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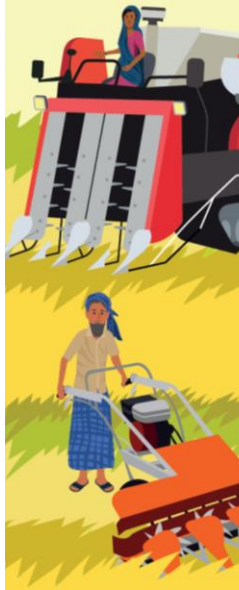
Mechanization and Transformation of Smallholder Agriculture: Evidence from China and Bangladesh

Shahidur Rashid, IFPRI
Xiaobo Zhang, IFPRI and Peking University



Agricultural Mechanization in Bangladesh- The Future

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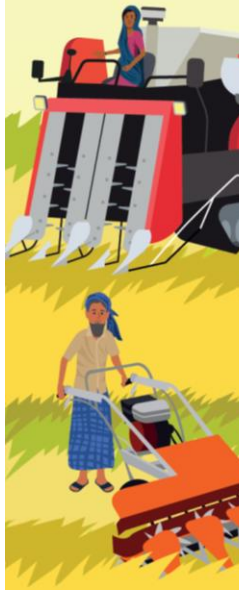
Plan of the presentation

- Setting the context
  - Historical Examples
  - Concepts and Indicators of Transformation
  - The issues to be considered
- Smallholders' Agriculture and Mechanization: The Debate
- Evidence from China and Bangladesh
- Summary and Implications



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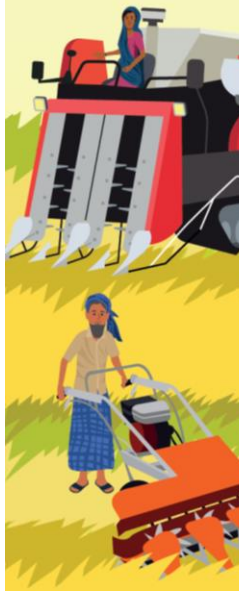
Historical context

- The first agricultural census report of Bangladesh (then East Pakistan) was published in 1960. The numbers implied a bleak future. Consider the following:
  - The average farm size was 3.7 acres (1.49 hectares)
  - An average rural household had eight members
  - Rice yield was just about one metric ton per hectare
  - Country's population (then about 50 million) was growing at an annual **rate of 3.5 percent**
  - And agricultural wages were **declining in real terms**.



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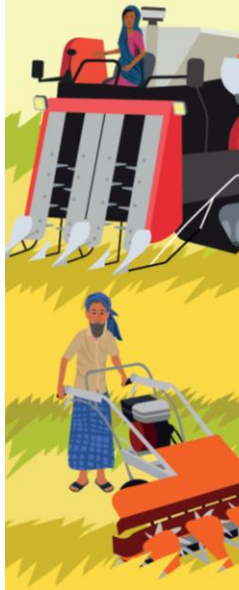
Historical context (2)

- Implications of the numbers from the 1st agricultural census were dire:
  - At 3.5% growth rate, population was going to double every 20 years, reaching 200 million by 2000, and 400 million by 2020.
  - Agricultural production was not going to catch up, making Malthusian prediction a distinct reality.
  - International development experts were writing off the region, and labeling countries in the region with “basket case”, “Triage”; with popularity of philosophical concept “Lifeboat Ethics” in the west.

None of these predictions turned out to be true—so, we have real reasons for celebration!



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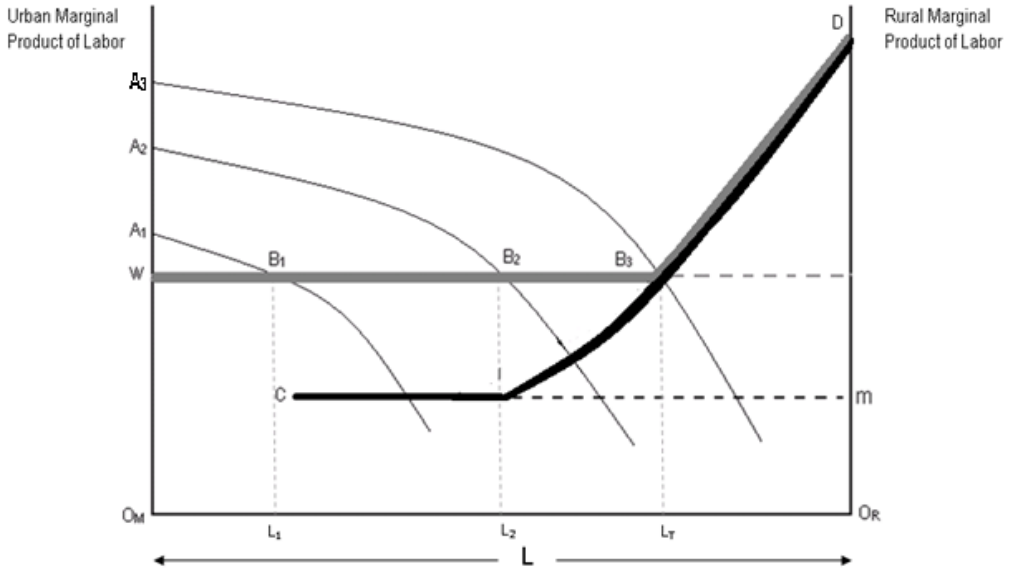
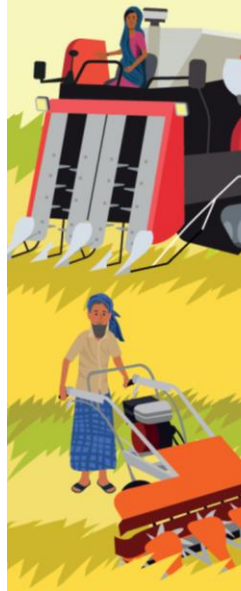
Concepts of Transformation

- Agricultural transformation should be viewed in light of the structural transformation. One of dominant theories of development (Lewis, 1954) viewed this as follows:

  - At the initial stages of development, urban (or non-farm) sector can hire workers without increasing wages. Thus, labor supply is not a problem at this stage (large pool of unemployed workers in rural areas)
  - But there comes a point, where rural wages start to increase and converge with the urban wages (called Lewis' Turning Point)





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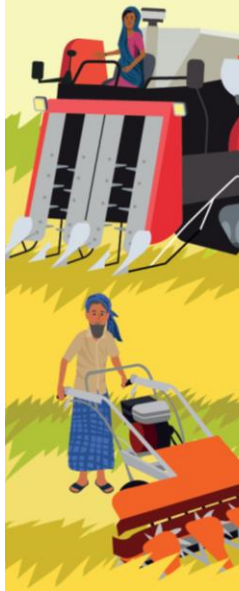
Indicators of transformation

- The following are common indicators of economic transformation:
  - Consistent decline in the share agriculture in the nation's overall income (GDP)
  - Rising real wages; and convergence of agricultural (rural) and urban wages
  - Increasing female participation in the national labor force.



