Testing of Hand Tools and Non Motorized Machines used in Agriculture in Asia Pacific Region

Shreemat Shrestha
Senior Scientist
Agricultural Engineering Division,
Nepal Agricultural Research Council
Khumaltar, Nepal.

1.0 Background:
Agricultural hand tools and implements has played important role in human civilization. A great range of agricultural tools and implements has been developed ingeniously all over the world, reflecting the experience handed down for many generations. These tools and implements were time tested and continuously evolved to fit in to the requirements of that particular farming community, cropping system and agro ecosystem. From the last centuries, the agricultural is modernized and mechanization through the adoption of tractor and motorized machinery and implements. A study by Clarke and Bishop (2002) reveals that the land cultivated by humans is estimated 40% in East Asia and 30% in South Asia. Despite the great progress of motorized machinery & implements in agriculture, hand tools and non motorized equipments still plays important role in agriculture in the majority of countries in Asia Pacific regions. Small farm size, lack of appropriate machinery, less affording capacity of small holder farmers, lack of skills, lack of repair and maintenance facilities etc. are the major reasons for the dominance of the hand tools and non motorized equipments in agriculture in the developing countries in this region. Hence, agriculture in the developing countries (eg. Nepal, Laos PDR, East Timor, Bangladesh, India, Philippines, Myanmar etc) this region will continue to depend for many years on hand tools, animal powered implements and non motorized agricultural machinery.

2.0 Hand tools used in agriculture:

2.1 Tillage for Seedbed Preparation:
It is the one of the most energy intensive operation in agriculture. In the majority of countries this operation is mechanized through tractors and power tillers. The small holders and the farmers of least developed countries have to depend upon animal and human power for tillage operation. Seed-bed preparation involves use of different types of hand operated tools and shallow chisel /desi or a mould board plough, disk harrow, cultivator, leveler pulled by draft animals.

Hand tools used for tillage are spade and hoes. Spade is used to dig, lift and turn soil for the preparation of arable land. Long handle spade is not found to be commonly used for tillage in India, Nepal, Pakistan, Bangladesh where as it is found to be used in America, European countries, Middle East, China, Indonesia etc. The spades are of different shapes and size depending upon its use for specific purpose, soil condition and local customs. Since, spades and shovels are used for agriculture as well as other construction works, they are found to be commercially produced in India and China for export to other countries.

In this region hand hoes and hooks are commonly used for digging, clod breaking, surface cultivation and weeding. It consists of steel blade with a hole for wooden handle. Blades of
digging hoe vary in size, shape, weight according to soil condition, user's physique, and crop grown etc. It is also commercially produced in small scale industry but in majority it is found to be produced by local artisans.

2.2 Intercultural operations:

Weeding is the most important task of small farmers. Mechanical weeding is most common but application of herbicides are increasingly getting popular. The best weed control program combines mechanical method, chemical and crop rotation. Row crop cultivation facilitates mechanical weeding. Khurpi, rake and hand hoe (pointed / flat as well as short/ long handle) are commonly used traditional hand tool for weeding. During weeding potato, same tool is found to be used in earthing up operation simultaneously. In the wetland (paddy field) rotary weeder and cono weeder are popular in this region. Where as for upland crops, v blade, wheel hoe, 3 tyne hoe, nail weeder etc. are commonly used in different countries in the region. Some of the hand tools used in weeding viz. rotary weeder, cono weeder, wheel hoe etc. are found to be commercially produced in tiny and small scale Industry but most of the hand tools used in weeding are found to be produced by local artisans.

2.3 Sowing/planting and fertilizer application

The sowing of seeds and planting of seedlings involve the use of planters, dibbler, seeders, seed drills and broadcasters. Manual rice transplanter (4 row and 6 row) is found to be introduced in various countries Sri Lanka, Bangladesh, India, Nepal etc. but it could not get popular due to various reasons. Seeding of pre germinating rice seed by drum seeder is reported to be successful in Vietnam where plastic made drum seeder is found to be produced. For dibbling of bold grain seed and fertilizer different models of dibblers are found to be manufactured in large scale in China and India. In Bangladesh manually operated Urea Super Granule (USG) applicator in paddy is getting popular. Manually operated rotary dibbling machine is also found to be commercially manufactured in Philippines and in Thailand.

