IOSR Journal Of Humanities and Social Science (IOSR-JHSS)
Volume 31, Issue 5, Series 4 (May, 2026) 66-77
e-ISSN: 2279-0837, p-ISSN: 2279-0845.
www.iosrjournals.org

Determinants Of Agricultural Wages In Odisha

Basanti Renu Hembram
Assistant Professor In Economics
Marwari College
Ranchi University, India

Abstract:
Agricultural wages play a quintessential role in the maintenance of rural households who work as farm workers. The agricultural development indicators viz., irrigation, cropping intensity, yield and mechanization play a prominent role in the determination of wages. Further socio-economic elements such as caste, education level, poverty also influence wages in the rural labour market. Using the backward criterion of multiple regression method, this paper attempts to identify the factors that determine wages of agricultural field labourers. The results of regression analysis show that literacy rate, poverty, cropping intensity and tractor use account for 44.2 per cent of the variance in average daily wages of male labourers. While the proportion of Scheduled Caste and Scheduled Tribe population, availability of labour, yield rate, high yielding variety coverage and tractor use together explain 53.3 per cent of the variance in the average daily wages of female labourers. In addition to that, it is also ascertained that on one hand; poverty, cropping intensity, and mechanization statistically significantly affect the male wages; whereas on the contrary female wages are significantly determined by only caste and coverage of a high yielding variety of seeds.

Keywords: *Agricultural wages - male labourer - female labourer - determinants - Odisha*

Date of Submission: 19-05-2026 Date of Acceptance: 29-05-2026

I. Introduction

In rural Odisha, agricultural wages are of prime importance for the livelihood of the rural households who work largely as farmworkers. The importance of agricultural wages can be seen from the rise in the percentage of agricultural labourers in wage-related activities, from 35 per cent in 2001 to 38.4 per cent in 2011 (Statistical Abstract of Odisha, 2012). Historically, it has been observed that there is a strong positive correlation between employment in casual agricultural wage and poverty in rural India (Lal, 1976; Singh,1990; Lanjouw & Stern, 1998; Sharma, 2001; Sundaram, 2001; Himanshu, 2004). The likelihood of being employed in agricultural wage labour falls monotonically as one rises in the consumption distribution. The rise in agricultural wages is strongly correlated with rural poverty reduction (Lanjouw & Murgai, 2008). Thus, employment and wages in agriculture can serve as a window of opportunity to raise the living standards in rural areas.

With the advent of the green revolution and the new agricultural technology, it is not only expected to generate an increase in the demand for labour but because of the increased importance of timely completion of each operation, it is also likely to increase the bargaining power of wage labour. As a result, agricultural wage rates are likely to be positively related to the level of agricultural development (Sidhu, 1988).

Irrigation has been considered as an engine of agricultural growth and an essential component of the green revolution. Irrigation development played a positive role in overall agricultural development (Vaidyanathan, 1994; 1987; Vaidyanathan et al. 1994). It is pointed out by Bardhan (1973: A 56) that "an increase in irrigation shifts upward the demand as well as the supply for labour. The higher yields for the wet crops, the multiple cropping and the more intensive inter-culture required in irrigated cultivation serve to raise directly the demand for labour. Regions with a larger proportion of its Net Sown Area (NSA) under irrigation can thus be expected to have a higher wage rate for agricultural labour".

Papola & Misra (1980) attempted to identify the factors that explain the inter-district variations in wage rate via demand-supply framework using cross-section data for 1971 in Uttar Pradesh. The variables such as alternative employment opportunity (per cent of rural workers engaged in non-agricultural works), yield (per hectare gross output), crop pattern, cropping intensity, irrigation (percentage of irrigated area to gross cropped area), land distribution, level of mechanisation, etc, were used for explaining the inter-district variations in the wage rate. The study found that the variables such as land concentration ratio, non-agricultural workers in the rural labour force, per hectare yield and cropping pattern have positively influenced the male wage rate. Surprisingly, the regression coefficient of irrigation turned out to be a non-significant variable in explaining the variation of the wage rate.

However, a more recent attempt was made by Narayanmoorthy & Deshpande (2003), to explore the relationship between irrigation development and wage rate of agricultural labourers. The results suggested that availability of irrigation positively impacts the agricultural wages through an increase in demand for labour, cropping intensity and shift in cropping pattern from low-value crops to high-value crops. Thus, the outcomes remain consistent with what was pointed out by Bardhan (1973).

Likewise, a significant shift in demand for labour such as those brought by the HYV's are capable of raising wages (Herdt & Baker 1972). It is further observed that there is a positive and significant relationship between agricultural productivity and agricultural wages; regions with higher productivity reflect higher agricultural wages (Lanjouw & Murgai, 2008). Evidence also suggests that labour productivity and land-labour ratio were found to be positively impacting the wage rate of female labourers (Acharya, 1989); again, labour productivity and diversification of labour into other occupations were the variables those positively influenced the wage rate of male labourers (Parthasarathy, 1996).

By the means of agricultural intensification, cultivation of High Yielding Varieties of seeds, growing multiple crops in different seasons, even though there is an increase in demand for labour irrespective of sex, agriculture has limited opportunities to absorb the growing labour force. This is because of increased agricultural mechanization, due to which the level of farm employment has stagnated or even declined in some parts of India (Bhalla, 1987; Bartsch, 1977).

Therefore, the generic deduction from most of the earlier studies is that agricultural wages are positively related with demand factors like irrigation, cropping intensity, use of HYV's and negatively related with supply factors such as the relative size of agricultural labour (Sidhu, 1988).

Accordingly, the prominent agriculture-related factors that determine the agricultural wages include irrigation, yield, cropping intensity and mechanization (Bardhan, 1970; Lal, 1976; Narayanmoorthy & Deshpande, 2003; Datt & Ravallion, 2007; Venkatesh, 2013).

Scrutinising the employment pattern in the rural economy, it is observed that there is a strong correlation between agricultural wage labour employment and lower standards of living, whether expressed in terms of per-capita consumption levels or terms of broader dimensions of well-being such as education levels and social status (Kijima & Lanjouw, 2005).