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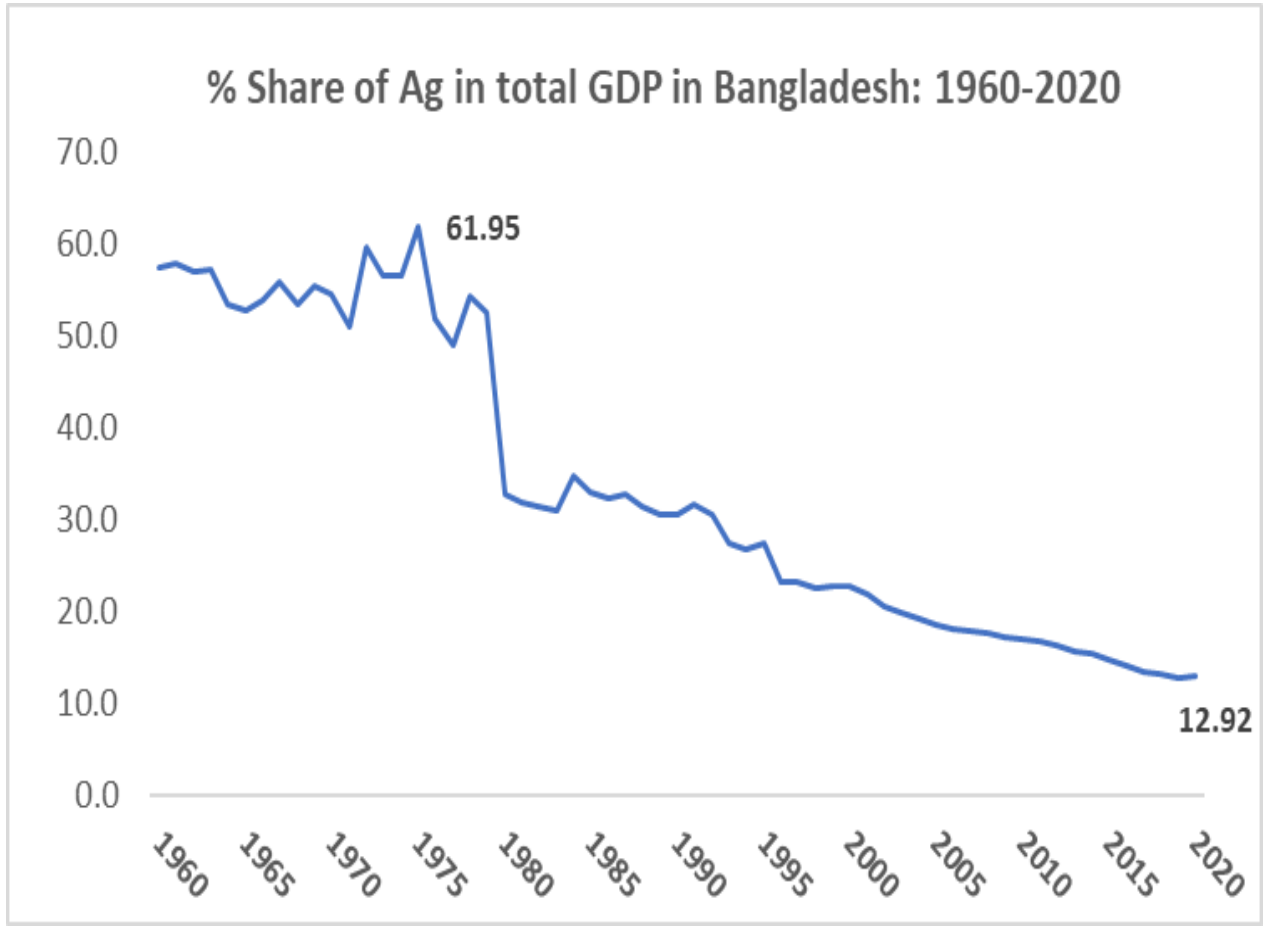
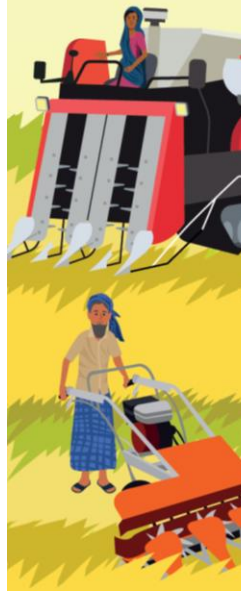
Indicators of transformation

- Figure to the right shows ag GDP (including forestry and fisheries) since 1960
- Consistent with the theoretical predictions, share of Ag in GDP has declined—precipitously since 1990s.
- Ag GDP accounted for over 60 percent for a few years after the country's independence





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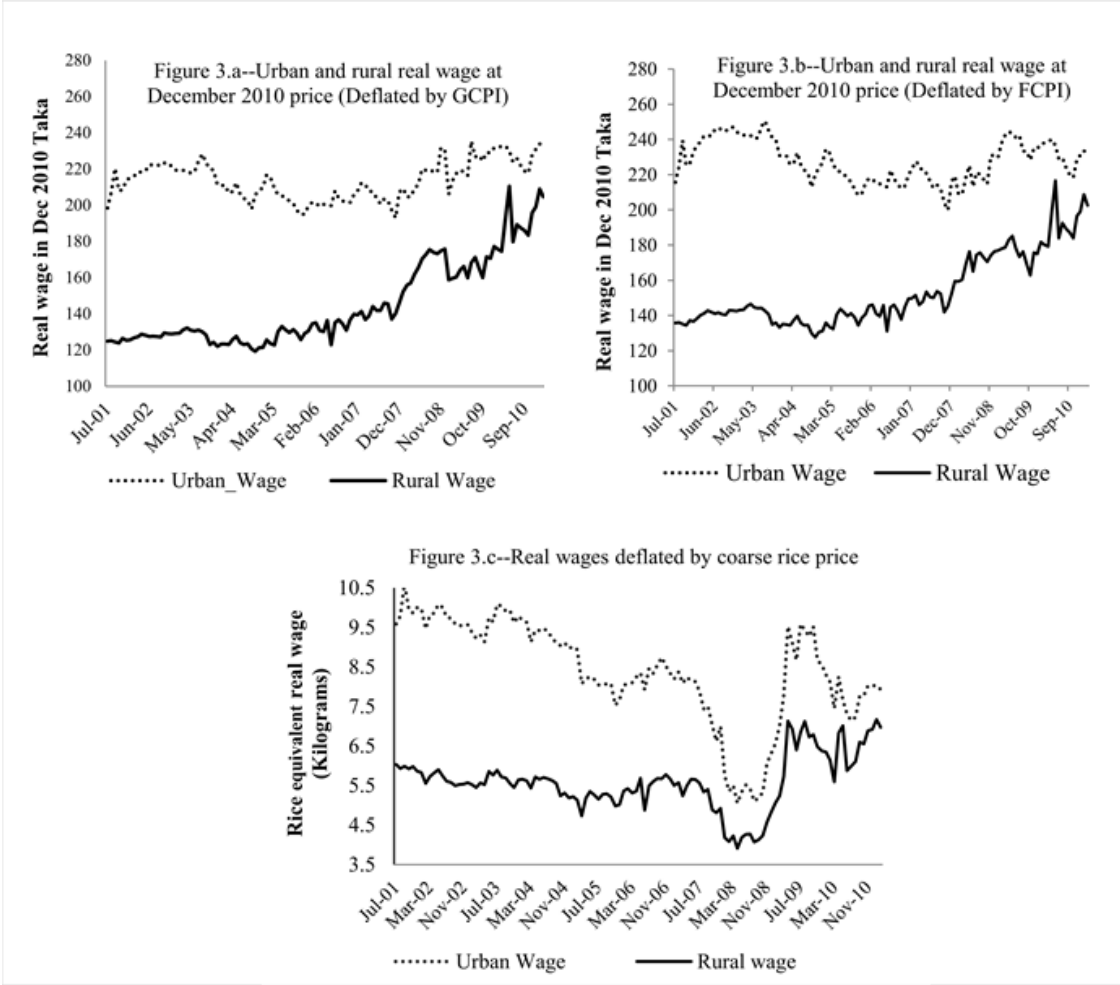
Indicators of transformation

- Figure to the right presents real wages deflated by general CPI, food CPI, and rice price.
- Clearly, real wages are rising with a clear trend of convergence
- In the 1960s through 1980s, average daily wage of an agricultural workers could buy only 3 kgs of rice.
- Between 2010 and 2015, average wage could buy as much as 9 kgs of rice.



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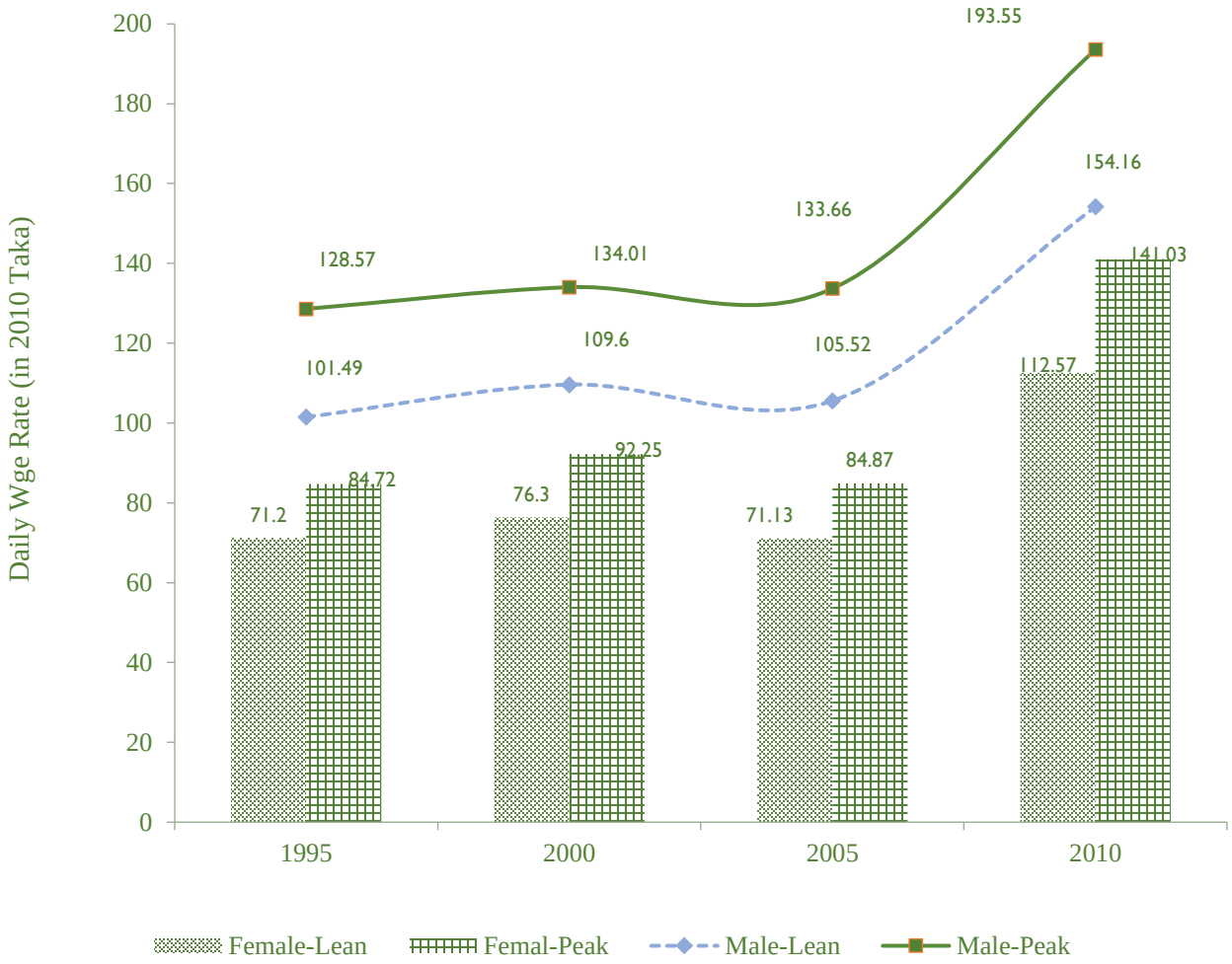
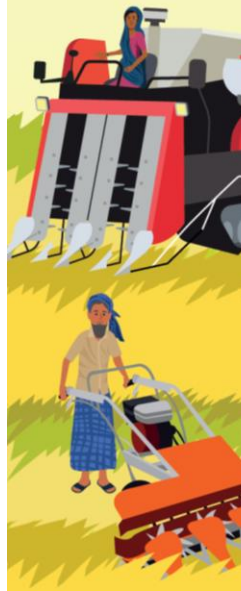
Wage disparity between male and female labor force

- Seasonality adjusted real wages of both male and female labor force shows an increasing trend
- Participation of female labor force in general has been consistently going up.
- Wage disparity between male and female labor force has gone down.





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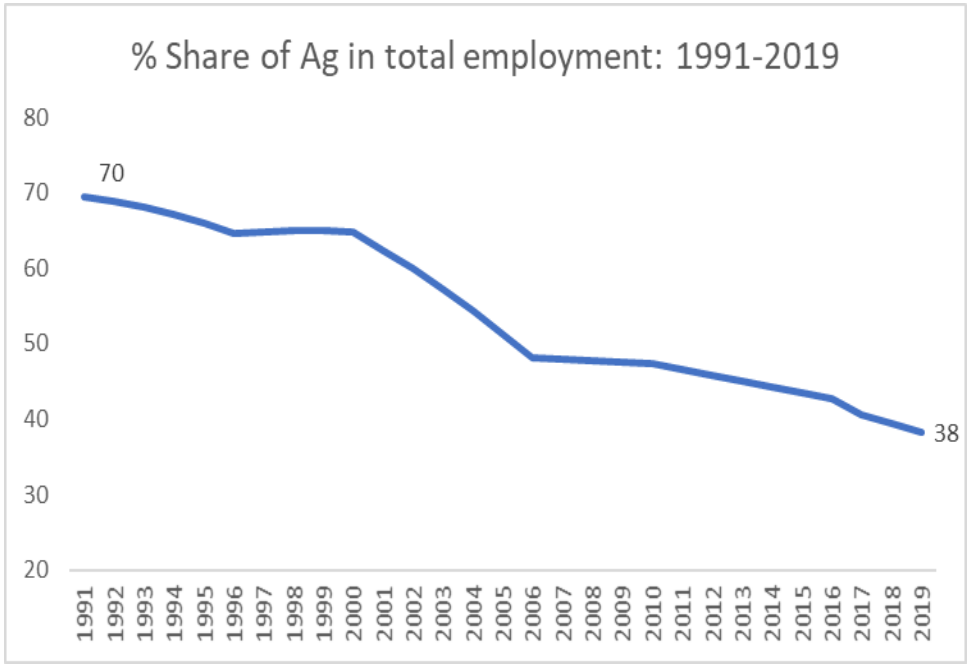
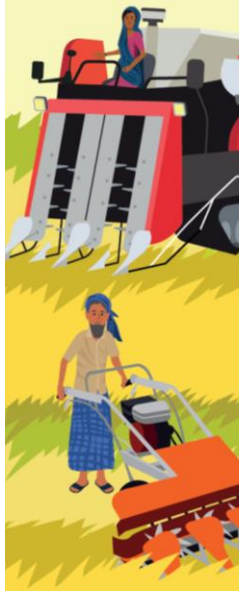
Issues to be considered

1. Share of agriculture in total employment has declined from about 70% in early 1990s to 38% in 2019
2. However, it has not declined as fast as the share of ag GDP, which dropped to about 12%.
3. There are debates about these trends, but recent IFPRI research suggest that ag GDP calculation misses out some key ingredients
4. There is prevailing view that mechanization is infeasible in smallholder dominated agriculture—experiences in China and Bangladesh go against that view





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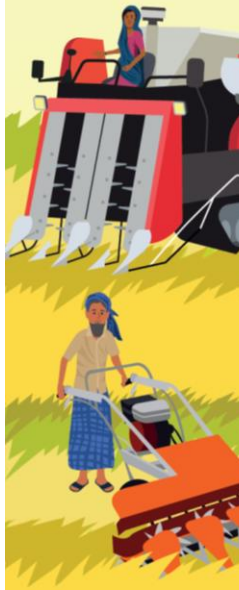
Smallholder Agriculture and Mechanization: The Debate and the China & Bangladesh Experiences



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Debate about Smallholder Famers

- Collier and Dercon (2009) argue that African agriculture's future lies in large farms because smallholder farmers lack sale of production.
- Fan and Chang-Kang (2005): Small is beautiful
- Is there a future for smallholder farmers?

