MECHANIZATION OF POTATO CULTIVATION IN INDIA

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Content Overview

- Indian Agriculture - An overview
- Potato supply chain
- Status of mechanization in potato production
  - Seedbed preparation
  - Planting
  - Interculture
  - Fertilizer application & plant protection
  - Harvesting
  - Processing
  - Grading and seed treatment
  - Storage
- Challenges and constraints in potato production
- Suggestions for regional cooperation
Indian Agriculture

- Net sown area - 140 million ha (42.6%)
- Agricultural workers - 263 million
- Employs about 52% of the work force
- Provides livelihood to about 60% of the population
- Contributes 13% to the Gross Domestic Product (GDP)
- Yearly production
  - Food grains – 252.7 million tonne (2014-15)
  - Pulses – 18.42 million tonne (2014-15)
  - Horticultural produce – 283.50 million tonne (2014-15)
  - Potato – 48.00 million tonne (2014-15)
- No. of land holdings – 138 million
Indian Agriculture

- Highest arable land - 47% of total land against Avg. 11% in the world
- Round the year cultivation - 15 agro-climatic zones and 46 soil types suited for round the year cultivation
- Ranks first in production of Pulses, Sorghum, Jute and allied fibers
- Second largest producer of Wheat, Rice, Groundnut, Potato, Tea, Fruits and Vegetables, Sugarcane
- Small fragmented land holdings, hill agriculture and shifting cultivation
- 137.8 million cultivators, over 5.0% own > 4 ha. Avg farm land size < 1.15 ha

Bottom of Pyramid Country: Affordability and equipment size are key to success.
Emerging - Cooperative ownership model/custom hiring, use of high end equipment
Land Holdings Patterns Call for Smaller Mechanization Solutions...


- Land fragmentation has gone up with number of marginal farmers increasing from 56K in 1985-86 to 92K in 2011, an increase of 67.3%
- Land available for agriculture has remained constant around 140 mha since 1970s

Land fragmentation and no new creation of land available for agriculture will call for flexible machinery adaptable to changing crop patterns
## Population Dynamics of Indian Agricultural Workers (No. in million)

<table>
<thead>
<tr>
<th>Particulars</th>
<th>2001</th>
<th>2011</th>
<th>2020</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country’s population</td>
<td>1029</td>
<td>1211</td>
<td>1323</td>
<td>1612</td>
</tr>
<tr>
<td>Total no. of workers</td>
<td>402</td>
<td>482</td>
<td>566</td>
<td>693</td>
</tr>
<tr>
<td>No. of workers as % of population</td>
<td>39.0</td>
<td>39.8</td>
<td>42.8</td>
<td>43.0</td>
</tr>
<tr>
<td>No. of agricultural workers</td>
<td>234</td>
<td>263</td>
<td>230</td>
<td>202</td>
</tr>
<tr>
<td>% of agricultural workers to total workers</td>
<td>58.2</td>
<td>54.6</td>
<td>40.6</td>
<td>26.0</td>
</tr>
<tr>
<td>No. of male agricultural workers</td>
<td>143.0</td>
<td>165.7</td>
<td>126.5</td>
<td>81.0</td>
</tr>
<tr>
<td>No. of female agricultural workers</td>
<td>91.0</td>
<td>97.31</td>
<td>103.5</td>
<td>121.0</td>
</tr>
<tr>
<td>% of females in agril. work force</td>
<td>39.0</td>
<td>37.2</td>
<td>45.0</td>
<td>60.0</td>
</tr>
</tbody>
</table>
Shortage of Agricultural Labour Triggering Mechanization Drive

MGNREGS wages are providing 'choice of work' to casual labour in rural areas

Seasonality in Employment

- 41
- 19
- 22
- 17

Peak Agriculture Season (39%)

April - June  Dec - Jan  July - Nov  Feb - Mar

Source: Impact of MGREGA on Farm Mechanization, FICCI, 2011.

39% of annual employment under MGREGA is provided during the peak agricultural season creating shortage of unskilled labor.

Other factors contributing to shortage of labor

- **Shift into services sector** for better working condition
- **Increasing urbanization and migration of villagers in search of greater opportunities**
- **Rise of rural entrepreneurs who are looking to set up businesses of their own**

Shortage of Labor in the Agri Sector will drive need for mechanization and will call for machines with minimal human intervention
Overview of Potato Supply Chain in India
Potato Production in India

- Potato - fourth most important food crop in India after rice, wheat and maize.
- Second largest producer in the world.
- Potato is a highly nutritious, easily digestible, wholesome food containing carbohydrates, proteins, minerals, vitamins and high quality dietary fibre.
- In India, 85 per cent of the crop is grown during winter season having short photo-period (about 10-11 h sunshine) and crop duration is limited to 90-100 days.
## Area, Production and Yield of Potato

