Agricultural Engineering Research in Pakistan: An Overview, Impact, and Restructuring

by

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Map of Pakistan
Introduction

- Agriculture contributes:
  - 22% of GDP
  - 44.8% of total employment
  - 66% of rural population depend on agriculture

Major crops and their production:

<table>
<thead>
<tr>
<th>Crops</th>
<th>Area (m. ha)</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>8.35</td>
<td>21.61 million tons</td>
</tr>
<tr>
<td>Rice</td>
<td>2.51</td>
<td>5.02 million tons</td>
</tr>
<tr>
<td>Maize</td>
<td>0.98</td>
<td>2.79 million tons</td>
</tr>
<tr>
<td>Cotton</td>
<td>3.20</td>
<td>14.26 million bales</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>0.97</td>
<td>47.24 million tons</td>
</tr>
</tbody>
</table>
Objectives

- To present an overview of agricultural engineering research
- To present its impact, financial resource mobilization, and the capacity building of the public funded research institutions
- To present the role of commercial’s enterprises, and restructuring of agricultural engineering research in the country
An Overview of Agricultural Engineering Research

- Resource conservation technologies
- Crop harvesting and threshing technologies
- Crop drying and processing technologies
- Water management/saving technologies
Low-cost Zero-Tillage Drill
Low-cost Zero-Tillage Drill

- Annual production is about 300 units
- 25 manufacturers are engaged in its local production
- A farmer may save up to Rs 6782/ha as timeliness cost
Fertilizer Band Placement Drill
Features of Fertilizer Band Placement Drill

• It places fertilizer about 5 cm away, and 5 cm deeper than the seed

• 50% saving of DAP can be attained by using this drill

• A farmer may get a benefit of Rs 3250/ha by using this technology
Reaper-windrower for Harvesting Wheat
Features of Reaper-Windrower

- It can be used for harvesting wheat and rice
- About 30,000 units are in operation
- A farmer may save Rs 1400/ha by using this machine through timeliness of operation and reduced labor input
- Its per annum benefit to farming community is Rs 2542 million
Wheat Straw Chopper
Features of Wheat Straw Chopper

- It harvest the uncut straw, and pick up the combine ejected straw from the combine harvested fields.
- It chopped the straw, and then blew it to a trolley.
- Seven manufacturers are engaged in local production of this machine.
- About 250 units are in operation.
High Capacity Rice Thresher
High Capacity Rice Thresher

- In Sindh and Baluchistan, all rice harvesting is done manually, and threshing is done with manual beating, bullock/tractor treading followed by manual cleaning.
- Therefore, this machine has great scope in these provinces.
- Its output capacity is 1.5 tons/hr.
- About 700 units are in operation.
- Seasonal saving from one machine is Rs 0.5 million.
Solar-cum-Gas Fired Fruit Dryer
Salient Features of Solar-cum-Gas Fired Fruit Dryer

- Solar-cum-gas fired dryer is capable to dry about 500 kg of fresh dates within 5 days
- The economic analysis revealed that one may earn Rs 72,100/season by adopting this technology
- More post harvest technologies are required to introduce in the country
Mobile Flat-bed Dryer for Sunflower
Autumn sunflower can be grown successfully in Pakistan, but its drying is not possible in sun, because of cold weather.

A mobile flat-bed dryer is developed to solve this problem.

It requires 3 hrs to dry 1.25 tons of sunflower from 30% moisture content down to a safe storage level of 10%.