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Adam Smith' Remarks on Division of Labor in Agricultural production

- **The nature of agriculture, indeed, does not admit of so many divisions of labor, nor of so complete a separation of one business from another, as manufactures**…… The impossibility of making so complete and entire a separation of all the branches of labor employed in agriculture is perhaps the reason why the improvement of the productive powers of labor in this art does not always keep pace with their improvement in manufactures.

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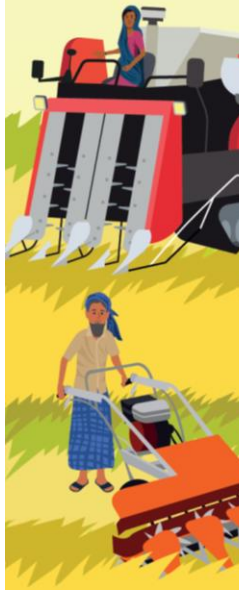
Pinglai's View

- Prof. Pingali has written a very thoughtful and widely cited review article in the *Handbook of Agricultural Economics* (2007).
- He holds a similar pessimistic view on rice mechanization in Southeast Asian countries (page 2790):
  - "In the absence of land consolidation and the re-design of the rice land to form large contiguous fields, the prospects for large-scale adoption of the harvester-combines are limited."



May 2009, Sichuan Province

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Distance from Peixian to Zizhong County: 1,079 miles (Distance from Dhaka to New Delhi: 885 miles)

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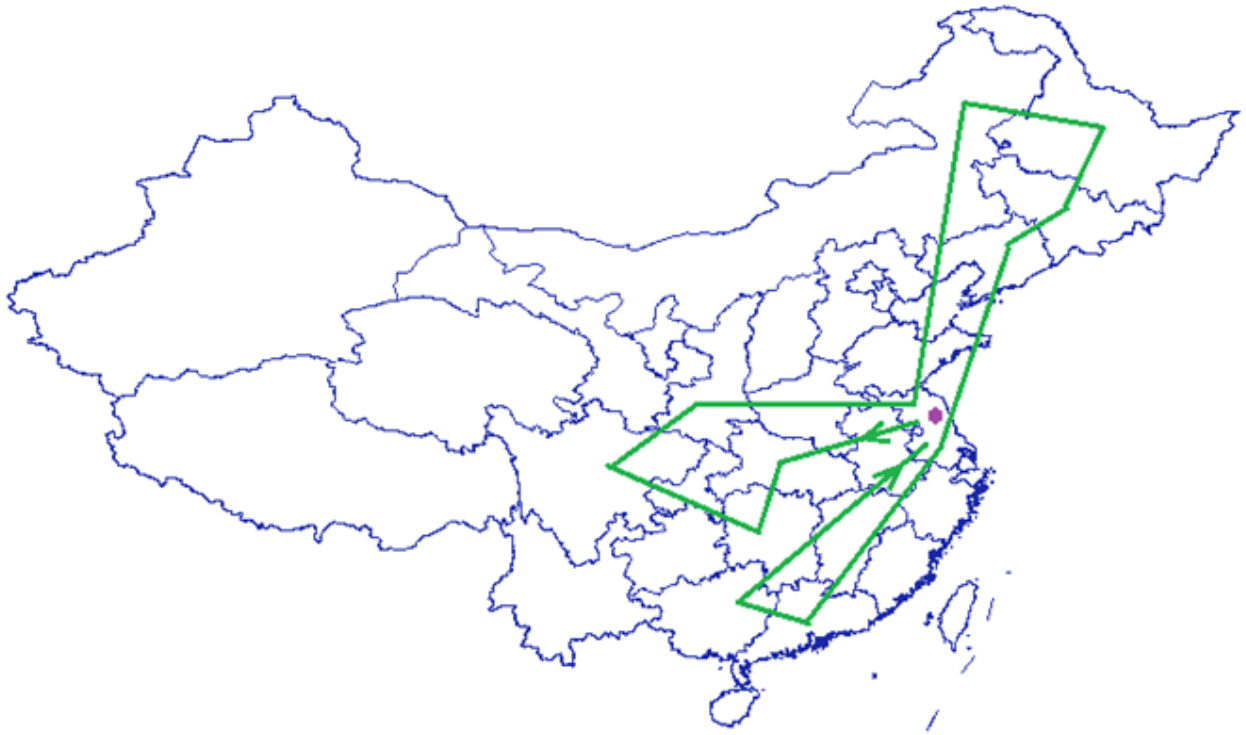
A Rice Harvesting Route



From the mid July to the end of November:
Hunan →Hubei → Sichuan→ Shannxi→Jiangsu → Shanghai→Inner Mongolia → Northeastern provinces→Jiangsu→Guangdong→Guangxi

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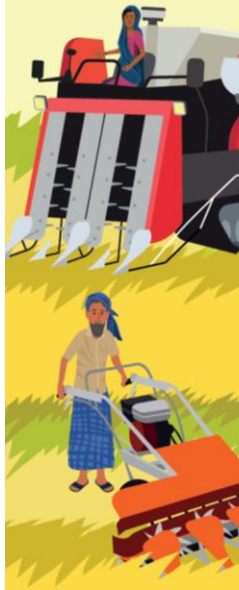
A Wheat Harvesting Route

Early April to early July：
Sichuan→Shannxi → Hunan→ Hubei→ Jiangsu→ Shandong→ Tianjin



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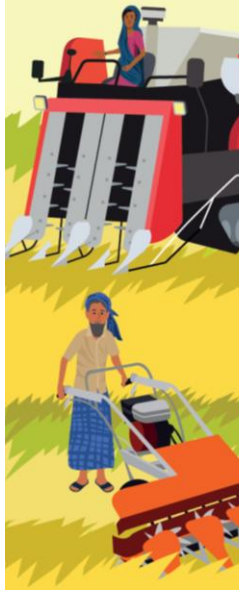
Answers to the Conundrum

- Agricultural production is divisible.
- Some steps of production, such as ploughing and harvesting, can be outsourced to others.
- Even in the US, migratory harvesting and pollination service are popular.
  - Steven Chang "The Fable of Bees: An Economics Investigation" JLE (1973)
  - Muth, Mary K., Randal R. Ruckers, Walker N. Thurman, and Ching-Ta Chuang. "The Fable of Bees Revisited: Causes and Consequences of the U.S. Honey Program." JLE (2003).
  - Nordhaus "The Beekeeper's Lament"