Lanjouw & Murgai (2008), conducted multinomial logit models in order to identify the occupational choice for the survey years, 1983, 1987/8, 1993/4, 1999/0, and 2004/5. The results highlighted that holding all the other characteristics (age, educational status, caste, per capita land holdings and the number of household members) constant corresponding to the overall average in the population, the predicted probability of employment in agricultural labour would fall if the caste status of the labourer was switched from SC/ST to non-SC/ST. During 2004, the predicted probability of employment in agricultural labour would be 30.7% if all individuals were scheduled castes or scheduled tribes. However, this probability would fall to 22.2% if their caste status were converted to non-SC/ST. Similarly, the predicted probabilities of employment in agriculture labour during all survey years fall sharply with the increase in education levels (at mean values of other characteristics viz., age, educational status, caste, per capita land holdings and the number of household members). [1]

Thus, those who take up agricultural wage labour as their principal occupation, usually have little or no education or are those who belong to scheduled castes or scheduled tribes. (Kijima & Lanjouw, 2005).

Alongside the above-mentioned factors, other factors affect the agricultural wages such as, the presence of the trade unions, non-farm employment and per capita income, which have been accounted for the increase and variation in rural wages (Vaidyanathan, 1986; Sen, 1996; Chand et al., 2009; Jose, 2013).

II. Data Sources And Methodology

Against the above backdrop, to identify the factors that determine the average daily wages of male and female field labourers in Odisha, district-level data have been used from multiple sources. The state of Odisha comprises of thirty districts, but; as the wage data is not available for Kendrapara district; therefore, the remaining twenty-nine districts are considered for the subsequent analysis.

Information regarding the socio-economic characteristics is drawn from Statistical Abstract of Odisha, published by Directorate of Economics and Statistics, Odisha. Agricultural statistics data are obtained from Odisha Agriculture Statistics, published by Directorate of Agriculture and Food Production, Odisha and average daily wages of field labourer are taken from Agricultural Wages in India, published by Directorate of Economics and Statistics, Department of Agriculture, Cooperation & Farmers Welfare, Government of India.

Two separate backward stepwise multiple regression analysis is carried out in SPSS for the year 2011. Essentially, this backward solution or technique is predicated on the assumption that the best set of predictor variables can be selected from a larger set of variables by using certain criteria for variable determination (Draper et. al, 1998).

Male wage and female wage are the outcome variables in the respective multiple regression process. The explanatory variables have been grouped under three heads: (i) Socio-economic characteristics, (ii) Farm characteristics and (iii) Technological advancement indicators (Table 1). All the explanatory variables taken for both male and female regression processes are identical to each other; except for the literacy percentages.[2]

Table no 1. Factors affecting the average daily wage of field labourers

Characteristics	Explanatory variables	Variable code
I. Socio-economic characteristics	Literacy percentage	LITM/LITF
	The proportion of SC/ST population to the total rural population	SC/ST
	Poverty ratio	POV
	Labour Availability per Net Sown Area (Number)	LAB
II. Farm characteristics	Crop yield of rice (Kg. /ha)	CYR
	Cropping intensity (in %)	CRI
	Average Size of the landholdings (in ha)	AVLAND
III. Technological advancement characteristics	Percentage of Gross Irrigated Area (GIA) to Gross Cropped Area (GCA)	IRR
	Fertilizer use per hectare (Kg. /ha)	FER
	High Yielding Variety Coverage of Rice (in %)	HYV
	Units of Tractors per '000 ha of the NSA (Number)	TRAC

Note. Field labour includes ploughing, reaping and harvesting, sowing and weeding operations.

Prior to the backward regression analysis, Pearson's linear correlation was applied to check the existence of a relationship between the dependent variables (male wage and female wage) and the respective explanatory variables in this research. Explanatory variables having very weak correlation value (less than 0.1 and -0.1) are not considered in further steps. Following this, labour availability, fertilizer use, HYV coverage and yield rate having a very weak correlation with the male wages have been dropped from the regression equation. However, in the case of the female wages, no explanatory variables are dropped from the backward solution regression analysis as the variables considered depict a correlation value of more than +/-0.1.

As the literature suggests that socio-economic characteristics like poverty, literacy; and agricultural development indicators namely irrigation, mechanization, productivity etc. play an important role in the determination of wages, a detailed account on the district-wise socio-economic characteristics, agricultural scenario and agricultural wages of both male and female field labourers are presented the following sections.

III. Socio-Economic Characteristics Of Odisha

Table 2 gives a district-wise socio-economic profile of Odisha for the census year, 2011. Before proceeding with the analysis of the table shown below, it is important to establish that the districts are arranged in descending order based on the percentage of the gross cropped area (GCA) under irrigation. This is done in order to investigate the impact of agricultural development on agricultural wages and gender inequality in agricultural wages in Odisha.[3] Irrigation here is considered as a manifestation of agricultural development, as it upsurges the use of other farm inputs. Accordingly, Jagatsinghpur district is at the top of the ladder of agricultural development and Kandhamal occupies the lowest rung (Table 2).

Table no 2. District-wise socio-economic indicators in Odisha, 2011

Districts	Literacy rate in rural areas		Proportion of SC/ST to total population	Poverty percentage	Labour availability (number per NSA)	Average landholding (area in ha.)
	Male	Female				
Jagatsinghpur	92.5	80.4	23.14	17.0	1.25	0.77
Balasore	86.7	71.3	34.01	30.0	1.64	0.78
Puri	90.8	77.3	21.01	18.0	1.22	0.84
Cuttack	90.1	76.5	25.86	15.0	1.74	0.86
Bargarh	82.8	63.8	40.60	35.0	1.22	1.34
Subarnapur	83.8	63.1	35.46	42.0	1.16	0.96
Bhadrak	90.3	76.1	25.79	17.0	0.67	0.89
Sambalpur	81.8	63.4	61.82	47.0	0.89	1.48
Dhenkanal	85.4	69.5	34.58	16.0	1.15	0.73
Khurda	89.4	76.3	22.03	14.0	1.06	0.92
Jajpur	86.5	72.7	32.79	20.0	1.34	1.18
Koraput	54.1	31.3	71.39	78.0	1.09	1.63
Mayurbhanj	72.2	50.3	68.86	61.0	1.69	0.92
Deogarh	81.3	62.0	52.80	67.0	1.38	1.02
Ganjam	78.5	56.8	24.60	25.0	1.53	0.93
Gajapati	61.2	39.2	66.73	75.0	2.21	0.81
Boudh	82.8	58.8	36.67	62.0	4.21	1.06
Nayagarh	87.7	71.1	20.78	33.0	1.00	0.82
Sundargarh	75.6	57.7	75.58	52.0	0.88	1.27

Keonjhar	76.8	56.3	60.24	47.0	1.18	0.99
Malkangiri	56.7	36.0	83.25	61.0	0.78	1.27
Kalahandi	70.4	44.3	48.51	49.0	1.29	1.39
Jharsuguda	84.3	66.6	59.96	29.0	0.85	1.00
Angul	84.8	66.3	34.39	22.0	0.99	0.97
Nabarangpur	55.0	33.0	72.86	56.0	1.81	1.28
Nuapara	69.3	43.2	48.49	62.0	0.91	1.22
Rayagada	56.2	33.5	77.82	70.0	1.60	1.22
Bolangir	73.8	50.3	41.18	67.0	0.43	1.11
Kandhamal	75.0	48.8	72.81	59.0	1.54	1.01
ODISHA	79.6	60.7	43.50	35.0	1.25	1.04

Notes. (i) Labour Availability calculated by the author using Census 2011 data and Odisha Agriculture Statistics data.

ii)Districts in the first column are arranged in descending order based on the percentage of the gross cropped area under irrigation.

Source: Odisha Statistical Abstract, 2012

Report on "Depth and Severity of Poverty in Rural Odisha: A District Level Estimation", Directorate of Economics and Statistics, Odisha

It is observed that the literacy rate of male is higher than the female in the rural areas of Odisha. Jagatsinghpur district shows the highest literacy percentage of rural male (92.5 %) and female (80.4%) and Koraput district shows the lowest literacy percentage for both the rural male (54.1%) and female (31.3%). Malkangiri, Rayagada, Sundargarh, Nabarangpur, Kandhamal, Koraput, Mayurbhanj, Gajapati, Sambalpur, Deogarh, Kalahandi, Jharsuguda, Nuapara and Keonjhar are the districts which show the greater concentration of the Scheduled Caste (SC) and Schedule Tribe (ST) population as compared to all Odisha share of SC/ST population to the total population. Head Count Ratio is always taken as Normal measure of poverty. When it is expressed in percentage (%) it is nothing but the percentage of the poor population lying below the poverty line. District-wise poverty HCR (%) varies between 14 per cent for Khurda to 78 per cent for Koraput district (Table 2).

Poverty percentage is below 20 per cent in six districts i.e. Khurda, Cuttack, Bhadrak, Jagatsinghpur and Puri but it is 70 per cent or above in Rayagada, Gajapati, and Koraput district. Thirteen districts have poverty HCR (%) less than all Odisha HCR whereas sixteen districts are with more poverty incidence. Districts namely, Kalahandi, Bolangir, Koraput Gajapati, Deogarh, Boudh, Mayurbhanj, Sundargarh, Keonjhar, Kandhamal and Sambalpur districts have more incidence of poverty than all Odisha.

The availability of the agricultural labourers per Net Sown Area (NSA) was found to be highest in Boudh district with four agricultural labourers followed by Gajapati district with two labourers. At all Odisha, labour availability i.e. labour/land ratio was 1.25.

The size of operational landholdings was greater than all Odisha in eleven districts namely Sambalpur, Jajpur, Koraput, Gajapati, Sundargarh, Malkangiri, Kalahandi, Nabarangpur, Nuapada and Rayagada. The average size of operational holdings ranged between 0.73 ha in Dhenkanal district to 1.63 ha in Koraput district and overall, in Odisha 1.04 ha was the average size of operational holdings during the Census year 2011 (Table 2).

IV. Key Agricultural Indicators In Odisha

Odisha is predominantly an agrarian economy. 83.3 per cent of the population resides in rural areas of Odisha. The cultivators and agricultural labourers constitute 53.24 per cent of the total main workers. Table 3 presents the district-wise key agricultural indicators in Odisha for the Census year 2011.

With regard to irrigation in Odisha, the state average of the percentage of Gross Cropped Area (GCA) under irrigation is 35.08 per cent. Jagatsinghpur (63.27%) shows the highest proportion of area under irrigation which is located in Coastal Plains; while Kandhamal district (16.85%) depicts the lowest irrigation coverage, which is in the Eastern Ghats (Table 3). There are eleven districts which depict a greater percentage of Gross Cropped Area (GCA) under irrigation in comparison to all Odisha and most of the districts come under the Coastal Plains.

The cropping intensity for all Odisha is 166 per cent. The highest and the lowest cropping intensity is found to be in Cuttack (231%) and Sundargarh district (130%) respectively. The overall coverage of High Yielding Varieties (HYV) of rice in the state is 84.23 per cent. Moreover, this proportion varies over districts; on one hand, it is as high as cent per cent in Ganjam district, while on the other hand, it is as low as 29.65 per cent in Kandhamal district. It is observed that both districts in the highest and lowest order of HYV coverage belong to the Eastern Ghats region.

