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USE OF SERRATED SICKLE TO INCREASE FARMER'S PRODUCTIVITY

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The sickle is still an ultimate choice hand tool for harvesting the new variety of rice. This preference continues. The sickles used by Balinese harvester are usually nonserrated. The sharpness of nonserrated sickles is reduced quickly, so the harvester needs time to sharpen them frequently, which mean time loss and productivity reduction. To solve this problem, research has been conducted using experimental treatment by subject design. Thirty-three harvesters voluntarily joined the study at the "Subak Yeh Ge" District of Kediri Tabanan Regency, using serrated and nonserrated sickles. The productivity was measured by dividing the number of paddy stalks cut every 15 minutes by increment of heart rate over the resting value. The opinions of harvesters about sickle performance were also collected. The results are as follows: 1. The sharpness of serrated sickles is more stable than nonserrated ones. 2. The use of serrated sickles reduces the workload and work time loss. 3. The productivity of harvesters using serrated sickles is always higher than those using nonserrated sickles, but significant productivity differences begin to appear from the second to the eighth 15-minute period ($p<0.05$). 4. Decreased productivity in both groups occurred from the first 15-minute period, but significant differences occurred from the fourth period in the group using nonserrated sickles and at the eighth period in the group using serrated sickles. 5. By use of the heart rate and the WBGT index, it is shown that harvesting can be continuously done over an 8-hour period.

INTRODUCTION

Land owned by Balinese farmers is very small. On the average, less than 0.5 ha is owned by each farmer. The equipment used daily is very simple and the design has been unchenged for years (Tewari et al., 1991). The sickle is one piece of the equipment being used for harvesting the new variety of rice paddy. It is easy to use, is readily available at low price, and can be easily repaired, and postharvesting losses are also smaller when it is compared with other equipment such as "anai-anai" (AAK, 1992; Suparyono and Setyono, 1994; Mamansari and Salokhe, 1994). Until now the sickle has remained a popular harvesting tool for farmers in Bali, though a harvesting machine (thresher) has been introduced. Farmers in Bali generally use ordinary sickles during the harvesting of a new variety of paddy, and Suparyono and Setyono (1994) stated that 67.4% of farmers use nonserrated sickles and 16.3% use serrated sickles.

In the southern part of Bali, especially in the region of Tabanan and Badung, sickles are made from pure iron; thus they can become blunt. During the paddy cutting, therefore, farmers must spend quite a lot of time to sharpen their sickles. Consequently they may waste working time while sharpening sickles, and this could lead to low productivity. According to Kulkarni and Sirohi (1985), the sharpened part of a sickle is the most important factor affecting the working capacity of farmers, and the handle determining the convenience in using this tool may also have an indirect effect on working capacity. Sutjana et al. (1997) found that farmers need a better quality of sickle, especially in its sharp parts. Moreover, Sen and Chakraberti (1989) stated that the use of serrated sickles may improve

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working efficiency. The present work was designed to test whether the use of serrated sickles may increase the productivity of farmers in Bali.

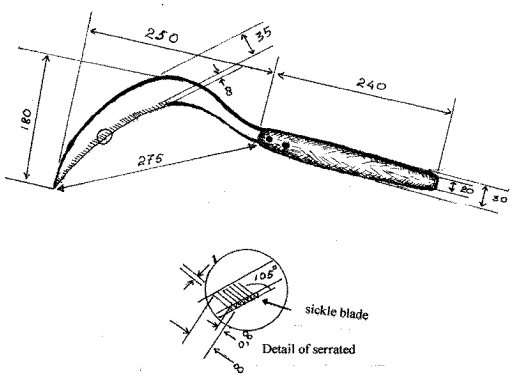
MATERIALS AND METHODS

Subjects

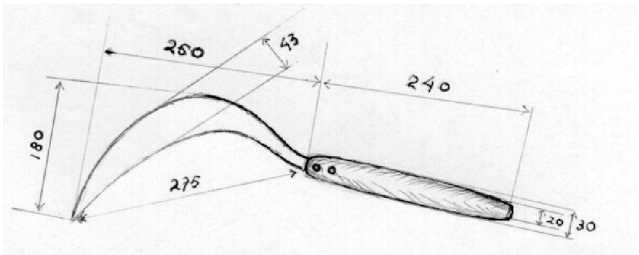
The subjects in this study were farmers at "Subak Yeh Ge", a district of Kediri, Tabanan Regency, who performed paddy cutting during the harvesting period of July to September 1997. Thirty healthy subjects were randomly selected for this study and underwent medical examinations. They were all male farmers, aged 38.15±4.67 yrs, height 167.94±4.44 cm, body weight 55.67±4.18 kg, systolic blood pressure 119.24±6.39 mmHg, and dyastolic blood pressure 79.39±7.04 mmHg. The working experience of all subjects was more than 6 years, so they were experienced in using the sickle properly.

