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Farmers'Injuries, Discomfort and Its Use in Design of Agricultural Hand Tools: A Case Study from East Java, Indonesia

Robertoes Koekoeh K. Wibowo[a*], Peeyush Soni[b]

[a]*Mechanical Engineering Department, Engineering Faculty, Jember University,Jember 68121, Indonesia*
[b]*Agricultural System and Engineering School of Environment Resources and Development, Asian Institute of Technology, Phatumthani 12120, Thailand*

Abstract

Farmers in East Java, Indonesia have opinions of the agricultural hand tools that they wear. In farming activities they get injured due to the use of agricultural equipments. The most injury was in hand. Farmers feel fatigue/discomfort in different levels of their body part when using agricultural tools. Majority of farmers complained to suffer fatigue in upper back (92.8%), mid back (93.6%), and lower back (91.8%), respectively. The third major criteria's design of agricultural hand tools base on survey resulted are be safe, good and fit in hand, and easy to use. The ergonomic evaluation suggests their handle length and diameter to be 12.4 cm and 3.0 cm, respectively.

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1. Introduction

In Indonesia, it is estimated that about 39.96 million farmers that are engaged in agricultural and allied activities. East Java to Farmer Households constitute the largest number of National Agricultural Households 5.1 million, which is divided into three, namely the Agricultural Household work the land themselves, Farm Household work the land with the wage distribution of agricultural products, and the Agricultural Household work land people paid with money (BPS- Statistics Indonesia, 2013). Helkamp & Lundstrom (2002) stated that farmers injuries are currently higher than injuries in workers industry. Severity of agricultural injuries worsen because of low infrastructure

* Corresponding author. Tel.: ; fax:
E-mail address: koekoeh@unej.ac.id

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availability, no age and gender specific work, long continuous working hour and occasional use of machines (Knapp, 1965, 1966). Zhou & Roseman (1994) reported that occurrence of agricultural injuries among farmers, the most frequency injured body parts in incidents were limbs. Patel et al. (2010) stated that currently is lack of study on agricultural sector injuries from developing countries because of non-availability of nationwide compiled information on agricultural injuries.

The study was aimed to give information of farmer's injuries and discomfort of agricultural hand tools during traditional farming activities and to conduct ergonomic study of agricultural hand tools to minimize injuries.

2. Methodology

2.1. Survey of agriculture injuries and discomfort level of farmer

The study identified popularly used agricultural hand tools in the three districts of Jember, Banyuwangi and Lumajang, East Java, Indonesia and conducted survey of farmers for study/record the tools and its parts causing injuries and discomfort to the farmer. The samples number was 502 farmers consist of 132 and 138 Javanese male and female farmers and 118 and 114 of Madurese male and female farmers respectively. This study uses qualitative and quantitative approaches using the survey method. The data used are primary data and secondary data, where primary data was collected by using instrument questionnaire, observation and interview guide has been prepared to the parties who are competent with the subject comfort and injuries of the farmers in the province of East Java. While, the secondary data obtained by collecting documentations about the conditions of farmers respond to agricultural hand tools from the relevant research in accordance with the problems.

2.2. Ergonomic evaluation for agricultural hand tool

By using a measuring instrument to measure body dimensions peasant farmers to obtain data anthropometry and measure the dimensions of the handle of agriculture tools are used by farmers. Measurements of body dimensions and length and diameter of agricultural hand tools were using equipment and measurement standards.

3. Results and discussions

The sequence hand agricultural tools from the most frequent to least rarely used when farming was sickle (100.0%), hoe (92.0%), big/long knife (69.3%), shovel (23.5%), sprayer (19.1%), and harrow (16.5%) respectively. The length and diameter dimension of agricultural hand tools is preserved in Table 1.

