MECHANIZATION OF SWEET POTATO PRODUCTION IN MALAYSIA

Dr Md Akhir bin Hamid
Engineering research centre
Malaysian Research and Development Institute (MARDI).
MALAYSIA
mdakhir@mardi.gov.my

27-28 June 2016, Kunming, China
Content overview

- Introduction
- Status of mechanization of sweet potato production
- Challenges and constraints faced for whole-process mechanization of sweet potato production
- Suggestions for regional cooperation for whole-process mechanization of potato production in Asia and the Pacific
- Conclusion
INTRODUCTION

- Sweet potato is becoming 6\textsuperscript{th} or 7\textsuperscript{th} most produced food crop in the world.
- The largest cultivated area is China about 3.5 mil. Hac- 43\% of total production in the World
- Its growth well on many type of soils and its special crops
- In Malaysia the total area cultivated was 1309 hac. in 2009 and Increase to 2505hac in 2013.
## Top ten sweet potato producing country in the world

<table>
<thead>
<tr>
<th>Country</th>
<th>Area (hectares)</th>
<th>Volume (Tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>3,524,505</td>
<td>79,090,068</td>
</tr>
<tr>
<td>Nigeria</td>
<td>1,115,000</td>
<td>3,400,000</td>
</tr>
<tr>
<td>Tanzania</td>
<td>675,000</td>
<td>3,100,000</td>
</tr>
<tr>
<td>Uganda</td>
<td>550,000</td>
<td>2,587,000</td>
</tr>
<tr>
<td>Indonesia</td>
<td>161,850</td>
<td>2,386,729</td>
</tr>
<tr>
<td>Vietnam</td>
<td>135,900</td>
<td>1,364,000</td>
</tr>
<tr>
<td>Rwanda</td>
<td>112,346</td>
<td>1,081,224</td>
</tr>
<tr>
<td>India</td>
<td>111,800</td>
<td>1,132,400</td>
</tr>
<tr>
<td>United States of America</td>
<td>45,810</td>
<td>1,124,230</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>39,076</td>
<td>1,354,911</td>
</tr>
<tr>
<td><strong>Total top ten</strong></td>
<td><strong>6,471,287</strong></td>
<td><strong>96,620,562</strong></td>
</tr>
<tr>
<td><strong>World</strong></td>
<td><strong>8,240,969</strong></td>
<td><strong>110,746,162</strong></td>
</tr>
</tbody>
</table>
### AREA PLANTED (HA) WITH TUBER CROPS IN MALAYSIA (Ministry Agricultural Malaysia 2013)

Areas and yield sweet potato production as compare to other tuber crops

<table>
<thead>
<tr>
<th>Year</th>
<th>Cassava (ha)</th>
<th>Cassava (mt)</th>
<th>Sweet potato (ha)</th>
<th>Sweet potato (mt)</th>
<th>Coco yam (ha)</th>
<th>Coco yam (mt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>3,075</td>
<td>68,508</td>
<td>1,309</td>
<td>13,495</td>
<td>656</td>
<td>6,366</td>
</tr>
<tr>
<td>2010</td>
<td>2,708</td>
<td>37,183</td>
<td>2,176</td>
<td>23,054</td>
<td>348</td>
<td>2,887</td>
</tr>
<tr>
<td>2011</td>
<td>2,596</td>
<td>33,206</td>
<td>2,229</td>
<td>26,582</td>
<td>385</td>
<td>2,802</td>
</tr>
<tr>
<td>2012</td>
<td>3,053</td>
<td>40,998</td>
<td>2,386</td>
<td>25,417</td>
<td>384</td>
<td>3,183</td>
</tr>
<tr>
<td>2013</td>
<td>3,205</td>
<td>43,048</td>
<td>2,505</td>
<td>26,688</td>
<td>403</td>
<td>3,342</td>
</tr>
</tbody>
</table>
Sweet Potato Growing Area

- Major growing area:
  - on tin-tailling (in rotation with yam-bean in Perak) - 91,000 Hac
  - drained peat (in Selangor and Johor) - 870,000 hac
  - Bris sandy soil (alternative crops replacing tobacco farm in Kelantan) - 165,000 Hac
  - on paddy land (as in the off-season in single crop area in Kedah) - 433,000 hac

- Sweet potato has an advantage over cassava – less competition from more lucrative crops.