<table>
<thead>
<tr>
<th>Year</th>
<th>Area (Mha)</th>
<th>Production (Mt)</th>
<th>Yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1949-50</td>
<td>0.239</td>
<td>1.54</td>
<td>6.59</td>
</tr>
<tr>
<td>1959-60</td>
<td>0.362</td>
<td>2.73</td>
<td>7.55</td>
</tr>
<tr>
<td>1969-70</td>
<td>0.496</td>
<td>3.91</td>
<td>7.89</td>
</tr>
<tr>
<td>1979-80</td>
<td>0.685</td>
<td>8.33</td>
<td>12.15</td>
</tr>
<tr>
<td>1989-90</td>
<td>0.940</td>
<td>14.77</td>
<td>15.71</td>
</tr>
<tr>
<td>1999-00</td>
<td>1.340</td>
<td>24.71</td>
<td>18.44</td>
</tr>
<tr>
<td>2009-10</td>
<td>1.840</td>
<td>36.58</td>
<td>19.92</td>
</tr>
<tr>
<td>2014-15</td>
<td>2.076</td>
<td>48.10</td>
<td>23.13</td>
</tr>
</tbody>
</table>

Source: Directorate of Economics & Statistics, Govt. of India
State-wise Area and Production of Potato in India (2014-15)

**Area**
- Uttar Pradesh: 29.21%
- West Bengal: 19.92%
- Bihar: 15.42%
- Madhya Pradesh: 6.57%
- Assam: 4.79%
- Others: 24.09%

**Production**
- Uttar Pradesh: 28.59%
- West Bengal: 26.17%
- Bihar: 13.81%
- Madhya Pradesh: 6.63%
- Assam: 3.71%
- Others: 21.09%
Value Chain for Table Purpose Potato

- Seed Growers
- Potato Farmers
- Storage Providers
- Distribution
- Vegetable Vendors
- Consumers
Value Chain for Potato Processing

Seed Growers

Potato Farmers

Storage Providers

Food Processing Industry

Distribution

Food Chain

Consumers
Status of Mechanization in Potato Production
Sub-soiler

It is suitable for breaking hardpan of the soil and loosening the sub-soil.

- Effective field capacity: 0.24 ha/h
- Operational speed: < 1 km/h
- Working depth: 450-650 mm
- Fuel consumption: 5-6 l/h
- Cost of operation: Rs. 3500/ha (US$ 52/ha)
Rotavator/Rotary tiller

- Prepares seedbed in a single operation
- Gives more uniform and better pulverization

- Effective field capacity: 0.25-0.40 ha/h
- Field efficiency: 70%
- Fuel consumption: 5.0-6.5 l/h
- Cost: Rs. 65000-80000 (US$ 950-1200)
- Cost of operation: Rs.1500/ha (US$ 20-25/ha)
## Tractor Operated Laser Land Leveller

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working width</td>
<td>1.80 m</td>
</tr>
<tr>
<td>Function</td>
<td>Fine leveling of fields with desired grade</td>
</tr>
<tr>
<td>Effective field capacity</td>
<td>0.17-0.20 ha/h</td>
</tr>
<tr>
<td>Field efficiency</td>
<td>70%</td>
</tr>
<tr>
<td>Water saving</td>
<td>20–30%</td>
</tr>
<tr>
<td>Cost</td>
<td>Rs. 3.0 to 4.0 lakh (US$ 4400-5900)</td>
</tr>
</tbody>
</table>
Straw chopper-cum-spreader and reversible hydraulic mould board plough in operation for mixing paddy residue
Potato Planting Machines

A. Semi-automatic
   - Belt Cup Type
   - Revolving Magazine Type

B. Automatic
   - Picker Wheel Type
   - Belt Cup Type
T. D. Semi-automatic Belt Type Potato Planter Ridger

- **Working width**: 1200 mm
- **Travelling speed**: 1.30-2.15 km/h
- **Effective field capacity**: 0.1-0.2 ha/h
- **Row to row distance**: 600 mm
- **Depth of planting**: 150-210 mm
- **Labour saving**: 75%
Tractor Operated Potato Planter

- Effective field capacity: 0.4 ha/h
- Operating speed: 2.5-3.0 km/h
- Field efficiency: 75-80%
- Saving in labour: 60-70%
- Cost (Semi-automatic): Rs. 45000 (US$ 700)
  (Automatic): Rs. 60000 (US$ 925)
Four Row Automatic Potato Planter

Manufacturer: M/s. Droli Mechanical Works, Moga, Punjab, India
Vertical Belt Paired Row Automatic Potato Planter (PAU)

- **Power source**: 34 kW tractor
- **Seed metering mechanism**: Vertical belt cup type
- **Effective field capacity**: 0.24 ha/h
- **Forward speed**: 2.5 km/h
- **Cost**: Rs. 85000 (US$ 1270)
- **Cost of operation**: Rs. 2700/ha (US$ 40/ha)
Self-propelled Power Weeder

