effect panel data regression analysis.

Table 4. Fixed effect results: Dependent variable- Gender Wage Gap Index in the Agricultural Labor Market of India.

Observations	102
Variables	Value of the Coefficient
priedu (Primary education for female)	-1.083** (0.6823)
wpermgnregp (Percentage days of the female of MGNREGA)	0.6632 (0.6865)
shg (total no. of SHG in the state)	-0.0032* (.000275)
cropint (Cropping intensity)	-1.32** (1.034)
socialexp (expenditure on social sector as a percentage of Net State Domestic Product)	-.3241 (0.2395)
Constant	4.3269*
R ² (within)	0.3401
Wald $\chi^2(5)$	2578.45***
F (16,80)	26.93***

Note: *** indicates 1% level of significance, ** indicates 5% level of significance and * indicates 10% level of significance.

6. Discussion

Based on the results given in Table 4, we can observe the following interpretations:

- The spread of primary education among the female population plays a decisive role in reducing gender discrimination in terms of wage among the female laborers. Expansion of education among female mainly in the rural areas generate awareness about rights among the female labor force which helps their bargaining strength during the time of deciding female farm wage. Besides that, it is also observed that after getting an education, the female members in the rural areas become less interested in working as unskilled labor in the agricultural sector which reduces female labor supply in that sector. Due to those two above reasons, the study shows that the states where the spread of female education at the elementary level is high, the male-female wage gap in the agricultural sector has become less.
- It was expected that the spread of MGNREGP work among the female labor force should play a positive role in gender discrimination in terms of offering wage during the time of agricultural production. But our result shows that expansion of MGNREGP work among the female labor force does not create any impact of the male-female wage gap in the farming sector. This result contradicts the earlier investigation of Azam (2012).
- Now a day, the microfinance system under joint liability credit system through forming Self-Help group becomes very popular in rural India. The group members are mainly the local village woman. Through participating in the microfinance programme, the rural women have got an alternative source of income, and gradually they have become an earning member of their family. They are not so much willing to work as an agricultural laborer. Resultantly, the supply of local labor in the agricultural sector has declined¹⁵. Due to less supply of female agricultural laborer, the willing female laborers get comparatively higher wage during agricultural peak season which ultimately can reduce gender discrimination in terms of wage in the agricultural sector.

- d. Cropping intensity is seen to be negatively associated with the gender wage gap. It is observed from our investigation that enhancement of cropping intensity can play a most positive role to reduce gender wise wage gap in the agricultural labor market in India. Except ploughing, the female workers are employed in almost all activities in agriculture, i.e. from land preparation to seed selection, planting, weeding, pest control, harvesting, crop storage, handling, marketing, and processing (Ghosh, & Ghosh, 2014). High cropping intensity in a state indicates multiple cropping in the post-rainy season. Lack of enough supply of male agricultural laborers during that time is a cause behind inclination to employ female agricultural laborers¹⁶. An increase in female labor demand can stimulate the wage, which can reduce the gender wise wage disparity.
- e. Expenditure on the social sector by the state government may reduce capability deprivation among the poor agricultural labor households, but that fails to minimize the gender-based wage gap in the agricultural labor market.

7. Conclusions and policy implications

Agricultural laborers are treated as unskilled laborers, and they have to devote only physical labor during different parts of agricultural production. In our male-dominated rural society, there is a belief that male laborers are much more productive than female laborers. Based on this belief the female agricultural laborers are paid less than their male counterpart. This paper shows expansion of education among the women particularly in the rural areas and more development and participation of microfinance system through forming self-help group mainly ¹among local women can enhance the empowerment and bargaining strength during the time of deciding wage rate of the female agricultural laborers before agricultural production. This bargaining power for women can reduce the gender wage gap in the agricultural labor market. But more participation of MGNREGP among women and percentage of NSDP spent on social sector expenditure fail to reduce gender discrimination among the agricultural laborers. Besides that, another important instrument which can minimize the gender wage gap is the enhancement of cropping intensity through the improvement of irrigation facilities in the rural area. For enhancement of farm income, an increase of cropping intensity is necessary. Due to the gradual decline of the family labor force after the break down of the joint family system, most of the Indian farmers cannot depend on family labor force during the time of agricultural production. They have to hire laborers. But at present, availability of different types of unskilled employment opportunities among the male laborers in post-rainy season, the farmers depend on female laborers. This non-farm employment opportunity enhances the demand of female laborers which help them to bargain for better wage and sometimes similar wage rate of the male agricultural laborers. It can also reduce the gender wage gap in the farm labor market.