2.4 Irrigation:

Dear several tradition water lifting devices viz. swing basket, water wheel etc. are used in this region. The treadle pump is found to be popular among small farmers of Nepal and Bangladesh for irrigation. More than 100000 treadle pumps are in use in Nepal. Low head simple drip (1.5 m head) is also found to be adopted by small farmers of Nepal in irrigation of vegetable crops.

2.5 Harvesting:

Sickle is commonly used hand tool for harvesting crops. The shape & size of sickle vary from one place to another as well as depending upon its utility. Serrated sickles are also getting popular among the farmers in this region due to increased efficiency. Primarily sickle is used for harvesting crop, but in village it is found to be used as multi-purpose tool viz. cutting chaff, clearing bushes, cutting fire wood in to small pieces, cutting vegetable etc. Sickles are mainly found to be fabricated by local artisans. Scythe is an important harvesting tool used for mowing grass; scythe with cradle can harvest wheat barley efficiently. Scythe is widely used in Europe, Middle East up to Iran but not found to be adopted commonly in this region. Manual fruit harvesters are also used in China, India, Thailand, Sri Lanka etc.
2.6 Threshing and cleaning:

Beating with a stick, or beating the grain on the stone, using flail, animal treading are the traditional methods used in threshing the grain. After the introduction of improved rice variety, pedal operated open drum thresher has become popular among small farmers in the region. Manual corn sheller, tubular corn sheller is also found to be popular among small farmers in Nepal, India, Thailand, Philippines etc. Pedal operated radish seed thresher, millet thresher cum pearler, vegetable seed cleaner etc. are also under promotion in Nepal. Manually operated fan type winnower is also popular in India. Manual groundnut sheller is found to be very popular in India, Sri Lanka, Thailand etc.

2.7 Other non motorized machines:

Grain milling traditional tools and machines viz. pounder, contour poise foot pounder, rotary quern, ghatta (watermills), screw press etc. are still used in the hilly areas of Nepal and India. These traditional grain milling machines are replaced by power operated machinery.

Manually chaff cutter hinge type and rotary blade with fly wheel is one of the very popular machine used by the livestock farmer in India and Nepal. Cycle trailer rickshaw, wheel barrow is also found to be used as manually operated transportation device in the region. Gravity rope way is one of the successful stories in innovation in transportation of agricultural produce in the hilly areas of Nepal.

3.0 Number of hand tools in the region:

Regarding the number of hand tools used in agriculture, there is no statistics available in this region. Hence the number of hand tools in each country is estimated (table 1.) based upon the number of agricultural labour force and assuming that each labour uses at least 3 types of hand tools (tillage, inter culture, harvesting etc. operations) in whole cropping period. These estimates are also compared with other estimate viz. P Nag et al (2004) and A Kumar et. al. (2007) estimated the agricultural hand tools used in India is 520 million 800 million respectively. Hand tools discussed here do not include sprayers, animal drawn implements, thresher, post harvest machinery because those are covered by other groups.