Table 1. The dimension of popularly agricultural hand tools in East Java

Agricultural hand tools	Handle		Weight (kg)
	Length (cm)	Diameter (cm)	
Sickle	12.2-16.3	2.5-3.9	0.3-0.8
Hoe	56.2-68.4	3.8-5.2	2.3-3.2
Harrow	63.1-72.7	3.5-4.2	1.9-2.8
Shovel	44.1-57.6	5.5-6.8	2.6-3.1
Big/long knife	11.8-16.8	3.8-5.2	0.8-1.8
Sprayer	-	-	22.8-25.7

The injuries of the body of farmers consist of injury in hand, arms, legs, thighs, and feet. The injuries on hands, arms, legs, thighs, and feet of male and female farmers were 40.24, 34.86, 4.38, 3.59, 4.38, 2.59, 1.00, 0.60, 33.07 and 10.56 % respectively.

Figure 1 depicts information of fatigue or discomfort felt by farmers on a particular part of their body when using agricultural hand tools. Corlett and Bishop (1976) used the technique for assessing postural discomfort. Majority of farmers complained to suffer fatigue in upper back (92.8%), mid back (93.6%), and lower back (91.8%), respectively. The pattern of trunk movement in high frequenty repetitive trunk flexion and may combine with twisting during farming may affect the upper back, mid back and lower back of farmers. Repetitive trunk motion will affected the pattern of trunk muscle coactivity that appeared to be the driving force behind diminished strength and functional capability as well as increased spine structural loading that included both compression and shear force. (Wolfe et al., 1996). Zautra et al. (2007) declared lifting any object over 8 kg per time will affect low back pain for farmers, which increased intradiscal pressure that can induce annular tears and internal disk disruption resulting in lumbar disc injury.

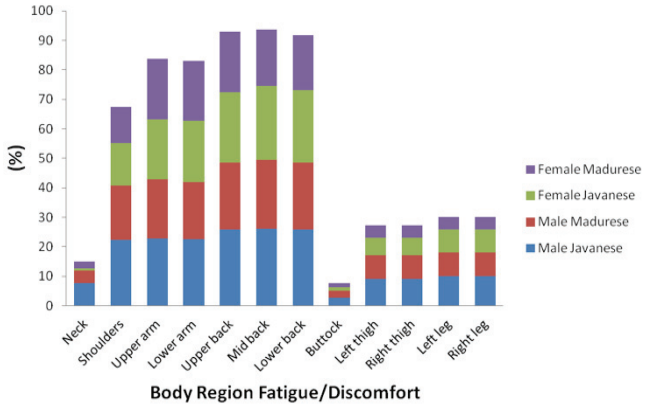

Fig. 1 Body part fatigue/discomfort of farmers when using agricultural tools

Table 2 provides the ranking of the descriptors based on mean rank of the rating score of hand agricultural tools characteristics that farmer's desire. In this study, agricultural hand tools rated the relationship of 15 descriptors with comfort in using agricultural equipments. The farmers were asked base on questioners about what their judgments imagining working with agricultural hand tools. Farmers are encouraged to think of farming tools that they want. They can use imagination, passions and experiences while using farm tools. Table 2 describes the ranking of the descriptors based on mean ranks, standard deviation and standard error mean. The mean ranks from 5.92 for safe to 9.79 for no inflamed skin.

From Table 2 is shown that most of farmers like safe hand tools, and then followed by good fit in hand, easy to use, reliable to no inflamed skin in the last. As functionality occupy first choice by farmers such as safe, good fit in hand, easy to use, reliable, and handle feels comfortable.

This study was different with Kuijt-Evers et al. (2004). This study states that safe in the first rank, good fit in hand, and easy to use in the first, second, and third rank respectively. However, Kuijt-Evers et al. (2004) stated that reliable, functional, and good fit in hand for occupy first, second and third rank in their research. The difference result of study because of different product and person as sample target for hand tools.

3.1. Ergonomic evaluation of selected agricultural hand tools

Anthropometric data that result from farmers' body measurement (Wibowo et al., 2012; Wibowo and Soni, 2013) and farmers' hand and isometric strength (Wibowo et al., 2013) can be applied to design of agricultural hand tools. In this research, the anthropometric database prepared by Wibowo et al. (2012) was used to evaluate the ergonomic relevance of the prevailing design of the agricultural hand tools popularly used in the study area such as sickle, hoe, harrow, shovel, big/long knife, and sprayer handle. Emphasis was given to their handle design and weight.