- AFTA implemented in 2010 - sweet potato is one of alternative crops replacing tobacco
Sweet potato Marketing

- Currently no major industry to absorb the sweet potato supply – Price very unstable.
- Sweet potato prices:
  - US$, 0.10 to US$ 0.27 kg tubers at the farm gate
  - Depending on the variety-orange/purple flesh high price
  - Time of the year-higher prices are encountered yearly during fasting month.
- The middlemen are responsible for transporting the tubers to the wholesale markets in the cities.
- Farmers sell their product directly in weekly farmer markets as known as pasar tani (manage by FAMA) thus bypassing the middleman.
Sweet Potato Utilizations

- Sweet potato is sold fresh use with no major processing industry
- Except for small-scale production of traditional snacks such as kerepek (crisp), and cakar ayam or as a filler in Chinese pastries, such as moon-cakes during the Mid-Autumn festival.
- This dependence on the fresh market limits the production of sweet potato, leading to drastic drops in price when production is expended suddenly
The crop production is labor intensive
More than half of total productions cost for labor
Traditional method involve large amount of labor for:
  - Planting
  - Crops maintenance
  - Harvesting
Land preparation – use tractor implements such as Plough, rotovator and bed former
Status of mechanization sweet potato production

- Most of field operation for sweet potato production can be mechanized except for peat soil
- The sequence of operations and implement involved shown in Table below.
- Most of the machines are imported.
- A few are locally developed
- Almost all of them has been tested at MARDI.
### Machinery available for sweet potato cultivation

<table>
<thead>
<tr>
<th>Operation</th>
<th>Machine requirement</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Land Preparation</strong></td>
<td>Rotovator</td>
<td>Suitable on <em>bris</em> soil, attached to a 30 hp 4 w tractor. Setting for ridger 1 016 mm for tractor operation.</td>
</tr>
<tr>
<td>a. Tillage (rotor)</td>
<td>Rotovator</td>
<td></td>
</tr>
<tr>
<td>b. Rotor + Ridger</td>
<td>Rotovator + ridger</td>
<td></td>
</tr>
<tr>
<td><strong>2. Planting</strong></td>
<td>Mechanical aid</td>
<td>cuttings 300 mm long, short internode, 8 nodes per cutting.</td>
</tr>
<tr>
<td>a. Planting materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Planting spacing</td>
<td>1 016 x 240 mm, 40 000 plants/ha</td>
<td></td>
</tr>
<tr>
<td>c. Planting method</td>
<td>Transplanter attached to a 30 hp 4 w tractor, planting on beds, 1.3 m wide.</td>
<td>Available</td>
</tr>
<tr>
<td><strong>3. Fertilizer applications</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. NPK (granular/ powder)</td>
<td>Spreader with some modifications</td>
<td>Available</td>
</tr>
<tr>
<td>b. Organic fertilizer (dry and granular/powder)</td>
<td>Spreader with some modifications</td>
<td>Modified, suitable for dry applications</td>
</tr>
<tr>
<td>Operation</td>
<td>Machine requirement</td>
<td>Availability</td>
</tr>
<tr>
<td>----------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>4. Pesticide spraying</td>
<td>Boom sprayer attached to a 30 hp, 4 WD tractor.</td>
<td>Available, tractor tracks follow the furrows during sprayer.</td>
</tr>
<tr>
<td>5. Water management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Irrigation</td>
<td>Any type of sprinkler available, depending on field conditions</td>
<td>Available</td>
</tr>
<tr>
<td>b. Drainage</td>
<td>Ridger or disk furrow</td>
<td>Available</td>
</tr>
<tr>
<td>6. Harvesting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Vine slashing</td>
<td>slasher or bale roller</td>
<td>Needs some modifications</td>
</tr>
<tr>
<td>b. Root digger</td>
<td>- Vibrator digger</td>
<td>Still under research/ manual collector is still needed</td>
</tr>
<tr>
<td></td>
<td>- Modified Houlton destroyer digger</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Some use of plough/mechanical implements but damage is high.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trailer attached to a tractor and manual collection</td>
<td></td>
</tr>
<tr>
<td>c. Root collection</td>
<td></td>
<td>Available</td>
</tr>
</tbody>
</table>
Land preparation at bris and tin tailing soil

- **Disk Plough**
- **Double disk harrow**
- **Rotor ridger**
- **Organic fertilizer applicator**
Landscape planning for mechanize sweet potato production
Single and double Planter

Single row Planter

Crop view - Single row

Double row Planter

Crop view - double row
Machines for Crops maintenance
Manual harvesting

<table>
<thead>
<tr>
<th>Slashing of Vines</th>
<th>1-2 day to dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut and roll or slashed</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Digging</th>
<th>Sub soiler/disc plough</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand tools</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Collector</th>
<th>transporter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basket/gunny</td>
<td></td>
</tr>
</tbody>
</table>
Mechanize Harvesting
### Estimated costs (US$) for manually and mechanically sweet potato production