Most of hand tools are locally fabricated by the village artisans tiny and small scale industries. In Nepal, it is estimated that 85 percent of these agricultural hand tools are locally fabricated by the village blacksmiths (Manandhar 1998). Due to lack of commercialization and modernization of their skill and product their profession is in verge of extinction in Nepal (Shrestha, 2008) In India also these hand tools are mainly manufactured by village artisans, tiny and small scale industries. There are about 1 million local artisans and 18000 tiny and small scale manufactures producing agricultural machinery in India (G Singh, 2005).
Table 1: Estimation of number of hand tools used in the countries in Asia Pacific region

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bangladesh</td>
<td>32.10</td>
<td>96.30</td>
</tr>
<tr>
<td>2</td>
<td>India</td>
<td>269.74</td>
<td>809.22</td>
</tr>
<tr>
<td>3</td>
<td>Nepal</td>
<td>12.07</td>
<td>36.20</td>
</tr>
<tr>
<td>4</td>
<td>Pakistan</td>
<td>24.52</td>
<td>73.56</td>
</tr>
<tr>
<td>5</td>
<td>Sri Lanka</td>
<td>4.03</td>
<td>12.08</td>
</tr>
<tr>
<td>6</td>
<td>Cambodia</td>
<td>4.97</td>
<td>14.90</td>
</tr>
<tr>
<td>7</td>
<td>Indonesia</td>
<td>49.51</td>
<td>148.54</td>
</tr>
<tr>
<td>8</td>
<td>Lao PDR</td>
<td>2.37</td>
<td>7.10</td>
</tr>
<tr>
<td>9</td>
<td>Malaysia</td>
<td>1.61</td>
<td>4.84</td>
</tr>
<tr>
<td>10</td>
<td>Myanmar</td>
<td>18.79</td>
<td>56.36</td>
</tr>
<tr>
<td>11</td>
<td>Philippines</td>
<td>13.40</td>
<td>40.21</td>
</tr>
<tr>
<td>12</td>
<td>Thailand</td>
<td>19.30</td>
<td>57.91</td>
</tr>
<tr>
<td>13</td>
<td>Timor</td>
<td>0.35</td>
<td>1.06</td>
</tr>
<tr>
<td>14</td>
<td>Vietnam</td>
<td>29.63</td>
<td>88.89</td>
</tr>
<tr>
<td>15</td>
<td>Russian Federation</td>
<td>6.25</td>
<td>18.75</td>
</tr>
<tr>
<td>16</td>
<td>China</td>
<td>500.98</td>
<td>1502.93</td>
</tr>
<tr>
<td>17</td>
<td>DPR Korea</td>
<td>3.07</td>
<td>9.20</td>
</tr>
<tr>
<td>18</td>
<td>Republic of Korea</td>
<td>1.27</td>
<td>3.82</td>
</tr>
<tr>
<td>19</td>
<td>Papua New Guinea</td>
<td>2.11</td>
<td>6.33</td>
</tr>
</tbody>
</table>

*FAO (2011)*

4.0 Subsidy system used in agriculture:

In general there is very limited subsidy provided to these hand tools in this region. However for some hand tools viz. USG applicator in Bangladesh, different hand tools by Central Sector Extension Program in India subsidy up to 50% is found to be provided. Farmers prefer to invest their own money for the purchase of hand tools and bullock drawn machinery and for others they avail the credits from the Banks. (G Singh, 2005)

5.0 Total amount of injuries in using hand tools:

Most of the countries in the world struggle with various degrees of inadequate data systems and measurement standards to avoid fatal and serious farm injuries. ILO data indicated that injury rates are increasing in developing countries. Machinery has the highest farm injury frequency and fatality rates worldwide (ILO, 2000). Agricultural workers in all parts of the world also share exposure to a common set of hazards, although the extent of the exposure and the degree to which it is managed vary greatly (Day, 2009)

Hand tool related injuries are a problem specifically seen commonly in the low income countries (LICs). Since the most hand tool injuries (e.g., cuts on the hands, feet and skins) have been classified as minor they often go unnoticed; however, their consequences are often painful and disabling because of delayed treatment. An agricultural accident survey was carried out by Indian Council of Agricultural Research (ICAR) during 2004-07 in
collaboration with Indian Agricultural Statistics Research Institute indicated that 34.2% accidents were due to hand tools. The high rate of work, awkward work posture and design deficiencies of the hand tools result in cumulative musculo-skeletal strain and injuries in farm activities (A Nag et. al, 2004). There are 1700 injuries related to hand tools per hundred thousand farm workers per year in rural India. Spades and sickles were involved in 46 % of farm injuries in India. Mohan and Patel (1992) recorded that these two machines caused 13% of total agricultural injuries, 11% by fodder cutting machines and 2% by thresher in India. Similarly fodder cutting machines caused 6% and thresher 16% of injuries in Pakistan (Mufti, Ahmed and Majid, 1989).