Cost of drying sunflower is Rs 1.25/kg.
Mobile Seed Processing Unit
Mobile Seed Processing Unit

- One of the constraints in providing healthy seed to growers is the un-availability of small scale seed processing technology.
- To solve this problem, a mobile seed processing unit was designed and developed.
- It has 98% cleaning efficiency, and its processing capacity is 1.5 tons/h, and 1000 tons/3-months season.
Water Management Technologies

Research is being focused in:

- Improving water use efficiency by adopting sprinkler and drip irrigation techniques
- Developing innovative water saving practices such as bed planting, and zero-tillage techniques
- Developing laser levelers for leveling agricultural fields in order to improve water use efficiency
Research Institutes

- Farm Machinery Institute (FMI), National Agricultural Research Centre, Islamabad
- Agricultural Mechanization Research Institute (AMRI), Multan
- Agricultural Mechanization Research Cell (AMRC), Tandojam
Universities

- Faculty of Agricultural Engineering and Technology, University of Agriculture, Faisalabad
- Faculty of Agricultural Engineering, Sindh Agriculture University, Tandojam
- Department of Agricultural Engineering, N.W.F.P. University of Engineering & Technology, Peshawar
Financial Resource Mobilization in R&D Institutions

- Non-Development Funding - Core funding provided to research institutions
- Development Funding - PSDP (Public Sector Development Program)
- Agricultural Linkages Program (ALP) - Scientists may get funding on competitive basis
- Funding from International Agencies - such as ACIAR (Australian Centre for International Agricultural Research)
Capacity Building of Research Institutions

- Research institutions are in short of trained manpower
- There is need to build/improve the capacity of these institutions in terms of measurement, design, and manufacturing capabilities
Extension of R&D Output
(Mechanism for Industrial Extension)

- Development of 1st Prototype
- Field evaluation of 1st prototype
- Modifications in 1st prototype, if required
- Demonstration of 1st prototype to commercial enterprises (C.E.), and end users
- In case C.E. shows interest, an agreement is signed between PARC & C.E.
- Research institutes provide technical assistance to C.E. for local manufacturing of these newly developed machines
Impact of Public Funded R&D Institutions

Farm machines already been developed and commercialized:

<table>
<thead>
<tr>
<th>FMI, Islamabad</th>
<th>AMRI, Multan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reaper-windrower</td>
<td>Pesticide sprayers</td>
</tr>
<tr>
<td>Zero-tillage drill</td>
<td>Wheat thresher</td>
</tr>
<tr>
<td>Groundnut digger and</td>
<td>Maize sheller</td>
</tr>
<tr>
<td>Thresher</td>
<td>Inter-culture tool bar</td>
</tr>
<tr>
<td>Paddy thresher</td>
<td>Rotary slasher</td>
</tr>
<tr>
<td>Wheat straw chopper</td>
<td>Bed and furrow shaper/planter</td>
</tr>
</tbody>
</table>
Farm Machines being Developed and Commercialized

FMI, Islamabad

- Solar-cum-gas fired fruit dryer
- Canola thresher
- Fertilizer band placement drill
- Mobile seed processing unit
- Mobile Flat-bed dryer
- FMI seeder for combine
- harvested paddy fields

AMRI, Multan

- Fodder cutter bar
- Rotary ditcher
- Maize cob harvester
- Vegetable nursery planter
- Groundnut sheller
- Stubble shaver
- Disc ratooner
Impact of Mechanical Reaping of Wheat
(Cost-benefit from Mechanical Reaping of Wheat in Pakistan)

- Cost of manual reaping (Rs/ha) 1564
- Cost of mechanical reaping (Rs/ha) 652
- Benefits to farmers (Rs/ha) 912
- Number of reapers in operation in 2006 30,000
- Number of ha wheat harvested with reapers in 2006 1.8 million ha
- Cost-benefit on 1.8 million ha (Rs million) 1641.6
- Average yield (kg/ha) 2500
- Increased yield/ha due to reduced timeliness losses (2%), kg 50
- Increased yield from 1.8 million ha (million kg) 90
- Additional benefit due to reduced losses (at 2006 wheat price of Rs 400/40 kg), million rupees 900
- Total benefit to farming community (million Rs) 2542
## Impact of Adopting Zero-Tillage Technology Technology

(Cost-benefit of using Zero-Tillage Technology)