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This study is expected to be helpful for the policymakers to take the necessary steps to remove or reduce the gender wage gap in the agricultural labor market of India.

Notes

- ¹ Agriculture is seasonal. The male members of the household who are unskilled sometimes migrate to other areas or join any better paid non-farm job. The women must stay with the family and supplement the family income they vigorously work as agricultural laborer even at a low wage.
- ² During the time of agricultural production; still, a large section of landlords gives more importance on the physical capacity of the hired laborer.
- ³ We consider this time-period because from 2010 onwards there is a tremendous expansion of MGNREGP in almost all the districts of India. Besides that, we have observed the increase of Self-Help Group among village women in all the states.
- ⁴ Absolute value of the gender wage gap can take identical value both at the higher mean value of the male wage rate as well as the low value of mean male wage rate. To overcome this difficulty, we have calculated the Gender Wage Gap Index of each state in each time-period.
- ⁵ It refers to rising of several crops for the same field during one agricultural year. It is constructed as $\sum(GCA_i)/NSA * 100$, where, GCA =Gross cropped area (ha.) in season i , ($i = 1, 2, \dots, n$) and NSA =Net sown area (ha.) in a year.
- ⁶ The Net irrigated area is the actual land area on which irrigation is done for growing crops for as many times as many in one agricultural year.
- ⁷ In this investigation, those variables are considered as explanatory variables which can influence the gender-based wage gap in the agricultural labor market.
- ⁸ Source: Indiatat.com
- ⁹ Cropping intensity of the i^{th} state in the t^{th} period may be correlated with the disturbance term of Equation (1) which accommodates agricultural production related factors like availability of family labor force of the farm household and use of modern equipment in the production process. Both these factors reduce hired labor demand during the time of agricultural production and can influence gender wise wage gap of the hired agricultural laborer. But we cannot accommodate those items in our original model because of lack of availability of state-level data. Other explanatory variables are uncorrelated with the disturbance term.
- ¹⁰ It is uncorrelated with the disturbance term mention in Equation (1)
- ¹¹ Participation of rural women of a state in the local informal labor market or any other income generating activity is very much dependent on the socio-economic condition of the rural households of that state.
- ¹² Incidentally, the Hausman test in our regression supports Fixed Effect model. The value of the $\chi^2 = 21.71$ which is significant at 1% level.
- ¹³ Fixed effect, and Random effect estimation assumes strict exogeneity of the instrument conditional on the unobserved effect. Random effect estimation adds the assumption that the Instrumental variable is uncorrelated with the unobserved effect. Besides that, Fixed effect instrumental variable works when the instrument varies over time. That is happening here. But in Random effect, the instrumental variable can be constant over time.
- ¹⁴ It is obvious because in our model due to lack of availability of different state-level data which may influence gender-wise wage gap in the agricultural labor market, we have limited scope for taking large number of explanatory variables. Besides that, here both T and N are not too large. For this reason, we have applied the Fixed effect estimation procedure. Hausman test also supports our claim.
- ¹⁵ In West Bengal, it is observed that, in the post-rainy season, the farmers are dependent on migrant female laborers during the time of agricultural production. But the cost of migrant laborers who mainly belong to the ST community is quite high (Kundu, 2006).

¹⁶ Kundu (2017) has observed in his village-level survey that, during post-rainy season, unskilled male laborers in rural areas prefer to work in MGNREGP because working there, they can earn good amount without devoting much effort.

Appendix

Table 5. *Average wage paid in MGNREGA and gender-based wage for agricultural laborers (in rupees) in 18 major states of India*