Methods

The study was designed as an experimental treatment by subject. On the first day, half the subjects were asked to cut paddies using the ordinary (nonserrated sickles) (Figure 1b), and the rest used serrated types of sickles (Figure 1a). On the next day the subjects who cut with ordinary sickles changed to serrated sickles and vice versa. The amount of paddies being cut was recorded, and the heart rates of farmers were also recorded by 10-pulse methods on the radial artery every 15 minutes for 2 hours. The comments of farmers using the two types of sickles, especially in regard to sharpness and convenience of use, were also obtained. The data were then analyzes by t test and an analysis of



a: Serrated type



b: Non serrated

Fig. 1. Sickle

Tukey at 95% level of significance.

RESULTS AND DISCUSSION

Body position

During the paddy cutting, all farmers were in a bending position and none was squatting. According to Nag et al., (1988), when compared with the squat position, the bend position may result in a 16% increase of working speed, but it requires 18% more energy. However, the bend position during longer periods of work may lead to a tensing of certain muscles and thus result in quicker tiredness and soreness (Schilling, 1982; Manuaba, 1985; Pheasant, 1991). To reduce these feelings, farmers occasionally must stand upright or sharpen their sickles.

Heart rate

The average work heart rate (Table 1) of subjects using the nonserrated sickles (SB) were always higher than for subjects using serrated sickles (SG) ($p<0.05$), except for the first 15 minutes. Because there is a linear relationship between the increased heart rate and the energy spent, it appears that paddy cutting with nonserrated sickles requires more energy than serrated sickles.

Time for rest and sharpening sickle

From the viewpoint of heart rate, paddy cutting may be considered not heavy work, but the bending position during cutting causes severe tension on the back muscles (Pheasant, 1991), which will result in a quicker sensation of tiredness. This could be worse if the farmers are getting older because of decreased elasticity of the muscle (Grandjean, 1988; Rodahl, 1989). As a consequence, farmers very often must stand upright and or take short breaks to sharpen their sickles. In doing so they potentially waste their working hours at an average of 9 minutes and 41 seconds for every 2 hours. The rests and sharpening times are shown in Table 2.

Productivity

Working productivity can be determined by using the formula, P=O/IT, where P = productivity, I = input, O = output, and T = time.

Table 1. Working heart rate in paddy cutters using nonserrated (SB) and serrated (SG) sickles at the "Subak Yeh GE" District of Kediri, Tabanan Regency. The values are mean ± SD.

Time	SG (N=33)	SB (N=33)	t	*P*
7.00	81.45 ± 7.11	82.91 ± 8.13	1.979	$p > 0.05$ *
7.15	99.36 ± 6.81	101.42 ± 7.95	3.34	$P < 0.05$
7.30	99.73 ± 6.16	101.45 ± 7.58	3.451	$P < 0.05$
7.45	100.06 ± 5.86	101.88 ± 7.54	2.531	$P < 0.05$
8.00	100.39 ± 5.88	102.12 ± 7.09	2.577	$P < 0.05$
8.15	100.48 ± 6.20	102.18 ± 6.58	2.541	$P < 0.05$
8.30	100.27 ± 6.13	102.48 ± 6.58	3.172	$P < 0.05$
8.45	100.18 ± 5.91	102.12 ± 6.70	2.945	$P < 0.05$
9.00	100.42 ± 6.18	102.48 ± 7.05	3.171	$P < 0.05$

* nonsignificant

Working productivity recorded every 15 minutes was calculated by dividing the number of paddy stalks being cut by increment of heart rate over the resting value. A comparison of working productivity during 2 working hours between farmers using ordinary sickles and those using serrated sickles is presented in Figure 2. The working productivity of farmers using serrated sickles was significantly ($p<0.05$) higher than that of farmers using ordinary sickles. In the first 15 minutes of work, no significant difference was noted between the two groups. This could mean that in the first 15 minutes the working ability of the two groups was just the same and the sharpness of the two types of sickles remained the same. No farmers were seen to sharpen their sickles. Starting from minute 20 and thereafter, however, some farmers were observed doing so. When we consider the working productivity from the first to the eighth 15-minute period of observation, productivity declined for both groups. The Tukey analysis showed that the decrease in productivity for farmers using serrated sickles occurred significantly (Tukey = 9.8716, $p<0.05$) after the eighth 15-minute period (2 hours), and that for farmers using nonserrated sickles occurred significantly (Tukey = 8.2336, $p<0.05$) after the fourth 15-minute period (1 hour). The decreasing productivity of farmers using nonserrated sickles occurred earlier than that of farmers using serrated sickles.