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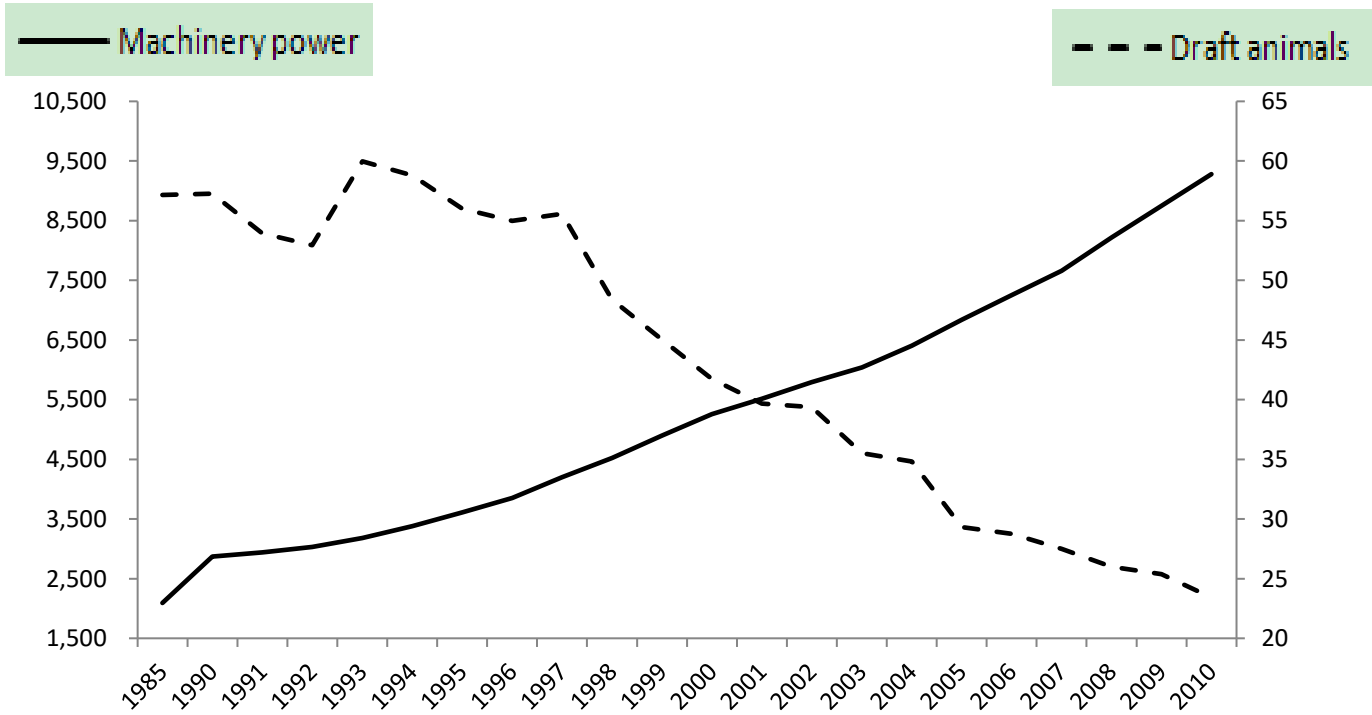
Machinery Power and Draft Animal



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Conditions for Outsourcing

- Market size: The division of labor is limited by the extent of the market (Stigler, JPE 1951).
- Machinery cost: combines are much more expensive than attached disc ploughs.
- Asset specificity: tractors have multi-functionality, while combines don't have.
- High labor cost.

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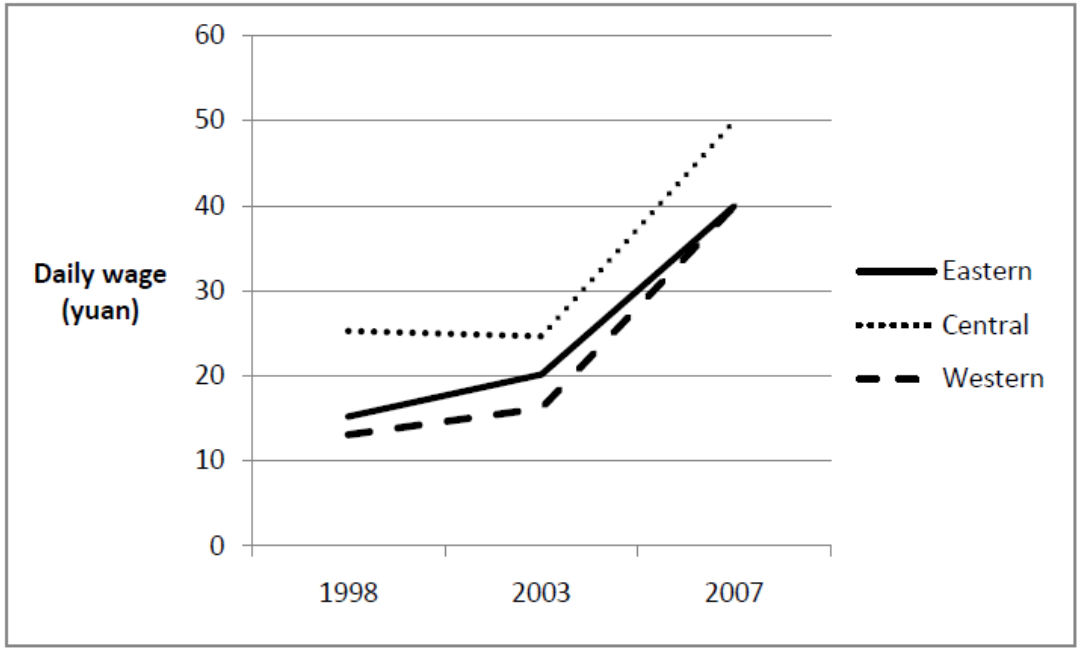
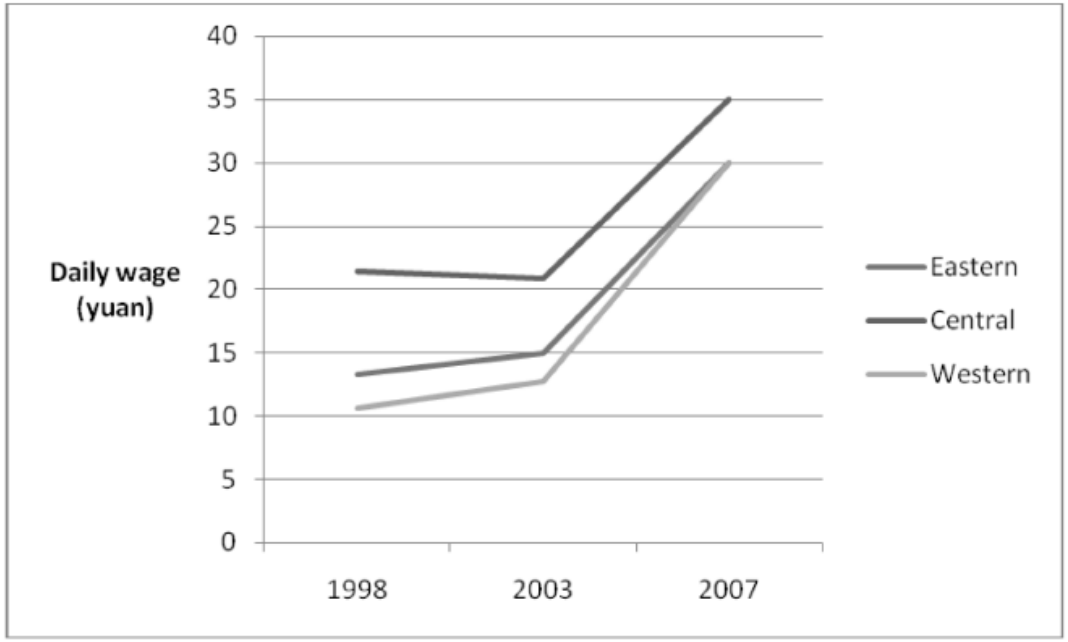
Daily Wages for Men and Women

Men



Women



Zhang, Yang, and Wang (China Economic Review, 2011)