States	Year	Average Wage rate per day per person(Rs.) in MGNREGA	Wage rate for male Agricultural labor(Rs)	Wage rate for female Agricultural labor (Rs)
Andhra Pradesh	2010-11	95.61	162.01	123.72
	2011-12	101.26	193.73	140.71
	2012-13	101.76	227.14	159.02
	2013-14	110.99	245.42	178.64
	2014-15	116.33	277	195
	2015-16	129.50	295.35	199.82
Assam	2010-11	119.22	117.48	95.15
	2011-12	129.17	142.34	113.54
	2012-13	132.28	177.38	138.23
	2013-14	151.87	208.99	166.04
	2014-15	166.98	242	190
	2015-16	178.94	244.89	200.06
Bihar	2010-11	101.60	129.48	112.09
	2011-12	114.13	140.41	115.1
	2012-13	122.01	184.36	165.99
	2013-14	152.64	190.67	170.56
	2014-15	165.73	205	195
	2015-16	176.80	215.05	202.65
Chhattisgarh	2010-11	107.42	85.26	66.5
	2011-12	114.98	117.43	87.68
	2012-13	121.64	125.02	88.33
	2013-14	142.98	149.64	103.96
	2014-15	150.18	176	124
	2015-16	152.80	180.8	133.96
Gujarat	2010-11	95.68	118.48	106.63
	2011-12	106.15	137.47	123.22
	2012-13	109.73	147.88	132.16
	2013-14	130.81	161.18	144.28
	2014-15	148.48	185	161
	2015-16	158.49	175.88	155.58
Haryana	2010-11	163.76	224.1	184.21
	2011-12	178.69	266.5	214.92
	2012-13	184.32	301.27	254.64
	2013-14	215.16	339.32	290.1
	2014-15	238.06	372	308
	2015-16	253.32	388.24	321.52
Himachal Pradesh	2010-11	108.64	157.87	127.74
	2011-12	117.41	177.08	148.16
	2012-13	120.17	195.66	170.58
	2013-14	137.46	208.52	188.33
	2014-15	153.42	247	228
	2015-16	161.24	276.3	252.47
Jharkhand	2010-11	111.33	105.79	99.64
	2011-12	119.77	103.73	99.23
	2012-13	121.99	119.25	110.5
	2013-14	137.97	154.71	140.63
	2014-15	157.96	171.01	154.29
	2015-16	161.97	181.56	169.66
Karnataka	2010-11	106.84	130.35	125.34
	2011-12	122.98	170.78	152.2
	2012-13	133.55	180.71	161.12
	2013-14	173.62	223.77	201.57
	2014-15	190.26	279	235
	2015-16	203.70	272.31	244.95

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Kerala	2010-11	119.99	305.96	235.92
	2011-12	138.63	363.71	282.57
	2012-13	144.06	433.05	336.19
	2013-14	180.16	486.2	375.2
	2014-15	214.28	535	405
	2015-16	231.82	576.47	427.03
Madhya Pradesh	2010-11	108.24	103.19	91.82
	2011-12	115.17	132.6	117.98
	2012-13	120.55	154.55	136.58
	2013-14	139.03	174.92	152.39
	2014-15	149.12	187	162
	2015-16	149.83	213.09	183.75
Maharashtra	2010-11	117.31	100	80
	2011-12	127.00	121.25	93.13
	2012-13	134.30	175	125
	2013-14	159.77	119.55	94.09
	2014-15	164.64	152	100
	2015-16	175.43	165	105
Orissa	2010-11	108.99	102.39	79.67
	2011-12	122.16	124.32	93.65
	2012-13	121.90	149.41	116.1
	2013-14	141.27	170.81	127.18
	2014-15	161.46	197	150
	2015-16	188.02	224.43	173.23
Rajasthan	2010-11	78.56	148.14	90.03
	2011-12	84.87	183.66	118.41
	2012-13	89.78	207.13	155.24
	2013-14	106.60	230.55	181.64
	2014-15	109.17	275	217
	2015-16	116.41	299.63	246.62
Tamil Nadu	2010-11	83.89	160.3	83.29
	2011-12	92.15	195.69	97.48
	2012-13	91.76	245.4	112
	2013-14	103.56	253.21	122.64
	2014-15	122.95	303	130
	2015-16	133.45	334.5	141.84
Tripura	2010-11	109.55	187.63	140.33
	2011-12	117.82	221.94	159.08
	2012-13	119.04	255.44	182.81
	2013-14	133.28	273.2	202.33
	2014-15	150.54	285	217
	2015-16	159.15	288.02	225.08
Uttar Pradesh	2010-11	110.94	124.46	116.16
	2011-12	119.26	150.66	131.13
	2012-13	123.21	179.72	154.23
	2013-14	141.61	202.56	179.69
	2014-15	155.54	226	191
	2015-16	160.88	238.4	216.1
West Bengal	2010-11	117.65	130.04	110.14
	2011-12	126.36	157.11	131.59
	2012-13	129.43	175.82	146.08
	2013-14	147.09	214.33	181.42
	2014-15	164.06	231	186
	2015-16	169.91	259.4	219.18

Source: Compiled by authors

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