The All India Coordinated Research Projects AICRP data indicated that the overall incidence rate of hand tools related injuries varied from 0.02 (northern India) to 0.42 (southern India) per 1,000 hand tools/yr. Tiwari et al. reported the incidence rate for sickles as 0.16, followed by pickaxes as 0.09 per 1,000 tools/yr in Central India. The sickle related injuries mostly occurred while harvesting hard-stem crops like pigeon pea, chickpea, mustard and sorghum, and low-back injuries have been reported for pickaxes (P Nag et al, 2004)). For axe, sugar cane cutter and chaff cutter higher severity injuries were sustained on upper extremities.

6.0 Social cost of injuries:

Due to increased number of hand tools and its use in this region, hand tool related injuries has got very significant social and economic cost. A survey conducted in India indicated that seventy percent of agricultural hand tool injuries had a recovery time of more than 7 days. Productivity was impaired to the tune of 24,000 days per hundred thousand population because of injuries (A Kumar et. al., 2008).

7.0 Testing of Hand tools

It is evident from the presentations of member countries in APCAEM technical committee meeting in Bangkok, there is severe needs of testing of agricultural machinery produced in the region and setup the common standard for the region. The testing of hand tools is expected to achieve following objectives.

- to provide reliable information to the farmers on the performance, safety, economic benefit on the use of hand tool and non motorized agricultural machinery

- to provide information to the manufacturer, importer and exporter on hand tool quality parameters, performance, durability and positive and negative aspects of the product (hand tool and non motorized agricultural machinery)

- To standardize the hand tool and non motorized agricultural machinery in the country

7.1 Testing parameters of hand tools:

Following are the major testing parameters that to be included:

- Technical Specification given by the manufacturer
  - Dimension
  - Weight
  - Performance (field capacity, efficiency, losses etc. depending upon the tool/
machine for particular operation & crop)
  - Material of construction
  - Specify the user for which it is designed (male/female; target community for ergonomic considerations)

- Safety parameters
- Durability
- Operation manual and safety considerations

7.2 Testing procedures:
The testing of hand tools and non motorized agricultural machinery may be voluntary and mandatory for subsidy, import and export purpose. Moreover, injury prone certain hand tools and non motorized agricultural machinery viz. hand operated chaff cutter, fan type winnower etc. should be tested mandatorily for safety parameters.

The testing will include lab testing as well as field testing.

8.0 Challenges in testing of hand tools.
The challenges of testing of hand tools are listed below:

- There is low level of awareness of the farmers (users of the hand tools and non motorized agricultural machinery) on the testing for standard, safe and quality hand tools and agricultural machinery.
- There are numerous hand tools and non motorized farm machines. Even the shape and size of same hand tool vary from one village to next and one country to next, it is difficult to standardize.
- The performance of the hand tools and non motorized agricultural machinery depend upon the user's
- As majority of hand tools are produced by the unorganized local artisans in the village level, it will be difficult to test the hand tools produced by them.
- Majority of village artisans and tiny industries use scrap material to produce hand tools, so the quality of hand tool produced vary from one piece to next moreover the tiny industries may increase the cost of tested hand tools and agricultural machinery.
- Poor capacity and low level of technology adopted by the village artisans in production of hand tools hinders the enforcement of quality hand tool production.
- Lack of strong policy in standardization and testing of agricultural hand tools in the countries in this region.
- Lack of institutional setup for the testing of agricultural hand tools in some countries like Nepal, Papua New Guinea, Bangladesh etc.
References:


