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Impact of Human Labour on the Cost of Cultivation Expenses of Major Cereal Crops in India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

India's primary cereal crops—paddy (*Oriza sativa L.*), wheat (*Triticum aestivum* L.), and maize (*Zea mays* L.) are highly dependent on labour from agricultural workers and are essential to the nation's agricultural economy. Owing to a lack of mechanisation in many areas, labour costs differ

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greatly depending on the area, size of the farm, and socioeconomic status. Exorbitant labour expenses primarily impact small and marginal farmers, diminishing their profitability and possibly impacting crop selection and food security. This study highlights how labour costs account for a sizeable portion of total agricultural expenses by examining the effect of labour costs on the cost of cultivating these crops across various Indian states. The study also looks at how mechanisation has been adopted unevenly, with some states reporting lower labour costs as a result of increased machinery use. This study indicates that the labour cost for cultivating paddy was highest in Assam (45%), while for maize (20%), it was highest in Andhra Pradesh (25%), and for wheat, in Bihar. Total labour cost was highest in Maize (₹2,3304) followed by Paddy (₹26,665), Wheat (₹13,960). This study suggested that mechanisation, wage standards, and labour management techniques could all help to reduce the high costs associated with using human labour to cultivate cereal crops.

Keywords: Agriculture; cereal; cost; crops; labour; policy.

1. INTRODUCTION

India is one of the largest producers of cereal crops like paddy, wheat and maize with a vast agricultural landscape. They support tens of millions by holding the country's agricultural economy together. But these crops are largely labour dependent and human cost is a large portion of the entire structure in cultivation. In rural India, not all areas have been mechanised and human labour is required for multiple stages of cultivation - from planting to weeding/ harvesting/post-processing.

To begin with, it is important to understand how the cost of cultivation changes depending upon human labour or not. This is the first reason, as labour costs rank significantly high in the total set of input costs for farming [1,2,3]. For instance, major cereal crops have very different costs of production depending on a multitude of factors such as the location (geographic region), farm size and availability of labour to name only a few but probably most relevant for differences in land/extensification or yields/intensification. Second, in a country like India where more than half the workforce depends on agriculture for livelihood, shift in labour dynamics directly links to rural incomes and lives [4,5]. A systematic understanding of how labour costs contribute to the cost of cultivation is important for policy makers, farmers as well as myriad stakeholders in agriculture.

Cereal Crop Production involves labour in all its functioning areas. For example, for more than 10 years the International Rice Research Institute (IRRI) has been working on paddy face mechanization intending to replace traditional rice crop-producing systems that are in most cases manual labour. Cereal crops such as wheat prove labour-intensive; sowing, irrigation & harvesting require massive manual input (most notably in non-mechanized areas). Although maize farming is relatively easier in terms of labour use compared to, say paddy or wheat, a significant amount of manual work also has to be put into land preparation and sowing while weeding the crop itself comes with much costs especially when done manually), harvesting (although not as capital intensive as most tropical root crops/plantain -the other major food security staples for Africa-one still needs reasonable good quality machinery (tiller/bush-weeder/ridger etc.) even if it just an ox-driven traditional plough) there are limited solutions where ridged planting on hill-slopes or fully mechanized operations so mixing this at least during the dry season would augment only eliminates completely.

Many elements determine the expense of human labour in sowing these cereal crops. These factors are highly dependent on the kind of seasonal labour demand, availability & wage rates in response to the same and overall socio-economic scenarios that dictate its cost. There are also regional differences, such as the disparity between irrigated and rain-fed areas that affects employment intensity in both quantity and quality [6,7]. Local low supply in migration weak areas, where there are alternative urban employment opportunities may result in higher labour costs [8,9]. Traditional farming techniques that support a lot of manual labour still rule the roost in others, contributing to extremely high hiring expenses.