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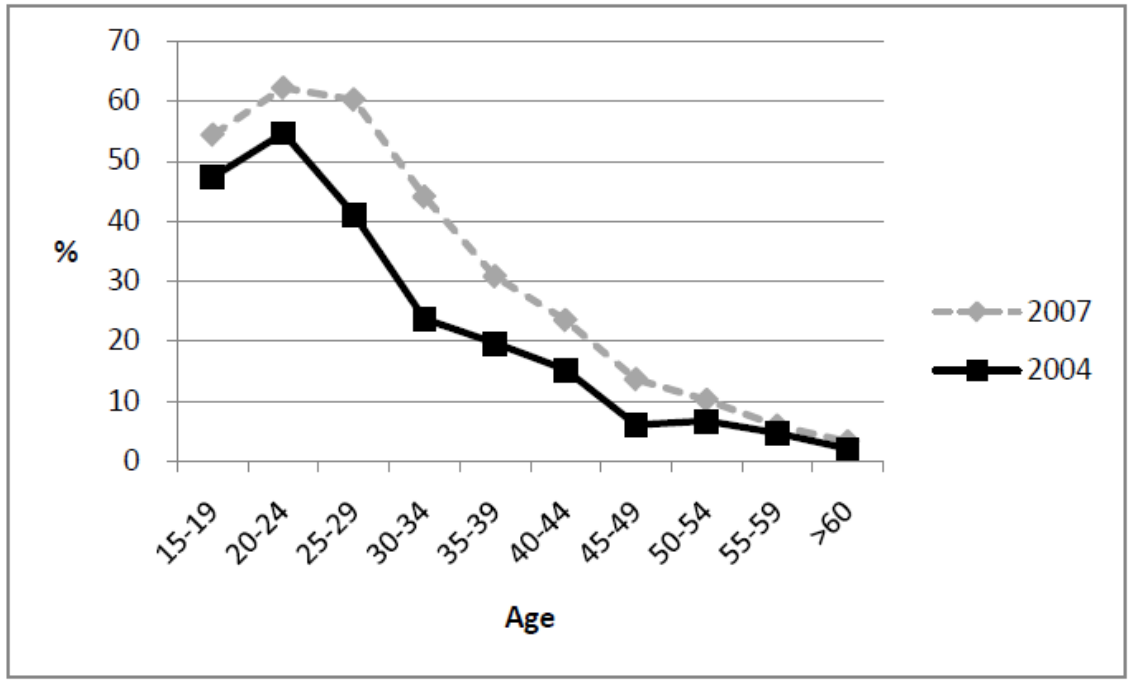
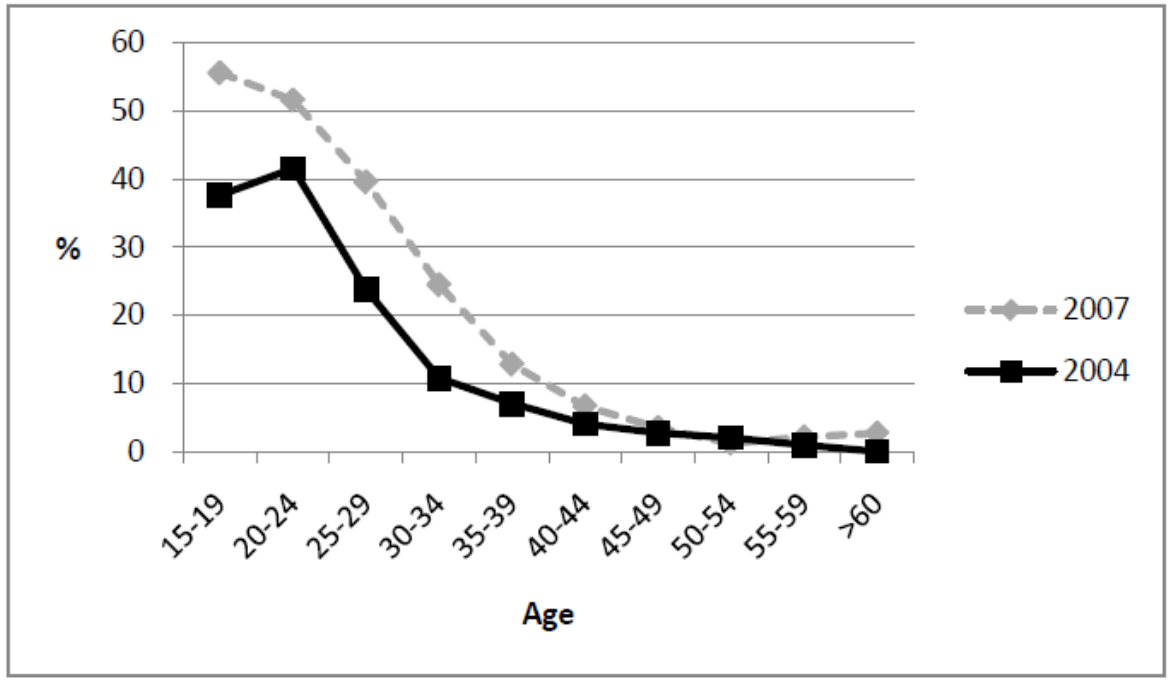
Share of Migratory Workers by Gender and Cohort

Men



Women



Zhang, Yang, and Wang (China Economic Review, 2011)

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Rice Production Steps

Economics text book: Cobb-Douglas or CES production function
Labor+capital+land+other inputs → Rice

Traditional rice production:
Land preparation → planting → weeding → irrigation
(draft animals or labor) (labor) (labor) (pumps or rain-fed)

→harvesting → threshing → drying
(labor) (labor, animal, or threshers) (labor)

Current practice in China:
Land preparation→ planting → weeding → irrigation →harvesting+threshing
(Tractors) (most by hand) (herbside+labor) (pumps) (combine harvester)

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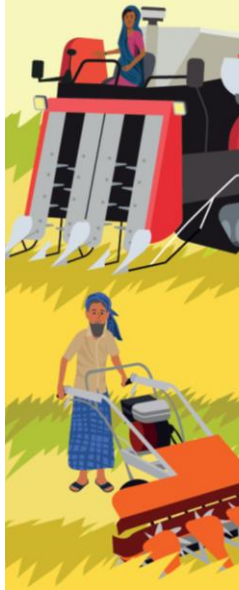
Rice Harvesting: National Market

- Rice is planted in many parts of China, mostly in flat areas. Thereby migratory labor-cum-machine service providers can travel up to 8 months to recoup the high cost of combines, which have no other uses.

- In a small country, such as Japan, migratory harvesting is not feasible because of low regional variations in seasons.

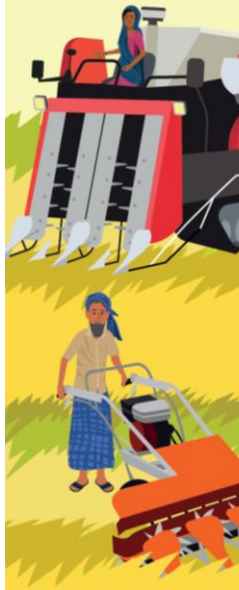


Use of Mechanization in Rice Production

Year	Variable	Using machinery	Hiring mechanization service
2012	Plow	86	82
	Plant	10	91
	Harvest	74	99
2008	Plow	72	80
	Plant	6	96
	Harvest	52	98

Based on authors' complementary survey attached to RCRE survey in 2013.

Zhang, Yang, and Thomas (China Economic Review, 2017)



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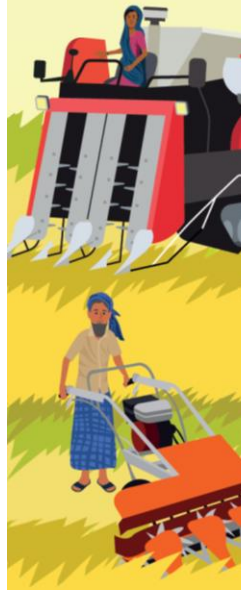
Ploughing market is mostly local because the ploughs attached to tractors are much cheaper and tractors can be used for other purposes in the slack seasons.



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Cross-Regional Mechanization Harvest Service

- Often clustered;
- 3-4 operators per team; Traveling in flocks (average 10 trucks) with combines on the top;
- Chasing production seasons for up to 8 months (average half year);
- Charging fee only half of the cost of hiring labors (about US$200 per hectare).

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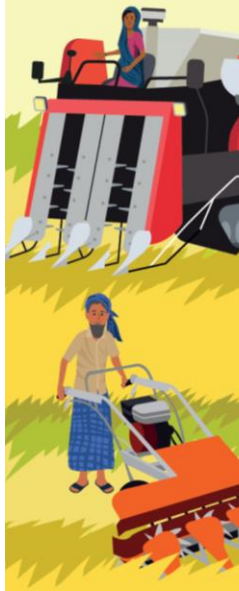
Peixian Cluster

- 36 rural mechanization cooperatives;
- 2,100 combine harvesters (mainly for wheat and rice);
- 1,100 are engaged in cross-province harvest service.
- Cross-regional harvest service started in 1998 with 50 combines largely supported by the county agricultural mechanization bureau.



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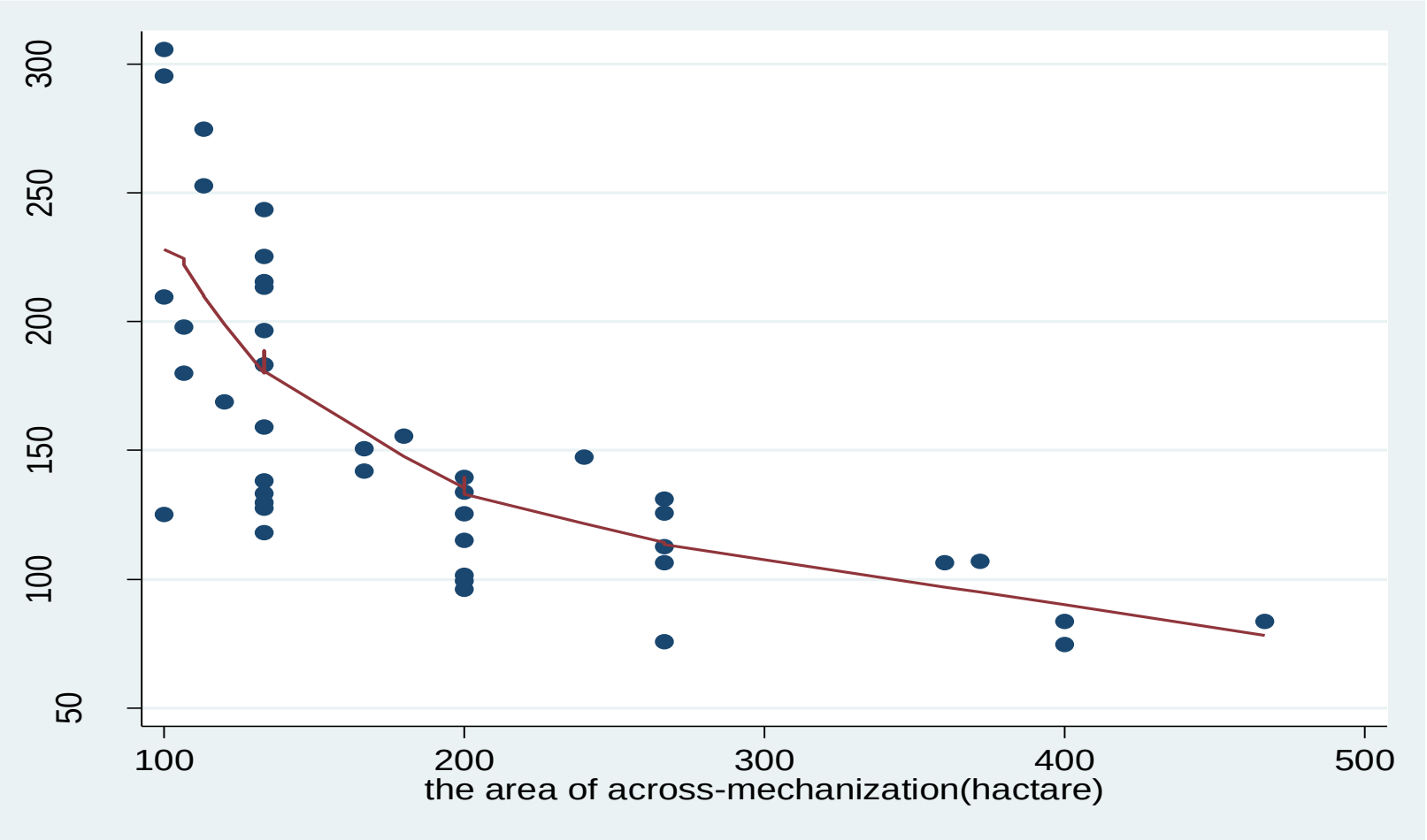
The Scale Economy of Cross-Regional Mechanization Service



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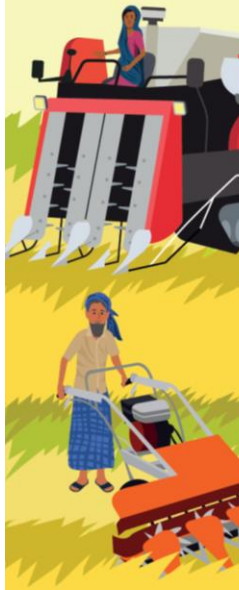
Advantage of Traveling in Groups

- Better coping with harassment and extortions from local gangs;
- Greater bargaining power with local agents thanks to large scale of harvesting;
- Pooling spare parts for repairing (even bringing a service truck);
- Sharing the search cost (like scout bees)



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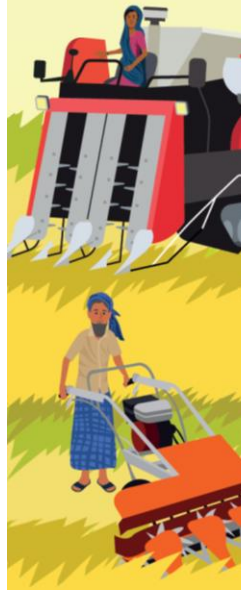
Income and Cost Per Team (RMB)

Variable	Median
1. Net income ($)	14,286
2. Total costs ($)	22,540
a) Repair and maintenance	3,175
b) Employee wages	7,937
c) Telephone	317
d) Food/lodging while traveling	4,762
e) Gasoline/diesel	6,349
3. Area served (hectares)	133
4. Days working away from home	179

About six times of rural per capita income in Jiangsu Province.



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Implications

- Lack of production scale has been regarded as a major constraints of smallholder farmers in developing countries, particularly in Asia.

- The Chinese case shows that agricultural production is divisible and some steps of production can be sourced to specialized service providers, such harvesting service, which run at a much larger scale.

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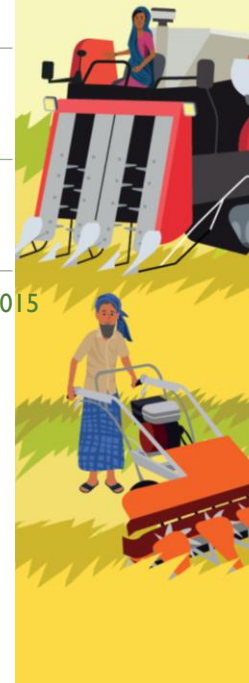
Real Rural Wages in Bangladesh

Zhang, Rashid, Ahmad, and Ahmed (World Development, 2014)