Table no 3. District-wise key agricultural indicators in Odisha, 2011

District	Gross cropped area under irrigation (in %)	Cropping intensity (in %)	High yielding variety coverage of rice (in %)	Fertilizer use (kg. /ha)	Yield rate of rice (in kg. /ha)	Farm tractor availability/ '000 ha of NSA
Jagatsinghpur	63.27	204	89.45	49.30	2435	2.55
Balasore	62.32	160	85.38	117.40	2149	0.71
Puri	58.75	216	76.63	69.34	1513	2.02
Cuttack	55.23	231	84.65	68.04	1916	1.90
Bargarh	54.26	153	99.99	127.92	2157	0.87
Subarnapur	51.48	191	99.99	44.51	2202	1.86
Bhadrak	51.39	154	75.99	121.25	1666	0.70
Sambalpur	38.84	152	98.82	139.37	1816	1.02
Dhenkanal	37.67	187	94.99	32.07	2103	0.95
Khurda	37.34	180	66.34	73.21	1567	2.20
Jajpur	35.62	196	76.52	54.36	1117	1.26
Koraput	34.51	151	83.92	46.86	1471	0.86
Mayurbhanj	34.23	143	68.64	50.29	1884	0.52
Deogarh	31.74	172	98.31	45.42	1641	1.32
Ganjam	28.75	184	100.00	55.31	594	0.78
Gajapati	28.22	219	99.05	33.68	1031	1.31
Boudh	28.10	176	94.73	49.48	1194	0.95
Nayagarh	27.57	176	73.60	35.95	648	1.46
Sundargarh	27.50	130	57.66	38.50	1794	0.87
Keonjhar	26.99	152	88.21	30.16	1713	0.72
Malkangiri	26.87	164	62.71	39.13	571	0.81
Kalahandi	26.17	168	97.50	57.43	966	0.70
Jharsuguda	24.58	134	99.82	89.64	1220	1.18
Angul	21.17	181	98.22	23.16	989	0.75
Nabarangpur	20.46	157	68.18	175.48	704	1.66
Nuapara	20.16	172	92.03	33.33	792	0.84
Rayagada	18.95	166	92.41	39.89	1256	1.29
Bolangir	18.54	134	94.16	49.45	430	0.60
Kandhamal	16.85	176	29.65	7.30	1145	0.39
ODISHA	35.08	166	84.23	62.25	1472	1.00

Note. Districts in the first column are arranged in descending order based on the percentage of the gross cropped area under irrigation.
Source: Odisha Agriculture Statistics, 2011.

The fertilizer use is 62.25 Kg. /ha in all Odisha. The maximum use of fertilizer per hectare is found to be in Nabarangpur district which is 175 Kg. /ha and the least use is seen in Kandhamal district which is only 7.3 Kg. /ha. Only nine districts depict a higher fertilizer use in comparison to the state average, out of which five districts are located in the coastal plains; while remaining four are in Central Table Land and the Eastern Ghats.

The major cereal crop grown in Odisha is rice which has a yield rate of 1472 Kg. /ha. It is noted that Jagatsinghpur district in Coastal Plain region (2435 Kg. /ha) shows the highest yield rate of rice and Bolangir district in the Central Table Land, exhibits the lowest yield rate of 430 Kg. /ha; translating the fact that both districts belong to the highest and lowest in the hierarchy of irrigation coverage respectively.

Concerning the district-wise extent of mechanisation in Odisha, the tractor/land ratio is calculated as farm tractor availability per one thousand hectares of net sown area and are shown in Table 4.3. The tractor/land ratio is 1.00 in all Odisha. The maximum tractor/land ratio is detected in Jagatsinghpur (2.55) and the least tractor/land ratio is noted in Kandhamal district (0.39). Only a few districts located in the coastal plain area, Jagatsinghpur (2.55), Puri (2.02), Khurda (2.20) reveal twice as much the tractors/land ratio than all Odisha (Table 3).

V. Wage Rates Of Agricultural Labourers In Odisha

Wages constitute a major component of the cost of cultivation, because of the labour-intensive nature of agricultural operations. Like any other commodity, price of labour i.e. wage is also determined by market forces of supply and demand. Data on agricultural wages prevailing in selected villages/centres, spread over the length and breadth of the country, is collected by the Directorate of Economics and Statistics (DES), Ministry of Agriculture and Farmers Welfare, on monthly basis. Data relates to the agricultural year, i.e. July to June. Simple arithmetic averages (monthly and annual) have been worked out on the basis of data received on daily wages for different villages/centres as reported in the monthly returns from the State Governments. In Odisha, during the period from 1956 to 2009, the average daily money wage earnings of the male labourers in agricultural operations were greater than female labourers (Swain et al., 2018).

Table 4 shows the district wise average daily wages of the field labourer in Odisha during 2011; and the field labour include agricultural operations such as ploughing, sowing, weeding, reaping and harvesting.

The average daily wage of male labourer ranged from Rs. 83.75 in Koraput district to Rs. 174 in Jajpur district; however, the female labourer's wage rate varies between Rs. 70 in Malkangiri district to Rs. 131.50 in Jagatsinghpur district. It was observed that districts (Jajpur and Jagatsighpur) exhibiting the maximum average daily wage of labourers have greater irrigation coverage as compared to all Odisha. Similarly, districts (Koraput and Malkangiri) showing the least wage for agricultural labourers, depict less proportion of area under irrigation in comparison to all Odisha.

The average wage rate of the male and female labourer was Rs. 125.28/day and Rs. 96.40/day respectively. It is observed that the average daily wage of male labourer remains greater than their female counterparts for all the districts (Table 4).

The disparity in wages is reflected by the male-female wage ratio in Table 4. On one hand, the utmost gender disparity in wages was observed in Ganjam district (1.98) which is one among the agriculturally backward districts in the state, with lower irrigation coverage translating to lower fertilizer use and yield as compared to all Odisha. On the other hand, the least male-female wage differential was seen in Khurda district (0.84); one of the agriculturally developed districts which show greater irrigation coverage, cropping intensity, fertilizer use, yield rate and twice the tractor/land ratio than all Odisha. At all Odisha level, the average daily wage of the field labourer for male and female was Rs. 124.32 and Rs. 93.65 respectively; giving 1.33 as the male-female wage ratio (Table 4).

Table no 4. District-wise average daily wages of field labourer in Odisha, 2011

(Wage in Rs. /day)

District	Male wage	Female wage	Male/female ratio
Jagatsinghpur	150.00	131.50	1.14
Balasore	159.17	108.33	1.47
Puri	150.00	122.50	1.22
Cuttack	144.50	127.22	1.14
Bargarh	97.50	80.00	1.22
Subarnapur	101.75	79.00	1.29
Bhadrak	162.22	122.00	1.33
Sambalpur	116.99	92.00	1.27
Dhenkanal	135.67	101.50	1.34
Khurda	105.05	125.67	0.84
Jajpur	174.00	119.50	1.46
Koraput	83.75	87.33	0.96
Mayurbhanj	89.83	105.67	0.85
Deogarh	96.50	83.00	1.16
Ganjam	159.81	80.83	1.98
Gajapati	137.25	87.78	1.56
Boudh	117.50	100.00	1.18
Nayagarh	144.00	116.00	1.24
Sundargarh	98.00	74.50	1.32
Keonjhar	141.00	87.78	1.61
Malkangiri	132.00	70.00	1.89
Kalahandi	150.00	100.00	1.50
Jharsuguda	97.50	73.50	1.33
Angul	122.50	91.83	1.33
Nabarangpur	113.42	93.00	1.22
Nuapara	105.25	75.00	1.40
Rayagada	129.00	99.00	1.30
Bolangir	101.00	81.83	1.23
Kandhamal	119.00	82.00	1.45
Odisha	**124.32**	**93.65**	**1.33**

Note: Districts in the first column are arranged in descending order based on the percentage of the gross cropped area under irrigation.

Source: Agricultural Wages in India, Directorate of Economics and Statistics, Government of India.

Further, to analyse the effect of agricultural development on the gender-based wage disparity in the rural labour market in Odisha, Spearman's rank correlation method was carried out using the percentage of GCA under irrigation as a manifestation for agricultural development and male/female wage ratio as a representation of gender wage disparity. The results reveal that irrigation coverage and gender wage disparity have a weak negative correlation (r= -0.32), which is statistically significant at 10 per cent (p=0.08).

VI. Conceptual Framework Of Backward Solution Of Multiple Regression Analysis

When there is a possibility of all independent variables not contributing to the explained variance, the elimination of those variables is encountered in the backward solution model. It is surmised that the statistical and empirical objective of this process revolves around the systematic removal of all non-contributing variables. Therefore, all possible combinations of predictor variables are explored before the final equation is determined.

To determine the factors influencing wages of agricultural labourers in Odisha; the backward solution method begins with seven variable prediction equation for regressing male wages and eleven variable prediction equation for regressing female wages. Then one variable elimination was attempted while conducting both the regression processes.

In this framework, the significance of loss in prediction due to the elimination was measured by the F test (Wert et. al, 1954). This method of eliminating one variable at a time was continued until the dropping resulted in a loss of predictive capability. In this case, the process was repeated until a significant F indicated that further removal resulted in too great a predictive loss. From the variables that remained, the final backward prediction equation was formed. The actual computational procedure (Draper et al., 1998) is as follows:

i) A regression equation containing all variables is computed,

ii) The partial F test is calculated for each variable. This variable is then treated as though it were the last to enter the regression equation.

iii) The lowest partial F test value, F_L, is compared with a preselected significant level, F_O.

Thus, at each step, the variable that is least significant is removed (i.e. variable with the largest probability of F is taken out). The condition followed here is such that if significance level (F_L) or probability of F is >= 0.10 (F_O) then that variable is removed from the model. This process continues until no non-significant variables remain in the model.

In raw score form, the following regression equation with seven variables was used to determine the male wage regression equation:

$$y_1 = \alpha + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7$$

Where,
y_1= average daily wage of a male labourer
x_1= literacy percentage of the male agricultural labourer
x_2= proportion of SC/ST population to the total population
x_3= poverty ratio (head-count ratio)
x_4= cropping intensity
x_5=average size of the landholdings
x_6= percentage of gross irrigated area to GCA
x_7= units of tractor per '000 ha of NSA

Similarly, the raw score form regression equation with eleven variables, which was used to determine the female wage regression equation is shown below:

$$y_2 = \alpha + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + b_{10}x_{10} + b_{11}x_{11}$$

Where,
y_2= average daily wage of a female labourer
x_1= literacy percentage of the female agricultural labourer
x_2= proportion of SC/ST population to the total population
x_3= poverty ratio (head-count ratio)
x_4= availability of labour per NSA
x_5= crop yield of rice
x_6= cropping intensity
x_7= average size of the landholdings
x_8= percentage of gross irrigated area to GCA
x_9= fertilizer use per hectare
x_{10}= high yielding variety coverage of rice
x_{11}= units of tractor per '000 ha of NSA

To evaluate the usefulness of each variable in predicting male and female wage in the rural labour market of Odisha, the analysis of regression tables is presented in the next section.

VII. Regression Results And Discussion: Backward Solution Method

Factors affecting wages of male labourer

The backward regression analysis is based on process such that, in the first (raw score) regression model all the explanatory variables are considered for the regression equation, further at each iteration process (i.e. in each subsequent models) it excludes the least significant variable to develop the final regression equation. Table 5 shows the variables entered/removed in the backward solution regression technique in each model, and Table 6 shows the summary of five different models which is used to select the "best" possible model with a combination of independent variables for predicting the agricultural wage of a male labourer.

Table no 5. Variables entered/removed in backward solution regression technique

Model	Variables entered	Variables removed	Method
1	LITM, SC/ST, POV, CRI, AVLAND, IRR, TRAC[b]	.	Enter
2	.	IRR	Backward (criterion: Probability of F-to-remove >= .100).
3	.	AVLAND	Backward (criterion: Probability of F-to-remove >= .100).
4	.	SC/ST	Backward (criterion: Probability of F-to-remove >= .100).
5	.	LITM	Backward (criterion: Probability of F-to-remove >= .100).
Notes. (i) Dependent Variable: Male wage.			
(ii) b= all seven variables entered.			

In the first stage/first model all the variables, viz., literacy percentage of the male labourer, the proportion of SC/ST population, poverty ratio, cropping intensity, the average size of the landholdings, percentage of gross irrigated area to GCA and units of tractor per '000 ha of NSA are entered.

Successively, irrigation coverage (% of GII to GCA), the average size of landholding, the proportion of SC/ST to the total population, literacy level among male labourers were eliminated from second, third, fourth and fifth model respectively. Thus, at each stage, one variable is dropped until model 5 (Table 5).

It is observed that while the predictors are removed, the adjusted r-square levels off. Higher the adjusted R^2 better the model fits the data. Thus, for determination of male wages fourth model is the final model which shows the highest adjusted R^2 at 0.442, which means that four variables; literacy percentage, poverty, cropping intensity and units of tractor per NSA account for 44.2% of the variance in average daily wages of a male labourer. The R^2 associated with Model 4 is 0.522 (Table 6).