Table 2. Times for rest and sickle sharpening in seconds for paddy cutters using serrated and nonserrated sickles

Working time	Serrated sickle		Nonserrated sickle	
	Resting time (sec)	Sharpening time (sec)	Resting time (sec)	Sharpening time (sec)
07.00-07.05	-	-	-	-
07.05-07.10	-	-	-	-
07.10-07.15	24.0	-	10.0	-
07.15-07.20	32.3	-	22.5	-
07.20-07.25	27.0	-	27.0	32.60
07.25-07.30	33.0	-	32.3	26.00
07.30-07.35	35.6	-	31.6	37.00
07.35-07.40	33.0	-	33.3	30.00
07.40-07.45	37.7	-	36.0	35.30
07.45-07.50	24.0	-	37.7	26.30
07.50-07.55	29.3	-	30.6	34.00
07.55-08.00	33.5	-	30.6	26.00
08.00-08.05	30.6	-	29.0	30.00
08.05-08.10	31.3	-	33.3	26.70
08.10-08.15	37.2	-	30.0	35.00
08.15-08.20	32.0	-	30.0	32.00
08.20-08.25	40.0	-	29.0	30.30
08.25-08.30	35.3	-	29.3	24.50
08.30-08.35	34.0	-	28.6	31.30
08.35-08.40	34.0	-	28.6	29.70
08.40-08.45	33.6	-	27.3	29.50
08.45-08.50	21.0	-	30.0	29.00
08.50-08.55	27.6	-	29.3	34.70
08.55-09.00	38.0	-	30.3	31.30
Total	670.1	0	641.7	611.5

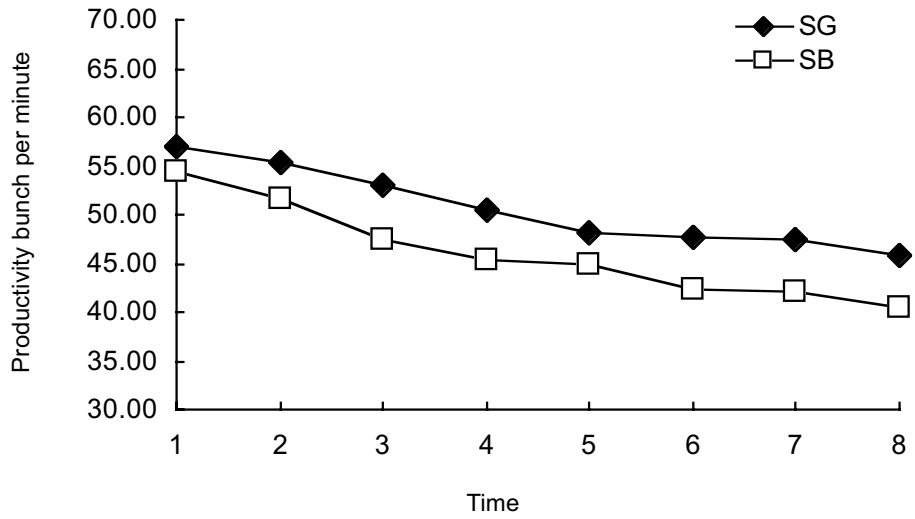


Fig. 2. Working productivity of the farmer using serrated and nonserrated sickles every 15 minutes. SG: serrated sickle; SB: nonserrated sickle. For explanation, see text.

Comments of the farmers

Comments of the farmers using both sickles are as follows: All farmers (100%) said that serrated sickles are sharper than nonserrated ones. Seventy five percent of the farmers said that both sickles had handles that were too big and had less curve. Subjective complaints: 75% low back pain, 45% neck ache, and 35% shoulder ache. These complaints might have a close relationship to the bending working body posture during paddy cutting.

CONCLUSIONS AND SUGGESTIONS

Conclusions

From the present study it can be concluded that

1) The productivity of farmers using serrated sickles are higher than that of farmers using nonserrated sickles.
2) The bending position while cutting, using both types of sickles, might lead to soreness in the lower backs and necks of farmers.
3) In consideration of the increase in heart rate and WBGT data, it can be concluded that paddy cutting can be done continuously up to 8 hours.
4) The sharp part of sickles needs to be improved in its curve and too big handle must also be taken into consideration

Suggestions

1) To optimize time for paddy cutting, farmers are urged to use serrated sickles during paddy harvesting.
2) To maintain productivity, farmers are urged to take a 3 minutes break every working hour.
3) Farmers should occasionally stand upright to minimize soreness and lower back pain.
4) Although paddy cutting can be classified as a work with medium physical strain in view of an increased heart rate and WBGT, the work can be continuously done up to 8 hours. To compensate body fluid lost through sweating as a result of solar radiation, farmers need to drink water regularly.

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