Because of the high labour costs, they are able to allow cereal crop farming and affect profitability and economic viability as well [10,11]. Slight increases in labour costs can lead to reduced profit margins or even financial losses for small and marginal farmers who form an overwhelming majority. It takes a special hue

when water requiring crops like paddy get involved as we already know rice cultivation is thirsty and labour-intensive at the same time. Farmers are forced with a predicament of choosing between high-cost labour or low profit crops that require less man power [12,13]. This is of national importance from a food security perspective and also for the socio-economic status of agricultural communities.

In the recent years, we have seen a gradual mechanization in Indian agriculture particularly in states like Punjab, Haryana parts of Uttar Pradesh where there is large scale wheat and paddy cultivation [14,15]. It has also reduced the dependency on labour in some places, with machines like combine harvesters, tractors and planters as well. Even with this, the rate of mechanization in general is still disparate across the country and many places are dependent on manual labour because of reasons like land fragmentation, financial limitations or inability to afford modern machines etc [16,17]. As a result, although mechanization is one path to lower labour costs, its spotty uptake across India provides an important counterpoint that complicates and challenges our understanding of agricultural labour in the country.

Human labour cost is a major component of the production costs of cereal crops, and therefore new mechanisms need to be implemented by policies to alleviate this tension between maintaining enough Human Labour power in relation with decreasing costs/productivity. This can be partly helped by the policy focus on skill development, fair wage standardisation and better working conditions for agricultural labourers. In addition, promoting sustainable agricultural practices method (e.g. SRI/System of Rice Intensification for paddy or zero-tillage in wheat) identification could also enhance productivity and reduce labour input requirements.

The lack of comprehensive research documenting the specific impacts of human labour on cultivation costs for cereals across various crops and regions in India is surprising, considering that labour costs are a primary factor in agriculture. Previous research [18,19,20,21,22] that considers this topic typically aggregates input costs and does not isolate the labour component or investigate its effect in relation to other mechanisms. This research is an attempt to fill this gap and aims to explore the cost of human labour in paddy, wheat, and maize cultivation by traiting specific geographic location throughout India. This study attempts to add value in this context and accordingly initiate a more informed discussion on agricultural policy as well as labour economics in India.

2. MATERIALS AND METHODS

2.1 Data Sources

Cost of cultivation data of paddy, maize and wheat was collected for the year 2021-22 from the Economics, Statistics and Evaluation Division (DES), an attached office of the Department of Agriculture, Cooperation and Farmers Welfare (DAC&FW) under the Ministry of Agriculture and Farmers Welfare (MOA&FW).

In order to help the government formulate policy, DES gathers, disseminates, and publishes statistics on a variety of aspects of agriculture and related industries. The primary goal of the Directorate is to generate and disseminate agricultural statistics, research, and analysis, as well as important data on area, production, land use, cost and yield of principal crops, and minimum support prices. It also implements programs related to improving agricultural statistics and conducts agro-economic research. The Directorate makes its inputs available to all researchers and stakeholders in the public domain.

2.2 Data Collection Methodology and Key Components of Cost of Cultivation Data

They gather information on the price of producing and cultivating 27 main crops, such as commercial crops, oilseeds, pulses, and cereals. Data is gathered from 19 states, with roughly 6000 sample holdings dispersed throughout these states.

A comprehensive survey method is used to gather the data, and it entails conducting in-person, seasonal interviews with farmers. The survey records a variety of inputs, including labour (both hired and family labour), irrigation costs, interest on working capital, depreciation on farm buildings and implements, and other incidental costs. The yield and value of the primary product as well as any byproducts are also included in the data.

Cost A1: It includes all actual expenses in cash and kind incurred in production by the farmer.

Cost A2: It is Cost A1 plus rent paid for leased-in land.

Cost B1: It is Cost A2 plus interest on the value of owned capital assets (excluding land).

Cost B2: It is Cost B1 plus the rental value of owned land.

Cost C1: It is Cost B1 plus the imputed value of family labour.

Cost C2: It is Cost B2 plus the imputed value of family labour. This represents the comprehensive cost, including the opportunity cost of owned resources and family labour.

Cost C3: It is Cost C2 plus a provision of 10% on Cost C2 to account for managerial functions performed by the farmer.

2.3 Categories of Labour in Cost of Cultivation

Labour is divided into two categories in the context of the cost of cultivation data: family labour and hired labour. Each type of labour has a specific function in agricultural operations. Family labour is the term used to describe the unpaid work performed by the farmer and their family members. To account for its contribution to the overall cost, the value of this labour is frequently estimated using local wage rates. In smallholder farming, where families mostly depend on their own resources, this kind of labour is essential. Hired labour refers to people who work for the farmer, either permanently or on a contract basis, and their pay is directly related to the costs of cultivation. While permanent labourers are hired for more consistent, ongoing work throughout the farming season, casual labourers are usually hired for shorter, task-specific tasks like planting, weeding, or harvesting. Hiring labour is an important and variable component of agricultural spending, with costs varying greatly based on factors such as local wage rates, seasonal demand, and the unique needs of various crops. Comprehending these classifications of labour is imperative for precisely evaluating the economic feasibility of farming methodologies and formulating suitable agricultural policies and interventions.

3. RESULTS AND DISCUSSION

Fig. 1 seeks to compare the proportion of human labour costs relative to the total cultivation cost for paddy, maize, and wheat across various states in India. These comparisons illuminate the variations in labour intensity required for different crops in different regions, which can significantly impact agricultural productivity, cost efficiency, and policy-making decisions.

3.1 Labour Cost Analysis for Paddy Cultivation

Paddy, a labour-intensive crop, incurs a substantial amount of labour costs across various states, with the highest contribution being observed in the states of Assam (44.96%), Odisha (44.57%), Bihar and Maharashtra (both at 42.07%) (Table 1) [23]. This reflects a heavy dependence on manual labour, likely stemming from traditional farming practices, irrigation requirements, and regional wage levels.

States such as Kerala (41.67%), Himachal Pradesh (40.45%), and Jharkhand (39.88%) also exhibit elevated labour costs [24], in contrast to Punjab (16.59%) and Haryana (22.81%), where labour expenses are notably lower [25]. This difference can be attributed to the greater degree of mechanization and more efficient agricultural methods in these regions.

Table 1. Impact of human labour cost on cost of cultivation (COC) of paddy

State	Labour cost on COC of Paddy (%)
Assam	44.96
Odisha	44.57
Bihar	42.07
Maharashtra	42.07
Kerala	41.67
Himachal Pradesh	40.45
Jharkhand	39.88
Gujarat	35.66
Uttar Pradesh	33.93
West Bengal	33.93
Andhra Pradesh	32.93

State	Labour cost on COC of Paddy (%)
Telangana	30.81
Madhya Pradesh	28.04
Karnataka	27.40
Chhattisgarh	25.30
Tamil Nadu	24.95
Haryana	22.81
Punjab	16.59

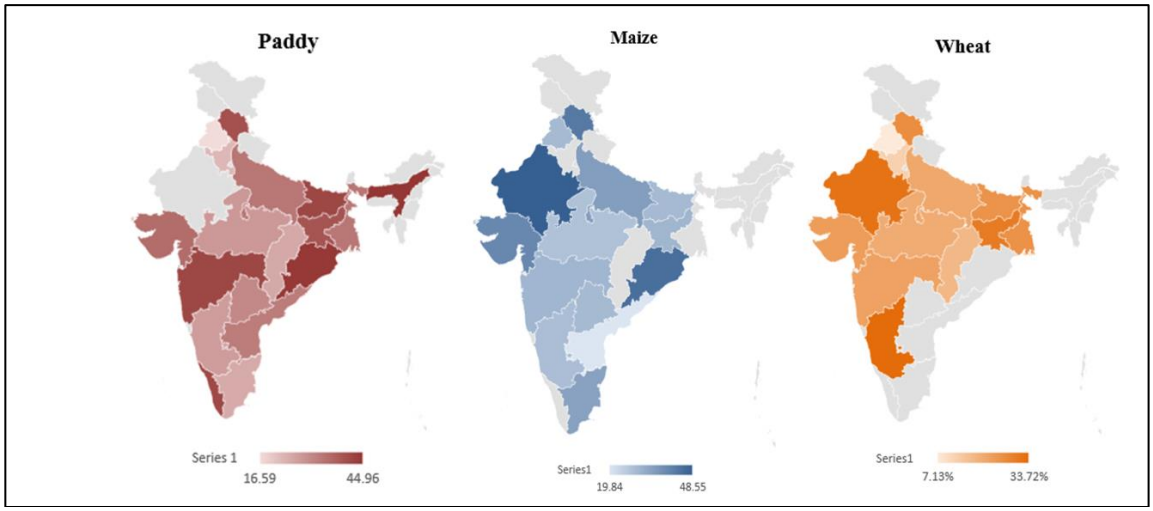

Fig. 1. State-wise impact of labour on the COC expenses of major cereal crops in India

Table 2. Impact of human labour on cost of cultivation of maize

State	Labour cost on COC of Maize (%)
Andhra Pradesh	19.84
Bihar	29.20
Rajasthan	48.55
Odisha	45.36
Himachal Pradesh	42.96
Gujarat	39.90
Uttar Pradesh	35.21
Tamil Nadu	34.33
Jharkhand	30.14
Maharashtra	30.02
Telangana	29.26
Punjab	29.25
Karnataka	28.41
Madhya Pradesh	27.53

Overall, this distribution suggests that areas characterized by high rainfall and traditional paddy cultivation tend to have higher labour costs, whereas regions with more industrialized farming practices experience lower labour expenses.

3.2 Labour Cost Analysis for Maize Cultivation

Labour costs for maize cultivation vary widely across states, with Rajasthan leading at 48.55 per cent, followed by Odisha at 45.36 per cent and Himachal Pradesh at 42.96 per cent (Table 2) [26]. These high percentages indicate that maize farming in these regions is particularly labour-intensive, likely due to specific agronomic requirements or traditional farming practices.

In contrast, states like Andhra Pradesh (19.84%), Punjab (29.25%), and Karnataka (28.41%) have significantly lower labour costs, suggesting the adoption of more mechanized farming techniques or less labour-intensive methods [27].

This variation highlights differences in cultivation practices and may reflect the impact of regional agricultural policies and the availability of labour.

3.3 Labour Cost Analysis for Wheat Cultivation

Wheat cultivation exhibits a distinct pattern, with Karnataka (33.72%), Rajasthan (32.02%), and Jharkhand (30.29%) having the highest labour costs (Table 3) [24]. These percentages suggest a heavier reliance on manual labour in these regions, possibly due to limited mechanization or the use of wheat varieties that demand more labour-intensive practices.

Conversely, Punjab (7.13%) and Haryana (12.45%) report the lowest labour costs, highlighting the influence of advanced mechanization and efficient farming techniques in these states.

The reduced labour costs in major wheat producing regions like Punjab and Haryana indicate that wheat farming benefits more from mechanization compared to other crops [28,29,30], reflecting variations in agricultural practices and resource allocation.

3.4 Comparative Analysis Across Crops

The data indicates that paddy typically demands the highest labour input across most states, followed by maize and wheat. This pattern corresponds with the inherent characteristics of these crops: paddy cultivation is generally more labour-intensive due to practices like transplantation, continuous irrigation, and manual harvesting, whereas wheat and maize are more amenable to mechanization.

States such as Odisha and Himachal Pradesh, where labour costs for paddy and maize are high, display varying labour costs for wheat, reflecting differences in agricultural priorities and the degree of technological adoption.

3.5 Implications for Agricultural Policy and Practice

States facing elevated labour costs for specific crops may benefit from policies that encourage mechanization and the efficient utilization of labour to lower cost and boost productivity. Analysing the variations in labour costs can pinpoint regions where agricultural labour plays a crucial role in the economy, highlighting where investments in labour saving technologies could yield the greatest benefits. This data can guide crop selection decisions based on labour costs, steering farmers, and policymakers towards more cost-effective agricultural strategies.

The tables serve as a basis for further investigation into the factors influencing labour costs across various crops and regions, encompassing socioeconomic conditions, crop management practices, and technological access. Comparative analyses could assess how labour costs affect overall agricultural productivity and profitability, thereby offering valuable insights for optimizing resource allocation in agriculture. These tables offer significant insights into the labour cost dynamics within Indian agriculture, spanning different crops and states. Understanding these variances is essential for crafting targeted agricultural policies, enhancing cost efficiency, and promoting sustainable farming practices.

Table 3. Impact of human labour on cost of cultivation of wheat

State	Labour cost on COC of wheat (%)
Bihar	25.35
Chhattisgarh	17.59
Gujarat	23.36
Haryana	12.45
Himachal Pradesh	26.55
Jharkhand	30.29
Karnataka	33.72
Madhya Pradesh	20.11
Maharashtra	22.29
Punjab	7.13
Rajasthan	32.02
Uttar Pradesh	21.13
West Bengal	25.64

Table 4. Labour Cost Distribution Across Family, Attached, and Casual Labour for Paddy, Maize, and Wheat in India

Labour cost distribution	Paddy	Maize	Wheat
Family labour	11,928.44	12,261.24	9,547.57
Attached labour	213.57	247.56	195.70
Casual labour	14,523.43	10,795.54	4,217.37
Total labour cost	26,665.43	2,3304.34	13,960.64

3.6 Breakdown of Labour Costs per Hectare for Major Cereal Crops in India

Table 4 displays the average labour costs for three major cereal crops in India—Paddy, Maize, and Wheat categorized into family labour, attached labour, and casual labour, along with the total labour cost per hectare for each crop. For Paddy, the average cost of family labour is ₹11,928.44, attached labour costs ₹213.57, and casual labour amounts to ₹14,523.43, resulting in a total labour cost of ₹26,665.43. For Maize, the average family labour cost is ₹12,261.24, attached labour is ₹247.56, and casual labour totals ₹10,795.54, leading to a total of ₹23,304.34. In the case of Wheat, family labour averages ₹9,547.57, attached labour is ₹195.70, and casual labour costs ₹4,217.37, culminating in a total labour cost of ₹13,960.64. These findings highlight the significant variability in labour costs across different cereal crops, reflecting variations in labour requirements, their types, and practices.

4. CONCLUSION

The economic feasibility of growing India's main cereal crops—paddy, wheat, and maize—is greatly impacted by the cost of labour. This study shows that labour costs, which vary significantly between states and crops, account for a sizeable portion of total cultivation expenses. Labour costs are particularly high in areas like Assam and Odisha that have limited mechanisation because of the heavy reliance on manual labour resulting from traditional farming practices and socioeconomic conditions. On the other hand, states with higher levels of mechanisation, like Punjab and Haryana, exhibit significantly lower labour costs, highlighting the advantages of adopting technology in lowering dependency on human labour. These results imply that, particularly in areas where labour costs are a major burden, targeted interventions are required to encourage mechanisation and boost labour efficiency as under unemployment and disguised unemployment is a major concern in Indian agriculture. Furthermore, encouraging labour-efficient, sustainable farming methods may increase output and profitability. The strategies that support access to modern machinery, improve skill development, and guarantee fair labour wages are examples of how policymakers can strike a balance between labour needs and cost reduction. Resolving these issues is essential to sustaining the livelihoods of millions of Indian farmers, ensuring food security, and increasing agricultural productivity, which further helps to achieve SDG-1 (*end poverty in all its forms everywhere*) to end extreme poverty globally by 2030. This study has a limitation in that it ignores a number of variables that can have a substantial impact on labour costs in the production of cereals in different states. We specifically did not take into account factors like labour skills, age, gender, and availability of mechanisation or labour. These variables may have an impact on labour efficiency and availability, which could result in variations in labour costs outside the scope of our current analysis. These factors should be investigated in future studies to give a more thorough understanding of labour cost variations.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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