Table no 6. Model summary of backward regression analysis of male wages

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.736	.541	.388	19.589
2	.732	.535	.409	19.255
3	.727	.529	.427	18.957
4	**.722**	**.522**	**.442**	**18.701**
5	.702	.493	.432	18.865
Notes. (i) Dependent Variable: Male Wages.				
(ii) Model 1. Predictors: (Constant), LITM, SC/ST, POV, CRI, AVLAND, IRR, TRAC				
(iii) Model 2. Predictors: (Constant), LITM, SC/ST, POV, CRI, AVLAND, TRAC				
(iv) Model 3. Predictors: (Constant), LITM, SC/ST, POV, CRI, TRAC				
(v) Model 4. Predictors: (Constant), LITM, POV, CRI, TRAC.				
(vi) Model 5. Predictors: (Constant), POV, CRI, TRAC				

Table 7 shows the test of significance of the fourth and final model using an ANOVA. There are 28 (N-1) total degrees of freedom. The F-value is 6.55. The p-value associated with this F value is 0.001which is <0.05 and therefore, it is concluded that the independent variables show a statistically significant relationship with the dependent variable, or that the group of independent variables reliably predict the dependent variable.

Table no 7. Anova results of male wage

Model 4	Sum of Squares	df	Mean Square	F	Sig.
Regression	9163.693	4	2290.923	6.550	.001
Residual	8393.651	24	349.735		
Total	17557.344	28			

The coefficients of the male wage regression model are shown in Table 8. Based on the non-standardized coefficients we obtain the final regression equation, which was derived from the backward solution method, for the male wages:

$$y_1 = 135.538 - 0.62\ 1x_1 - 0.856x_3 + 0.561x_4 - 18.817x_7$$

Where y_1 is the average daily wage of a male labourer
x_1= literacy percentage of the male agricultural labourer

x_3= poverty ratio (head-count ratio)
x_4= cropping intensity
x_7= units of tractor per '000 ha of NSA

Table no 8. Regression coefficients of male wage

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	135.538	58.701		2.309	.030
LIT	-.621	.518	-.289	-1.200	.242
POV	-.856*	.300	-.714	-2.850	.009
CRI	.561*	.175	.569	3.201	.004
TRAC	-18.817**	8.311	-.407	-2.264	.033

Note: * Significant at 1 per cent level
** Significant at 5 per cent level

The regression results of male wages show that poverty and units of tractor per '000 hectares of NSA show expected negative sign of parameter estimates and are statistically significant. The negative sign of poverty can be explained in a way that with an increase in poverty there is a decrease in bargaining power on the part of the labourer and he would readily accept the low wages. The coefficient of tractor-use is also found to be negatively associated with male agricultural wages, which implies that the use of tractor reduces the agricultural wage rate of the male labourer.

Similarly, in the line of expectation, cropping intensity also depicts a positive sign which is also statistically significant. As cropping intensity is a demand-inducing variable and explains the intensity of crop cultivation in a region. Any region where the cropping intensity is higher, the demand for labour is also higher; and the higher demand for labour is expected to push the wage rate of agricultural labourers. Thus, an increase in cropping intensity leads to an expectation of labour for an increase in wages (Narayanmoorthy and Deshpande, 2003; and Datt and Ravallion, 2007). However, contradicting the usual expectation, the coefficient of literacy was found to be negative and is not statistically significant.

Factors affecting wage of female labourer

Similarly, in order to identify the factors that determine the wage of the female labourer, the first raw score regression model takes into account all the variables, further in the consequent models (Model 2 to Model 9) one variable is dropped as shown in Table 9. In the first stage/ first model all eleven variables, viz., female literacy rate, the proportion of SC/ST population, poverty rate, labour availability, crop yield of rice, cropping intensity, the average size of landholding, irrigation coverage (% of GII to GCA), fertilizer use, high yielding coverage of rice, tractor use per NSA were considered (Table 9).

Table no 9. Variables entered/removed in backward solution regression technique

Model	Variables Entered	Variables Removed	Method
1	FEMLIT, SC/ST, POV, LAB, CYR, CRI, AVLAND, IRR, FER, HYV, TRAC^b	.	Enter
2	.	IRR	Backward (criterion: Probability of F-to-remove >= .100).
3	.	AVLAND	Backward (criterion: Probability of F-to-remove >= .100).
4	.	FEMLIT	Backward (criterion: Probability of F-to-remove >= .100).
5	.	POV	Backward (criterion: Probability of F-to-remove >= .100).
6	.	CRI	Backward (criterion: Probability of F-to-remove >= .100).
7	.	FER	Backward (criterion: Probability of F-to-remove >= .100).
8	.	LAB	Backward (criterion: Probability of F-to-remove >= .100).
9	.	CYR	Backward (criterion: Probability of F-to-remove >= .100).
Notes. (i) Dependent Variable: Female wage			
(ii) b= all eleven variables entered.			

Sequentially explanatory variables namely, irrigation coverage, the average size of landholding, literacy percentage among female labourer, poverty ratio, cropping intensity, fertilizer use, labour availability, crop yield was excluded from second, third, fourth, fifth, sixth, seventh, eighth and ninth model respectively (Table 9).

Table 10 presents the model summary of the different models (Model 1 to Model 9), out of which the "best" possible combination of independent variables is selected by comparing the adjusted R for predicting the wage of a female labourer. Out of nine models, the seventh model is selected as the final model which shows the highest adjusted R^2 of 0.533. It means that proportion of SC/ST population, availability of labour, yield rate, high yielding variety coverage and tractor use together explain 53.3% of the variance in average daily wages of the female labourer (Table 10).

