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Technological Changes and Labour Utilization in Agricultural Development of Karnataka: A case study of Thumakur district

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Abstract
Technological progress plays a crucial role in transforming agricultural productivity and labour dynamics. This study examines the effect of technological change on labour utilization in the agricultural sector of Karnataka. Based on secondary data from 2000 to 2024, the analysis highlights the shift from labour-intensive traditional farming to skill-intensive mechanized production systems. While mechanization has reduced the demand for manual labour during peak seasons, it has simultaneously created new employment opportunities in machinery operation, custom hiring services, farm advisory, processing and marketing. The study argues that agricultural development in Karnataka depends not only on technology adoption but also on labour transition through skill upgrading, market linkages and diversification into non-farm agricultural enterprises. This study also analyses the patterns of mechanization, labour displacement, and the emergence of skilled labour in Tumakuru district. Findings show that mechanization has reduced manual labour by nearly 40–45% while creating new employment opportunities in machinery operation, micro-irrigation management, drone-based spraying, nursery management, and digital farm advisory services.

Keywords: Technological change, agricultural mechanization, labour utilization, skill-intensive agriculture, employment transition, Karnataka

1. Introduction

Karnataka is one of the most agriculturally diverse states in India, with conditions ranging from irrigated command areas to drought-prone dry zones. Historically, agriculture in Karnataka relied heavily on manual labour for ploughing, weeding, irrigation and harvesting. Rising rural wages and labour shortages—caused by urban migration and the expansion of non-farm jobs—intensified the need for technological change. Over the past two decades, the state has witnessed major innovations such as:

The most pressing issue in the world today is the food supply. The demand for food has increased at more than twice the rate of population growth in the last 35 years. In fact, according to a report by the Food and Agriculture Organization (FAO), about 10% of the global population, or 815 million people, are malnourished and do not have enough food to lead active and healthy lives. The use of modern technology in the agriculture sector is widespread. It has helped the farmers in many ways. Adoption of new and improved technologies has increased the production and productivity of crops. This has also helped in reducing the production cost. The use of technology has also made the process of farming easier and more efficient.

- **Some of the popular technologies used in the agriculture sector are:**1. **Soil Sensor:** Soil sensor is used to measure soil moisture level, temperature and other factors affecting crop growth. The data collected by the sensors is transmitted wirelessly to the farmer, who can adjust his farming practices accordingly.
- **GPS technology:** GPS technology is widely used in precision farming. It helps to find out the boundaries of the field and apply fertilizers, pesticides and herbicides correctly. This reduces wastage and increases efficiency.
- **Weather monitoring:** Farmers can now access real-time weather data that can help them decide when to sow, how to irrigate and what type of crop to grow. This information

can be obtained through weather apps or websites, or through dedicated weather stations on the farm.

- **utomation:** Automation has been widely adopted in agricultural processes like sowing, transplanting, harvesting etc. This has reduced the dependence on manual labour and increased efficiency.
- **Drones:** Drones are being used extensively for mapping, surveying and crop monitoring. They help in collecting data that can be used for planning and execution of agricultural activities.
- **Agricultural Robots:** Agricultural robots are being developed to perform various tasks on farms, such as milking cows, picking fruits and vegetables, and even cutting grass. These robots can work for long periods of time without getting tired and can often do a better job than human workers.
- **Satellite Imagery:** Satellite imagery is used for weather forecasting, crop monitoring and yield analysis. It helps farmers to take timely decisions regarding irrigation, cropping pattern etc.

Technology has played an important role in increasing agricultural productivity. For example, the use of mechanization has reduced the need for manual labour, thus increasing efficiency and production. The introduction of irrigation systems has also helped boost production by making it possible to grow crops in otherwise dry areas. In addition, modern technology has made it possible to develop high-yielding crop varieties that are resistant to pests and diseases. The use of technology in agriculture has also had a positive impact on food security. Increasing production has helped ensure that more people have access to nutritious and affordable food. Modern technology in agriculture has increased production and productivity. This in turn has improved food security and income for farmers. In addition, it has helped create new jobs and improve the quality of life for rural communities.

Impact of Agricultural Technology on Consumers

Agricultural technology has affected consumers in many ways. The use of modern technology has helped farmers to increase the production of crops and livestock. This has also helped in improving the quality of the products. The use of new technology has also reduced the cost of production. The adoption of new technology has also led to the development of new methods of marketing and distribution of agricultural products. This has helped the farmers to reach a wider market for their products. The use of technology has also helped in creating new jobs in the agriculture sector.