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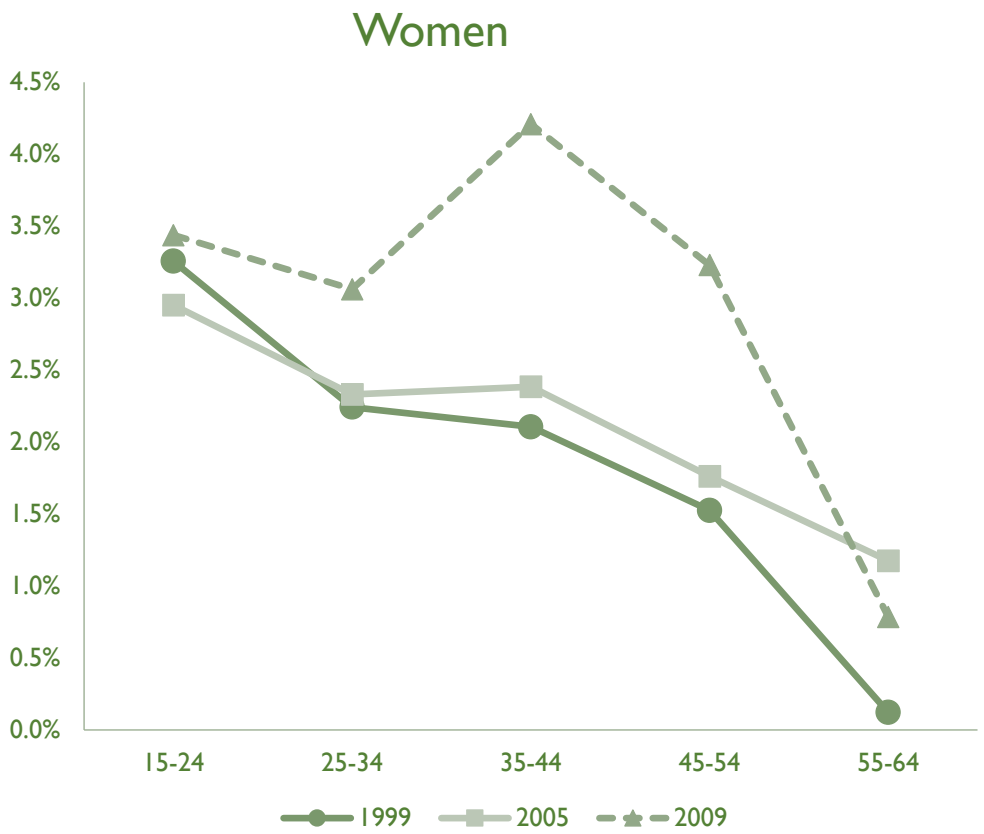
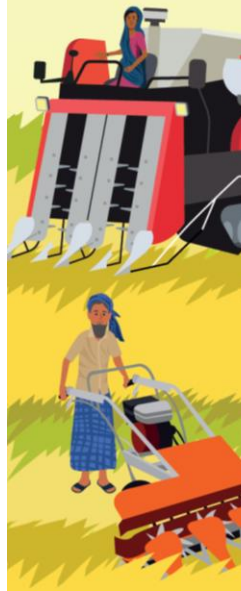
Share of Working-Age Men and Women in Manufacturing Sector





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Manual harvesting and mobile threshing service, Bangladesh, 2012


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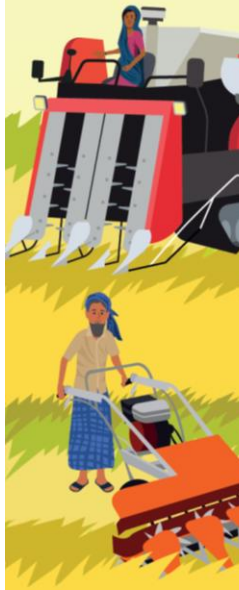
Conclusions

- Rising labor cost is a key driver of agricultural mechanization
- Mechanization does not hurt rural employment. Instead, it facilitates the economic transformation.
- Mechanization is possible in Bangladesh dominated by smallholder farmers.



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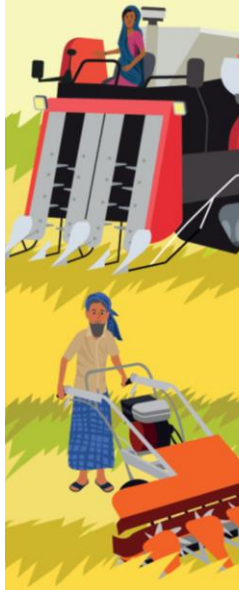
Experience of Myanmar

- Mechanization has taken off in just five years.
- Wherever there is road access, there are combine harvesters and tractors.
- No tariff for agricultural machinery import.
- Farmers can use Land Form 7 as collateral to get bank loans with interest rate between 12 and 14 percent.



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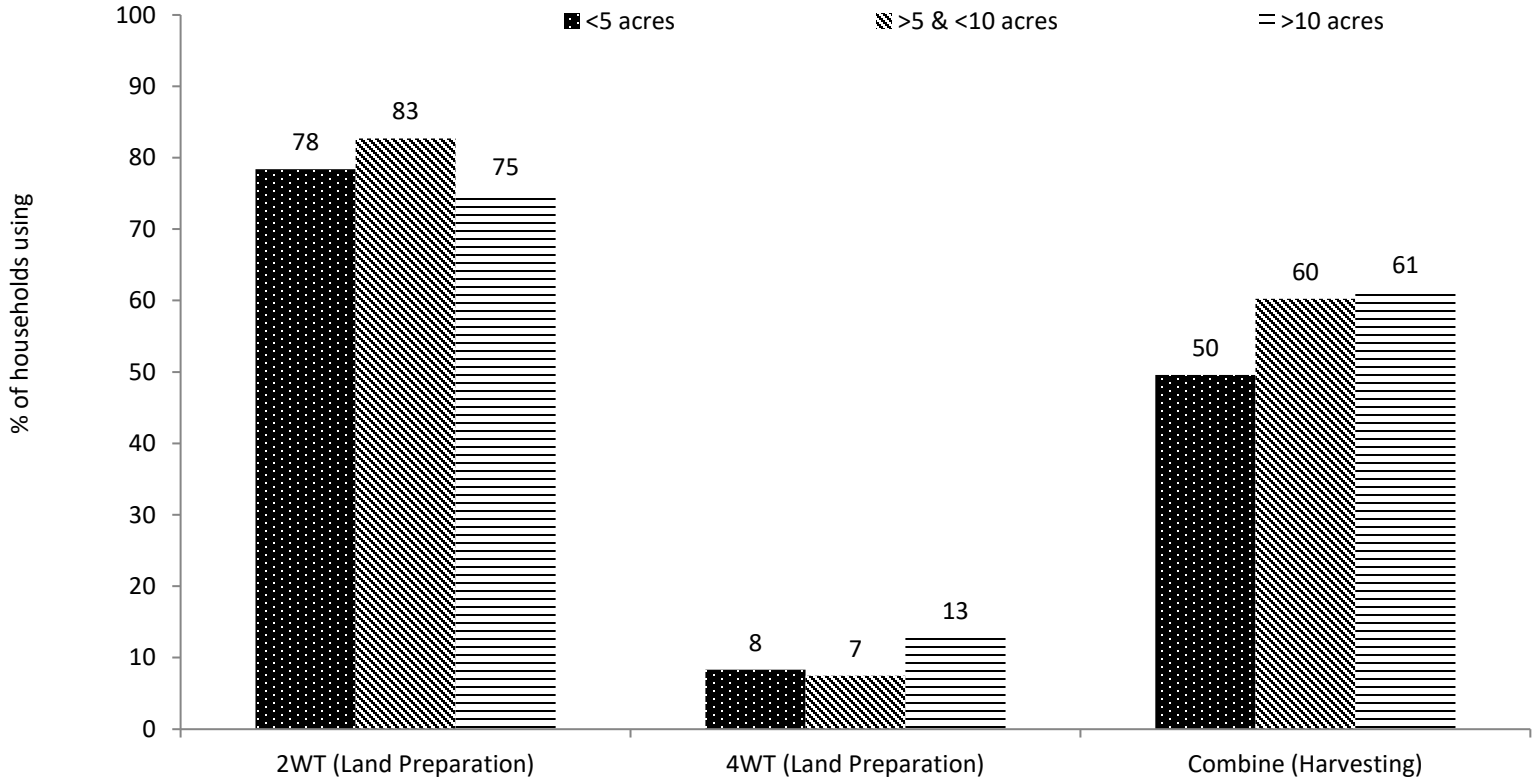
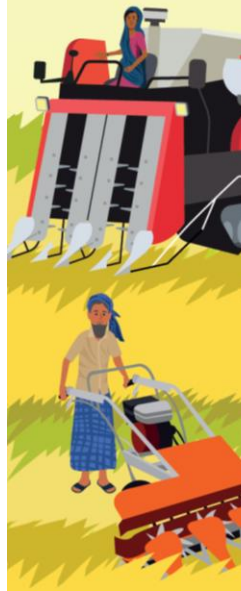
Share of Households Using Machinery for Land Preparation And Harvesting in Myanmar, by Farm Size Group (2015/16)



The use of machinery has little to do with farm size thanks to the active ploughing and harvesting service market.



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