Used for weeding row crops such as potato, cotton, sugarcane, maize, pigeon pea and vegetable and orchard crops

- Field capacity: 0.10-0.13 ha/h
- Saves 90% operating time, and 30% in cost of weeding
Spring Tyne Cultivator

- Single operation
- Field capacity: 0.8-1.2 ha/h
- 3 & 5 row configuration
## Tractor Operated Fertilizer Broadcaster

<table>
<thead>
<tr>
<th>Power source</th>
<th>Tractor (45 hp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective swath width, m</td>
<td>6.75</td>
</tr>
<tr>
<td>Fertilizer application rate, kg/min</td>
<td>25.00</td>
</tr>
<tr>
<td>Saving in cost as compared to manual broadcasting, %</td>
<td>2.50</td>
</tr>
<tr>
<td>Saving in labour as compared to manual broadcasting, %</td>
<td>81.80</td>
</tr>
</tbody>
</table>
Tractor Operated Boom Sprayer

- Field capacity: 1.12-1.25 ha/h
- Field efficiency: 75%
- Fuel consumption: 5.5 l/ha
- Cost of operation: Rs. 800/ha (US$ 12/ha)
Haulm Cutting

- Minimizes skinning and bruising damage during harvesting by destroying haulm 10 to 12 days before the harvesting
- Control transmission of virus through leaves and stems under favorable condition
- Improved soil-potato separation during harvesting.

- Driven by 35 hp tractor or above
- Field capacity : 0.5 ha/h
Animal Drawn Potato Digger

- Cutting width: 300-450 mm
- Working depth: 200 mm
- Operating speed: 2.0-2.5 km/h
- Field capacity: 0.05-0.12 ha/h
- Field efficiency: 60%
- Cost: Rs. 7200 (US$ 110)
Potato Digger Elevator

- Field capacity: 0.2-0.3 ha/h
- Field efficiency: 60-70%
- Exposed bulbs: 100%
- Cost of machine: Rs. 40000 (US$ 615)
- Cost of operation: Rs. 1000/ha (US$ 15/ha)
Potato Digger Elevator
Potato Harvester

Features
- Direct offloading to trailer
- Less damage to potatoes
- Control system includes adjustment of inclination of belt and depth

M/s. Ganesh Agro Equipments, Mehsana, Gujarat, India

- Power source: 34 kW tractor
- Weight: 1550 kg
- Working width: 1310 mm
- Conveyor belt length: 2120 mm
Tractor Operated Potato Combine

- Offset-trailed type tractor operated (> 40 kW)
- Single row
- 2 t hopper capacity
Tractor Operated Potato Combine
Grading/Sizing

Potato grading is generally done manually

Output capacity : 2.6 t/h
Sizing efficiency : 85-90%
Potato Handling

- **Manual handling**
- **Two trays (50 kg) trolley**
- **Eight trays (200 kg) trolley**
- **Fork lift assisted handling** (50 trays/1250 kg)
Storage

- 85% of potato is produced during winter season and stored during long hot summer.
- Potatoes are stored at 10-12° C for processing and table purpose.
- Seed purpose potatoes are stored at 2-4° C.
- Traditional low-cost and non-refrigerated storage structures (evaporative or passive evaporative cooling based) are in use in India.
- In non-refrigerated storages, sprout suppressants are used to prevent excessive weight loss and shrinkage due to sprouting.
Processing

- 7% of the total annual production of potato is processed in India as compared to 60% in USA and 47% in the Netherlands
- Increase in demand for processed potato products in India and international market
- Need to expand potato processing industries in India to produce flour, cubes, granules, flakes and starch.
Potato Chip Making Machines

Potato Peeler
Capacity : 188 kg/h

Potato Slicer
Capacity : 150 kg/h
Challenges and Constraints for Whole-process Mechanization of Potato

- Mechanization of loading and unloading of potato seeds in a tank for seed treatment.
- Need of low cost planters for planting of cut seeds of potato for growing crop for table purpose.
- Need of low cost potato digger cum elevator or potato combine for harvesting.
- Need to keep tubers well covered with soil or mulch from planting to harvesting to protect from disease and pest attacks.
- Need to develop light weight farm tools and equipment to mechanize potato cultivation in hilly region.
- Enhance potato processing industries in India to produce flour, cubes, granules, flakes and starch.
Suggestions for Regional Cooperation

- The member countries can help India in providing technical knowhow and low cost technologies particularly for mechanization of potato harvesting and processing.
- Provide technical knowhow and improved farm equipment and machinery for potato production and processing to member countries.
- Help in formulation of standards and testing of potato cultivation machinery to promote regional trade.
Conclusions

- Future potato mechanization through mechanical sources of power
- Machines suitable for custom hiring – Automatic potato planter and potato digger elevator
- Need to enhance processing of potato for value addition
- Low cost and small size potato combine suiting to Indian condition are needed.
- India can provide technical knowhow on potato production machinery to member countries in the region.
Thank You

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