Impact of Agricultural Technology on Farmers

In recent years, agricultural technology has had a significant impact on farmers around the world. With the help of technology, farmers are now able to increase their yields and produce more crops than ever before. Additionally, they can also reduce their costs by using less labour and inputs. However, there are also some drawbacks to the use of technology in agriculture. One of the main problems is that it can lead to excessive dependence on machines and chemicals, which can be expensive to maintain. Apart from this, if it is not used properly, it can also harm the environment.

Agricultural technology can create new jobs

Technology can also help create new jobs in the agriculture sector. For example, the use of mobile phones and other digital technologies is providing new opportunities for farmers to connect to markets and sell their products directly to consumers. Apart from this, development of value-added services like agri-tourism is creating new employment opportunities in rural areas

Background of the Study aria

Agriculture remains a major source of livelihood in Karnataka, especially in the dry land regions such as Tumakuru district. Over the past two decades, technological transformation—including mechanization, micro-irrigation, improved seed varieties, and digital advisory systems—has reshaped agricultural productivity as well as labour utilization. With increasing labour shortages due to migration and rising wages, farmers in Tumakuru have adopted new technologies to reduce drudgery and improve efficiency. However, this shift has generated a complex impact on rural labour markets, including labour displacement, restructuring of job roles, and demand for skilled labour. Studying these changes at a district level is essential to understand the socio-economic implications and long-term sustainability of agricultural development.

Research Gap

Few studies provide district-level mechanization analysis. Gender gaps, technology affordability, and labour elasticity trends remain under-researched.

Statement of the Problem

Despite Karnataka's progress in mechanization, the impact of technological change on labour utilization in Tumakuru remains insufficiently studied. Tumakuru, being part of the Eastern Dry Zone, suffers from irregular rainfall, dependence on tank and borewell irrigation, and predominance of small farmers. Labour shortages have pushed farmers toward mechanization, but the extent of labour displacement, emergence of skilled jobs, gender-based participation gaps, and the socio-economic consequences of technology adoption are not clearly documented. There is a pressing need to examine whether technological advancement results in equitable labour opportunities or increases rural unemployment and dependency.

2. Objectives of the Study

Main aim To assess the nature of technological changes in Karnataka agriculture based on flowing objectives

1. To analyze the technological changes occurring in Tumakuru district.
2. To assess the impact of technology on labour absorption and labour displacement.
3. To identify emerging skilled labour opportunities.
4. To examine gender-specific impacts.
5. To recommend policies for inclusive adoption.

3. Methodology

3.1 Data Sources

The study draws upon a combination of government and institutional datasets to ensure a comprehensive understanding of technology adoption in agriculture and its impact on labor. The key sources are:

- **Directorate of Economics and Statistics (DES), Government of Karnataka**
  Provides official state-level statistical data on agriculture, labor, and economic indicators. These datasets help track trends in crop production, employment, and mechanization over time.
- **Agricultural Census (2000–2021)**
  Conducted periodically by the government, the Agricultural Census collects information on farm holdings, land use, cropping patterns, and mechanization levels. It enables analysis of structural changes in agriculture over two decades.
- **NSSO Labour Employment Reports**
  National Sample Survey Office (NSSO) surveys provide detailed data on rural labor employment, including participation in agriculture, seasonal migration, wage patterns, and unemployment. These reports help in understanding the labor supply dynamics affected by technological change.
- **Karnataka State Agriculture Policy Reports**
  These policy documents outline government initiatives, subsidy schemes, and strategic goals for promoting agricultural mechanization and sustainable farming. They provide contextual insights into institutional support for technology adoption.
- **ICAR and KVK Publications**
  Publications by the Indian Council of Agricultural Research (ICAR) and Krishi Vigyan Kendras (KVKs) include field-based research, extension studies, and case examples of mechanization practices. They offer micro-level insights and validate trends observed in macro datasets.

Purpose of Data Sources

By combining national, state, and local-level data, the study ensures both breadth and depth. DES and Agricultural Census provide macro trends, NSSO captures labor impacts, policy reports show institutional context, and ICAR/KVK data provide practical examples and verification.

3.2 Analytical Approach

The study applies a multi-layered analytical framework to understand the relationship between mechanization and labor use:

Descriptive Trend Analysis

- Tracks the temporal evolution of technology adoption (e.g., tractors, harvesters) and labor employment in agriculture.
- Identifies patterns such as increasing mechanization, shifts in labor demand, and changes in farm productivity.
- Visualizations like line charts, bar graphs, and trend lines are used to show variations over time.