<table>
<thead>
<tr>
<th>Operation</th>
<th>Cost in Rs/ha</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>With zero-tillage drill</td>
</tr>
<tr>
<td>Land preparation</td>
<td></td>
</tr>
<tr>
<td>▪ 4-cultivations @ Rs 437/ha</td>
<td>-</td>
</tr>
<tr>
<td>▪ 2-planking @ Rs 175/ha</td>
<td>-</td>
</tr>
<tr>
<td>Planting</td>
<td></td>
</tr>
<tr>
<td>▪ 2-cultivation and 1 planking</td>
<td>-</td>
</tr>
<tr>
<td>▪ Drilling</td>
<td>790</td>
</tr>
<tr>
<td>▪ Planking</td>
<td>175</td>
</tr>
<tr>
<td>▪ Broadcasting</td>
<td>-</td>
</tr>
<tr>
<td>▪ Total</td>
<td>965</td>
</tr>
<tr>
<td>▪ Cost advantage of zero tillage over farmer practices</td>
<td>= 2282 Rs/ha</td>
</tr>
<tr>
<td>▪ Benefit of zero-tillage technology through early planting, 15 days at 30 kg/day/ha</td>
<td>= 4500 Rs/ha</td>
</tr>
<tr>
<td>▪ Total benefit of zero-till over farmers’ practices</td>
<td>= 6782 Rs/ha</td>
</tr>
<tr>
<td>▪ Number of drills in operation</td>
<td>= 3600</td>
</tr>
<tr>
<td>▪ Annual cost-benefit</td>
<td>= 1465 million Rs</td>
</tr>
</tbody>
</table>
Role of Commercial Enterprises (Tractor Manufacturers)

- Tractor manufacturers have made significant efforts in indigenization of tractors by deleting substantial quantities of imported components.
- They saved foreign exchange & provided employment opportunities to the skilled labor.
- Two firms (Massey Ferguson and Fiat) are presently engaged in tractor manufacturing, and they have achieved over 80% deletion.
- Total number of tractors in country are about 401,663.
- New investors are being encouraged.
- Federal Govt. has allowed one-time import of 10,000 tractors at zero tariffs.
### Role of Agricultural Machinery & Implements Manufacturers

<table>
<thead>
<tr>
<th>Census Year</th>
<th>Tractor</th>
<th>Cultivator</th>
<th>Thresher</th>
<th>Trailer</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>401,663</td>
<td>369,866</td>
<td>137,270</td>
<td>242,655</td>
</tr>
<tr>
<td>1994</td>
<td>252,861</td>
<td>236,272</td>
<td>112,707</td>
<td>176,412</td>
</tr>
<tr>
<td>1984</td>
<td>157,310</td>
<td>146,863</td>
<td>78,377</td>
<td>98,787</td>
</tr>
<tr>
<td>1975</td>
<td>35,714</td>
<td>31,619</td>
<td>5,635</td>
<td>18,074</td>
</tr>
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Restructuring of Agricultural Engineering Research

- So far in Pakistan, Agricultural Engineering research has been focused in Farm mechanization, and Water management. There is need to include following areas too.
  - Precision agriculture
  - Post harvest Engineering
  - Energy System Engineering
  - Environmental Engineering
Conclusions and Recommendations

- The research institutes have developed and introduced a number of technologies.
- The research institutes and universities are contributing a lot in developing/disseminating innovative equipment, and imparting training/education in agricultural engineering.
- The research funding to research institutions/universities is available through non-development funding, PSDP funding, and ALP (Agricultural Linkages Program) on competitive basis.
Conclusions and Recommendations (Cont..)

- The impact of introducing new farm mechanization technologies on Pakistan’s economy is tremendous, and credit of this goes to research institutes, and commercial enterprises.

- There is need to restructure research in agricultural engineering with more emphasis on fruit, vegetables, and grain preservation, precision agriculture, developing environmentally sound agricultural practices, and utilization of renewable energy resources.
Thank You
Very Much