Table no 10. Model summary of backward regression analysis of female wages

Mode	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.797	.636	.400	14.216
2	.797	.636	.433	13.816
3	.797	.636	.463	13.449
4	.797	.635	.489	13.119
5	.796	.634	.512	12.819
6	.791	.626	.523	12.673
7	**.785**	**.617**	**.533**	**12.540**
8	.772	.596	.529	12.598
9	.756	.571	.520	12.719
Notes. (i) Dependent Variable: Female Wages.				
(ii) Model 1. Predictors: (Constant), FEMLIT, SC/ST, POV, LAB, CYR, CRI, AVLAND, IRR, FER, HYV, TRAC				
(iii) Model 2. Predictors: (Constant), FEMLIT, SC/ST, POV, LAB, CYR, CRI, AVLAND, FER, HYV, TRAC				
(iv) Model 3. Predictors: (Constant), FEMLIT, SC/ST, POV, LAB, CYR, CRI, FER, HYV, TRAC				
(v) Model 4. Predictors: (Constant), SC/ST, POV, LAB, CYR, CRI, FER, HYV, TRAC				
(vi) Model 5. Predictors: (Constant), SC/ST, LAB, CYR, CRI, FER, HYV, TRAC				
(vii) Model 6. Predictors: (Constant), SC/ST, LAB, CYR, FER, HYV, TRAC				
(viii) Model 7. Predictors: (Constant), SC/ST, LAB, CYR, HYV, TRAC				
(ix)Model 8. Predictors: (Constant), SC/ST, CYR, HYV, TRAC				
(x) Model 9. Predictors: (Constant), SC/ST, HYV, TRAC				

Table 11 shows the test of significance of the model using an ANOVA. There are 28 (N-1) total degrees of freedom. The F-value is 7.399 and p-value associated with this F value is 0.00 which is <0.05 and therefore it is concluded that the group of independent variables reliably predict the dependent variable.

Table no 11. Anova results of female wage

Model 7	Sum of Squares	df	Mean Square	F	Sig.
Regression	5817.598	5	1163.520	7.399	.000
Residual	3616.950	23	157.259		
Total	9434.548	28			

The coefficients of the female regression model are shown in Table 4.12. Based on the non-standardized coefficients we obtain the following regression equation for female wages:

$$y_2 = 128.431 - 0.520x_2 + 3.913x_4 + 0.005x_5 - 0.365x_{10} + 9.293x_{11}$$

Where y_2 is the is average daily wage of a female labourer
x_2= proportion of SC/ST population to the total population
x_4= availability of labour per NSA
x_5= crop yield rate of rice
x_{10}= percentage of HYV coverage of rice
x_{11}= units of tractor per '000 ha of NSA

Table no 12. Regression coefficients of female wages

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	128.431	18.402		6.979	.000
SC/ST	-.520*	.134	-.572	-3.879	.001
LAB	3.913	3.542	.143	1.105	.281
CYR	.005	.004	.167	1.233	.230
HYV	-.365**	.149	-.331	-2.441	.023
TRAC	9.293	4.941	.275	1.881	.073

Notes: * Significant at 1 per cent level
** Significant at 5 per cent level

The sign of the share of SC/ST population to total population is found to be negative as expected and is highly statistically significant, which indicates that for every unit increase the proportion of the SC/ST population, there is 0.52 unit decrease in the female wages. The coefficient of crop yield of rice shows expected positive sign, which suggests that improvement in yield leads to increase in demand of labour which further paves the way for an increase in wages (Sidhu 1988; Narayanmoorthy and Deshpande, 2003; Datt and Ravallion, 2007). HYV coverage of rice shows an unexpected negative sign of the coefficient, but then again is statistically significant which indicates that with the rise in the area under the high yielding variety of seeds, female wages will decrease.

The supply of agricultural labour also plays an important role in determining wage rates. However, contradicting to the expectation, the coefficients of labour availability was found to be positive. Similarly, parameter estimate of units of tractor/ '000 ha of NSA (i.e. variable used as a manifestation of mechanisation) also depicts a positive sign which goes against the anticipation. However, both the variables viz., labour availability and units of tractor/ '000 ha of NSA remain statistically insignificant.

VIII. Conclusion

The paper aimed to identify the factors that affect the wages of agricultural field labourers; by employing backward criterion of regression analysis using district-level data regarding socio-economic conditions, farm characteristics and technological advancement indicators. The results demonstrate that poverty, cropping intensity, and mechanization statistically significantly affect male wages. Poverty and tractor use negatively influence the wages of male labourers. Higher is the incidence of poverty, lower is the bargaining power in the hands of the labourer; again, with greater use of machines to perform the agricultural activities such as ploughing, there is a shift from the use of man and animal power to machine power, which ultimately negatively distresses the male wages. Cropping intensity has a positive effect on male wages which indicate that with a rise in cropping intensity there is a possible increase in demand for labourers and eventually their wages.

On the other hand, the proportion of SC/ST population significantly affects the female wages. Caste itself plays a very important role in participation in women in the labour market, usually, low income, low caste and poor women hire out labour and work in others field on wage payment. Among social groups, scheduled castes and scheduled tribes also earn substantially lower wages. HYV coverage negatively and significantly influences the female wages; which indicates that with a rise in HYV coverage there is a decline in the female wages. The possible explanation behind this is that with technological changes in cultivation more and more farmers opt for chemical herbicides, harvesters, threshers, rice mills, maize shellers etc. instead of manual workers, which have displaced a large number of women and reduced their employment potential (Swain et al., 2019). Thus, there is a deceleration in female labour absorption due to the adoption of labour-saving technologies which adversely influence the female wages. Further, the results of this study certainly indicate that yield have a positive impact on female wages.

Notes:

1. It is important to recognize that these are stylized probabilities – in reality SC/ST's would have education levels and landholdings well below the national average as well.
2. Explanatory variables relate to the district-wise data, and therefore all the variables that are agriculture-related, labour availability and poverty ratio remain same in both the regression equations (male and female). Literacy among male and female labourers differ from each other and thus it is only variable which changes its values in the regression equations; however, other variables remain the same.
3. See section 4.5 which the shows wages of agricultural labourers and examines male-female wage differentials alongside agricultural development.

References

[1]. Acharya, S. (1989). Agricultural Wages In India: A Disaggregated Analysis. Indian Journal Of Agricultural Economics, 44(2), 121-139. Https://Doi.Org/10.22004/Ag.Econ.272232

[2]. Bardhan, P. (1970). 'Green Revolution' And Agricultural Labourers. Economic And Political Weekly, 5(29 & 31), 1239-1246.

[3]. Bardhan, K. (1973). Factors Affecting Wage Rates For Agricultural Labour. Economic And Political Weekly, 8(26), A56-A64.