<table>
<thead>
<tr>
<th>Description</th>
<th>Manual productions</th>
<th>Mechanical Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mineral soil</td>
<td>Sandy soil</td>
</tr>
<tr>
<td>Land preparation</td>
<td>240</td>
<td>160</td>
</tr>
<tr>
<td>Planting</td>
<td>176</td>
<td>176</td>
</tr>
<tr>
<td>Crop maintenance</td>
<td>582</td>
<td>1424</td>
</tr>
<tr>
<td>Harvesting</td>
<td>264</td>
<td>264</td>
</tr>
<tr>
<td>Total costs</td>
<td>1262</td>
<td>1924</td>
</tr>
<tr>
<td>Cost per kg Tubers</td>
<td>0.064</td>
<td>0.096</td>
</tr>
</tbody>
</table>

- Machinery system in sandy soil savings US$ 400 per hectare, compared to a manual: Yield of 20 tonnes/ha (US$ 0.02/kg).
## Working rate in the manually and mechanically operations for sweet potato production on bris soils

<table>
<thead>
<tr>
<th>Operation</th>
<th>Traditional Method</th>
<th>Man-hours/ha</th>
<th>Mechanized Method</th>
<th>Hours/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ploughing</td>
<td>Hand tool</td>
<td>60-67</td>
<td>Planter, Spreader</td>
<td>60-67</td>
</tr>
<tr>
<td>2. Rotor tilling</td>
<td>Manual with tool</td>
<td>150-160</td>
<td>(row)</td>
<td>6-8</td>
</tr>
<tr>
<td>4. Cutting vines</td>
<td>Manual,</td>
<td>50</td>
<td>Inter-row weedier</td>
<td>2-2.5</td>
</tr>
<tr>
<td>5. Planting</td>
<td>Manual with tool</td>
<td>60</td>
<td>Boom sprayer</td>
<td>2</td>
</tr>
<tr>
<td>6. Fertilizer</td>
<td>Knapsack sprayer</td>
<td>60</td>
<td>Rotor slasher</td>
<td>2-2.5</td>
</tr>
<tr>
<td>7. Irrigation</td>
<td>Manual</td>
<td>16</td>
<td>Digger-collector</td>
<td>2</td>
</tr>
<tr>
<td>8. Weeding</td>
<td>Hand tool</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Pesticide application</td>
<td>Manual</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vine slashing</td>
<td>Manual</td>
<td>352</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root digging</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root collection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>795-813</td>
<td></td>
<td>96-112</td>
<td></td>
</tr>
</tbody>
</table>
Challenges and constraints faced for whole-process mechanization of sweet potato production

1. Machinery for sweet potato production is expensive and farmer not entitle to buy.
2. Machineries for tuber crop cannot be used in wet soil condition raining season.
3. Facilities and resources for the purpose of machineries training is incomplete.
4. The lack of skilled trainer for training.
5. The recognition of trainer standards are not uniform
6. The lack of skilled labour in agriculture mechanization and automation
7. Limited transfer of technology
8. Young generation are not interested in agriculture
9. Farmers area is small between 1-2 hac, not suitable to own machinery
Suggestions for regional cooperation for whole-process mechanization of potato production in Asia and the Pacific

- Scaled labour can be developed through training courses for field machineries handling. In this regard, any member of Asia and the Pacific had technology to give training courses to the service provider, farmer or entrepreneur for mechanised in field production of sweet potato.

- The machineries training and courses can give benefit to the workers to handle field machineries for sweet potato production. It also can extract the young people work in agriculture by using machine. This should have training courses to the young farmers and agriculture Agency to supervisor of Agriculture machinery.
Conclusion.

- A complete machinery system based on a standard four-wheeled tractor has been developed and tested for mechanized commercial sweet potato production.
- Almost all field operations in the production of sweet potato can be mechanized.
- Mechanized production can save a substantial amount of labour and costs of field operations.
- Mechanized production involves a large amount of capital.
- Carefully planning is needed for machinery optimum used in the field.
Asian and Pacific Workshop on Whole-Process Mechanization of Potato Production

Thank you

Dr. Md Akhir bin Hamid
Engineering research centre
Malaysian Research and Development Institute (MARDI), Persiaran MARDI-UPM,
43400 Serdang, Selangor.
MALAYSIA
Tel: 603-8953 4765
mdakhir@mardi.gov.my

27-28 June 2016, Kunming, China