These agricultural hand tools essentially comprise a handle and a functional part. Handle design and material are normally selected by the local manufactured. The length and diameter of handles that used in East Java are shown in Table 1.

Kumar et al. (2008) classified hand tools as with the small handle (handle length <25 cm), medium handle (handle length 25-50 cm), and long handle (>50 cm). The sickle used in the study area can therefore be considered as small handled tool, whereas hoe and harrow are long handle tool. Shovel is classified between medium and long handle tool, and big/long knife is small handle tool.

Table 2. Rank of tool descriptors based on mean ranks

Descriptor		Mean ranks	SD	Std. Error Mean
1	Safe	5.92	4.281	.191
2	Good fit in hand	6.20	3.925	.175
3	Easy to use	6.24	4.291	.192
4	Reliable	6.49	4.374	.195
5	Handle feels comfortable	7.23	3.888	.174
6	Pleasurable	7.34	4.333	.193
7	No blister	7.89	3.817	.170
8	Lightweight material	8.15	3.757	.168
9	Easy to take along	8.32	4.788	.214
10	No pain	8.49	3.700	.165
11	High quality	9.30	4.081	.182
12	No numbness in fingers	9.43	3.904	.174
13	No slippery handle	9.54	3.772	.168
14	Famous brand	9.70	4.619	.206
15	No inflamed skin	9.79	4.019	.179

Dewangan et al. (2008) stated that a good design for handle should be in accordance with corresponding anthropometric dimensions of target user; namely the length of handle should accommodate the maximum dimension of hand breadth of thumb. Wibowo et al. (2012) reported that the 95^{th} percentile value of breadth at thumb is 10.9, 11.4, 10.4, and 10.4 cm for Javanese, Madurese male and female farmers, respectively. Taking a clearance value of 0.5 cm on each side of the grip, the length of handle comes to 11.9, 12.4, 11.4, and 11.4 cm, respectively. Therefore, the value recommended in the study area for the length of the handle of sickle and big/long knife is 12.4 cm. For a better grip the handle diameter should not exceed the inside grip diameter of the operator. Therefore, the handle diameter should be according to 5^{th} percentile value of the inside grip diameter of the target group to accommodate the larger population group. These values are 3.4, 3.4, 3.5, and 3.0 cm for Javanese, Madurese male and female farmers, respectively (Wibowo et al., 2012); thus 3.0 cm is recommended for the study area.

Barnes (1949) recommended handle for whole hand with cylindrical shape, with at least 10 cm long and around 3-4 cm diameter. Ayoub & Lo Presti (1971) prescribed maximum diameter of handle as 4 cm. Nag et al. (1988) stated that the diameter of the handle should be a little lesser than the inside grip diameter. Wibowo et al. (2012) studied that the values of 1^{st} percentile value of the inside grip diameter of farmer are 3.1, 3.0, 3.3, and 3.0 cm, respectively for Javanese, Madurese male and female farmers. Thus the diameter of the handle recommended is 3.0 cm.

4. Conclusions

The injuries of the body of farmers consist of injury in hand, arms, legs, thighs, and feet. Majority of farmers complained to suffer fatigue in upper back, mid back, and lower back. Most of farmers like safe hand tools, and then followed by good fit in hand, easy to use, reliable to no inflamed skin in the last. As functionality occupy first choice by farmers such as safe, good fit in hand, easy to use, reliable, and handle feels comfortable. Base on the anthropometric dimensions of the farmers, the dimension that recommended for the length of the sickle and big/long handle is 12.4 cm. Furthermore, the diameter of the sickle and big/long knife handle recommended is 3.0 cm. Similarly, the diameter of hoe, harrow, and shovel is recommended to be 3.0 cm.

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