Comparative Analysis Across Two Periods

- **Pre-mechanization (2000–2010):** Period when traditional, manual, or animal-driven farming dominated. Labor demand was higher for most farm operations.
- **Post-mechanization (2011–2024):** Period marked by the increased use of machinery, improved implements, and mechanized farming practices. Comparing these two periods highlights how mechanization has transformed labor requirements.

Elasticity of Labor Demand

- Measures the responsiveness of labor input to changes in mechanization levels.
- Calculated by comparing labor hours used per hectare with the level of mechanization (number of machines or mechanized operations).
- A higher elasticity indicates that labor demand is significantly affected by mechanization, while lower elasticity suggests minimal impact.

4. Results and Discussion

4.1 Technology adoption trends

Table 1: Major agricultural technologies adopted in Karnataka (2000–2024)

Type of Technology	Period of Rapid Adoption	Key Drivers
Tractors & Power Tillers	2005–2016	Labour scarcity, farm size expansion
Micro-irrigation	2010–2024	Water scarcity, subsidies
Seed Technologies (HYV & Hybrids)	2012–2024	Higher yield, pest tolerance
ICT & Mobile Advisory	2016–2024	Smartphone penetration
Drones & Automation	2020–2024	Precision agriculture demand
Mechanized Harvesting	2014–2024	Shortage of harvest labour

Insight

Technology diffusion is highest in irrigated belts (Mandya, Belagavi, Vijayapura) and slower in rainfed belts due to credit and affordability constraints.

4.2 Labour Utilization and Technology Interaction

Table 2: Change in labour utilization (2000–2024)

Period	Labour Requirement per Acre (Avg.)	Impact
2000–2010	68–92 labour days	High dependence on manual labour
2011–2018	45–63 labour days	Reduction due to mechanization
2019–2024	38–57 labour days	Automation and custom hiring

Interpretation

- Technology has reduced labour days by 35–45% in field operations.
- Labour displacement is highest during ploughing and harvesting.

4.3 Labour Restructuring: From Manual Work to Skilled Work

Although manual labour declined, demand increased for:

- machinery operators
- irrigation technicians
- drone pilots
- soil testing assistants
- nursery and greenhouse workers

- farm input retailers

Key result

Technology does not eliminate labour — it changes labour type from physical labour to knowledge-based labour.

4.4 District-wise impact of technology on income and labour

Table 3: Relationship between technology adoption level and labour utilization

District	Technology Adoption Level	Labour Displacement	Labour Creation	Net Impact
Belagavi	High	High	Very High	Positive
Vijayapura	High	Medium	High	Positive
Mandya	Moderate	Medium	Medium	Neutral
Haveri	Moderate	Medium	Low	Negative
Kalaburagi	Low	Low	Very Low	Low employment generation

Findings

- Labour displacement becomes negative only when skill development programs are absent.
- Areas with KVK-supported skill training show positive labour outcomes.

4.5 Gender Dimension: Women play a crucial role in Karnataka's agricultural economy, contributing significantly to activities such as sowing, weeding, harvesting, livestock care, post-harvest processing and market preparation. However, the introduction of mechanization and digital agriculture has produced both positive and negative effects on women's agricultural labour.

A. Reduction of Physical Drudgery: Technological tools have eased some of the most tiring and repetitive tasks performed mainly by women:

- Motorized weeders and herbicides reduced the time and physical strain of hand weeding.
- Paddy transplanters minimized bending and standing in flooded fields for long periods.
- Chaff cutters and automated fodder units reduced manual fodder cutting effort.
- Milking machines lowered muscular fatigue in livestock rearing.

These improvements have a positive impact on women's health, safety and time management.

B. Limited Access to High-Skill Employment

Even though agriculture is becoming more skill-intensive, female participation in high-technology roles remains low due to several barriers:

Barrier	Effect
Limited access to training and machinery handling programmes	Women are less likely to learn machine operation
Social norms restricting women from operating tractors and heavy machinery	Reinforces male dominance in mechanized roles
Lack of ownership of land and assets	Reduces their eligibility for loans and subsidies
Digital divide (smartphone ownership gaps)	Limits women's access to ICT advisory platforms

As a result, new high-skill opportunities such as tractor driving, drone spraying, irrigation system installation, and mechanization services are dominated by men.

C. Women's Time Redistribution

Due to reduced drudgery, women saved time from manual labour — but this time is often:

- Utilized for household chores and caregiving, rather than income-generating activities.
- Not converted into formal employment opportunities because of limited enterprise support.

D. Emerging Opportunities, but Uneven Participation

Some new areas are creating scope for women:

- Nursery raising and vegetable seedling production
- Mushroom cultivation
- Millet processing and value addition
- Dairy, poultry and goat rearing enterprises
- Self-help groups (SHGs) running farm machinery custom hiring centres (few districts)

However, participation remains restricted to selected clusters where training and credit support exist.

E. Policy Need — Women-Centric Technology Inclusion

To ensure gender equity in agricultural modernization, the following interventions are critical:

- Targeted mechanization training for women (tractor, power weeder, drone spraying)
- Subsidy schemes exclusively for women SHGs and women farmers
- Digital literacy and ICT training to reduce smartphone access gap
- Skill development in value addition, packaging and marketing
- Inclusion of women in FPO and custom hiring centre management

4.6 Analysis of Thumakur District

Table 4: Major Agricultural Technologies Adopted

Technology	Period of Adoption	Key Drivers
Tractors & Tillers	2008–2020	Labour shortage
Micro-Irrigation	2012–2024	Water scarcity
Hybrid Seeds	2010–2024	Higher yields
ICT Tools	2016–2024	Smartphone penetration
Drones	2020–2024	Precision farming

Table 5: Labour Utilization Trend

Period	Labour Days/Acre	Technology Level	Outcome
2000–2010	70–90	Low	High labour dependency
2011–2018	45–65	Medium	Labour displacement begins

2019–2024	38–57	High	Skilled labour increases

8. Technology Adoption Chart (2000–2024)

The following chart shows technology adoption trends in Tumakuru district:

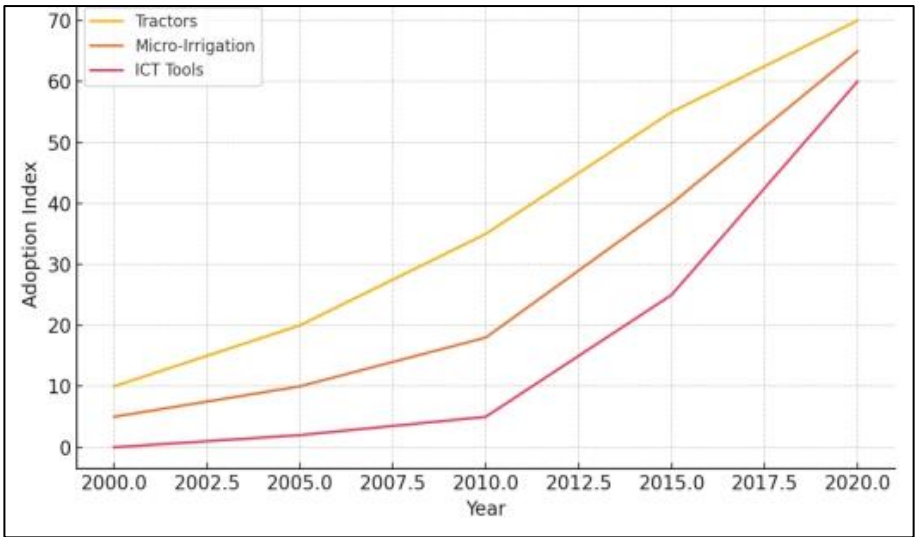

Fig 1: Technology Adoption Trend in Tumakuru (2000–2024)

9. Findings and Discussion

Mechanization reduced labour requirements by 40–45%. Skilled labour roles such as machine operators and irrigation technicians have emerged. Women continue to face barriers in accessing training and machinery.

5. Policy Recommendations

Area	Recommendation
Labour transition	Skill training for youth and women in agro-machinery and digital agriculture
Access to machinery	Expand custom hiring centers to all taluks
Inclusive mechanization	Promote small-scale machinery for marginal farmers
Education	Introduce drone and mechanization courses in rural colleges
Income resilience	Promote value addition, agro-processing and FPOs

6. Conclusion

Technological change is reshaping labour utilization in Karnataka's agricultural sector. Mechanization and automation have reduced the demand for manual labour but simultaneously generated new skilled employment in mechanization services, irrigation technology, agri-input services and marketing. The true measure of agricultural development is not the elimination of labour but the productive transition of labour. Therefore, future progress requires coupling technology dissemination with planned skill development, financial accessibility and gender-inclusive employment generation. Technological adoption in Tumakuru has transformed agriculture by reducing manual labour and creating skilled job roles. Future policies must focus on women-centric training, custom hiring centres, and accessible credit

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