[4]. Bhalla, S. (1987). Trends In Employment In Indian Agriculture, Land And Asset Distribution. Indian Journal Of Agricultural Economics, 42(4), 537-560. Https://Doi.Org/10.22004/Ag.Econ.271868

[5]. Bartsch, W. H. (1977). Employment And Technology Choice In Asian Agriculture- A Study Prepared For ILO, World Employment Programme.

[6]. Chand, R., Garg, S., & Pandey, L. (2009). Regional Variations In Agricultural Productivity: A District Level Study. National Centre For Agricultural Economics And Policy Research, New Delhi, Discussion Paper No. NPP, 1, 2009.

[7]. Datt, G., & Ravallion, M. (1998). Farm Productivity And Rural Poverty In India. The Journal Of Development Studies, 34(4), 62-85. Https://Doi.Org/10.1080/00220389808422529. Directorate Of Economics And Statistics. (2012). Statistical Abstract Of Odisha. Government Of Odisha.

[8]. Draper, N. R., & Smith, H. (1998). Applied Regression Analysis (3rd Ed.). John Wiley & Sons, Inc. Https://Doi.Org/10.1002/9781118625590

[9]. Herdt, R. W., & Baker, E. A. (1972). Agricultural Wages, Production And The High-Yielding Varieties. Economic And Political Weekly, 7(13), A23-A30.

[10]. Himanshu. (2004). Wages In Rural India. Mimeo.

[11]. Javeed, S., & Manuhaar, A. (2013). Women And Wage Discrimination In India: A Critical Analysis. International Journal Of Humanities And Social Science Invention, 2(4), 06-12.

[12]. Jose, A. V. (2013). Changes In Wages And Earnings Of Rural Labourers. Economic And Political Weekly, 48(26&27), 107-114.

[13]. Kijima, Y., & Lanjouw, P. (2005). Economic Diversification And Poverty In Rural India. Indian Journal Of Labour Economics, 48(2), 349-374.

[14]. Lal, D. (1976). Agricultural Growth, Real Wages, And The Rural Poor In India. Economic And Political Weekly, 9(26), A47-A61.

[15]. Lanjouw, P. & Stern, N. (1998). Economic Development In Palanpur Over Five Decades. Oxford University Press. Https://Doi.Org/10.1093/0198288328.001.0001

[16]. Lanjouw, P., & Murgai, R. (2009). Poverty Decline, Agricultural Wages, And Non-Farm Employment In Rural India: 1983-2004. The World Bank.

[17]. Narayanamoorthy, A., & Deshpande, R. S. (2003). Irrigation Development And Agricultural Wages: An Analysis Across States. Economic And Political Weekly, 38(35), 3716-3722.

[18]. Parthasarathy, G. (1996). Recent Trends In Wages And Employment Of Agricultural Labour. Indian Journal Of Agricultural Economics, 51(1), 145-167.

[19]. Papola, T. S., & Misra, V. N. (1980). Labour Supply And Wage Determination In Rural Uttar Pradesh. Indian Journal Of Agricultural Economics, 35(1), 106-120. Https://Doi.Org/10.22004/Ag.Econ.269111

[20]. Sen, A. (1996). Economic Reforms, Employment And Poverty: Trends And Options. Economic And Political Weekly, 31(35 & 37), 2459-2477.

[21]. Sharma, H. R. (2001). Employment And Wage Earnings Of Agricultural Labourers: A State-Wise Analysis. The Indian Journal Of Labour Economics, 44(1), 27-38. Https://Doi.Org/10.1007/S41027-018-0104-9

[22]. Sidhu, H. S. (1988). Wage Determination In The Rural Labour Market: The Case Of Punjab And Haryana. Economic And Political Weekly, 23(52&53), A147-A150.

[23]. Singh, I. (1990). The Great Ascent: The Rural Poor In South Asia. Johns Hopkins University Press. Https://Doi.Org/10.2307/1242472

[24]. Singh, Jaivir, & Meenakhi, J. V. (2004). Understanding The Feminisation Of Agricultural Labour. Supplement To Indian Journal Of Agricultural Economics. 59(1), 1-17.

[25]. Sundaram, K. (2001). Employment And Poverty In 1990s: Further Results From NSS 55th Round Employment-Unemployment Survey, 1999-2000. Economic And Political Weekly, 36(32), 3039-3049.

[26]. Swain, M., Das, L., & Hembram, B. R. (2018). Agricultural Development And Gender Inequality In Rural Labour Market In Odisha. Agricultural Economics Research Review, 31(Conf),25-32. Https://Doi.Org/10.5958/0974-0279.2018.00019.8

[27]. Swain, M., Das, L., & Hembram, B. R. (2019). Gender Inequality In Rural Labour Market In Odisha: Some Micro Evidence From Dhenkanal District. IASSI-Quarterly, 38(2), 212-226.

[28]. Vaidyanathan, A. (1986). Employment And Poverty In 1990s: Further Results From NSS 55th Round Employment-Unemployment Survey, 1999-2000. Economic And Political Weekly 36(32), 3039-3049.

[29]. Vaidyanathan, A. (1987). Irrigation And Agricultural Growth (Presidential Address). Indian Journal Of Agricultural Economics 42(4), 503-27.

[30]. Vaidyanathan, A. (1994). Employment Situation: Some Emerging Perspectives. Economic And Political Weekly 29(50), 3147-56.

[31]. Vaidyanathan, A. (1994). Second India Studies Revisited: Food Agriculture And Water, Madras Institute Of Development Studies, Madras.

[32]. Vaidyanathan, A., Kumar, A. K., Rajagopal, A., & Varatharajan, D. (1994). Impact Of Irrigation On Productivity Of Land. Journal Of Indian School Of Political Economy 6(4),60-145.

[33]. Venkatesh, P. (2013). Recent Trends In Rural Employment And Wages In India: Has The Growth Benefitted The Agricultural Labourers? Agricultural Economics Research Review, 26(Conf), 13-20.

[34]. Wert, J. E., Neidt, C. O., & Ahmann, S. J. (1954). Statistical Methods In Educational And Psychological Research, Appleton-Century-Crofts, Inc.