Kasetsart J. (Nat. Sci.) 41 : 1 - 7 (2007)

Inter-row Hand Weeders

Kitti Wongpichet

ABSTRACT

The project's objective was to develop an inter-row hand weeder for controlling young weeds in crop fields. Iterative work was carried out comprising development, testing, and improvement of a series of hand weeders. The first prototype was hand weeder 1 (spikes and rubber band), subsequent improvements resulted in hand weeder 2 (spikes and rubber band; with wheel), hand weeder 3 (blade and rubber band; with wheel), hand weeder 4 (blade and rake; with wheel) and eventually hand weeder 5 (blade and blade; with wheel). Comparing to hand hoes, it took less time for all hand weeders to weed out the equivalent area; and users did not get fatigued as much as using hand hoes. Spiked hand weeders did not work well with grown up weeds, but were acceptable for weed seedlings; whereas bladed hand weeders performed equally good compared to hand hoes. Among all five hand weeders, model 5 seemed to be the most appropriate since it worked well and could be made locally with relatively low cost.

Key words: hand weeder, spikes, blade, hand hoe

INTRODUCTION

Weed control implements popularly used by Thai smallholder farmers are hand hoes and mini-spades. These small tools scrape weeds off the ground to desiccate and/or damage weeds so that they can not re-grow and/or be buried down (Martens and Martens, 2005). This method is convenient; however, it is labor intensive and causes tiredness easily. Moreover, more expenses required for hiring extra labor.

During the past few decades there was an implement called wheeled hoe, the most common make was "Planet Jr" from USA. This hand weeder was used effectively to weed out between rows. However, probably due to the increasing cost, it disappeared from the market. Recent search in the internet showed no more Planet Jr wheeled hoe available. There is, however, a make of this implement available for sale but with quite a high cost; and it has to be ordered from abroad. This is unacceptable for smallholder farmers (Wongpichet *et al*., 2003). Even there have been some attempts to make this implement locally; they always failed due to the inappropriateness of techniques and materials used.

Since weeds can be killed easily when they are at early stages of growth. This practice can also reduce labor and cost substantially. Smallholder farmers need low cost implements which can be purchased or made locally. Therefore the objective of this project was to develop a small hand weeder to be used for getting rid of young weeds growing between crop rows; and this implement must be relatively cheap and could be made locally.

Faculty of Agriculture, Ubon Ratchathani University, Warin Chamrap, Ubon Ratchathani 34190, Thailand.
E-mail: kitti@agri.ubu.ac.th

MATERIALS AND METHODS

A series of hand weeders were developed at the Faculty of Agriculture, Ubon Ratchathani University, Thailand; and were tested in a farmer peanut and corn fields beside the campus during January to May 2006.

1. Hand weeder development

1.1 Hand weeder 1 (spikes and rubber band) The structure of hand weeder 1 (Figure 1), in general, was similar to a wheeled hoe. The framework (chassis) was a plastic toilet lid and seat used to hold other parts. The width and length of this part were 36 and 42 cm, respectively. Screws were used at different places to hold the lid and seat tightly together. Then a 26 × 30 cm^2 steel frame, with a bar across at the middle, was fitted to the framework (convex side of the lid down).

Thirteen cm steel spikes, sharp at one end, were inserted diagonally through the holes on the lid part of the framework (sharp ends down and forward) and then were welded to the middle bar above. There were two rows of spikes across the framework width in zigzag pattern.

A 6 × 32 cm^2 rubber band made of old truck tire was fitted to the rear of the chassis by using a piece of flat steel together with bolts and nuts. Then steel rods were welded to hold this part in place, that is, this part folded down perpendicular to the framework's plane.

The handle bar made of steel pipe bended into U shape with a distant of 40 cm apart. One bolt and nut were used to hold each end of the handle bar to the front of the frame on the chassis, so that the handle bar could move up and down as desired. At the rear of the steel frame, there was a "double tube" mechanism connecting the handle to the frame for height adjustment.

1.2 Hand weeder 2 (spikes and rubber band; with wheel) Hand weeder 1 was slightly modified by adding a 5 in swivel wheel in front of the chassis (Figure 2). The frontal part of the chassis was heat bent upward to fit the wheel.

1.3 Hand weeder 3 (blade and rubber band; with wheel) The structure of hand weeder 3 (Figure 3), in general, was the same as that of weeder 2, except the spikes on both rows were replaced with a double edged steel blade. This blade connected to the steel frame above by using two rods pierced through the plastic lid of the chassis. Plane of the blade was parallel to that of the chassis and there was a 4 cm gap. The blade size was 5 × 33 cm^2; both edges were the same fashion as a plastic ruler.

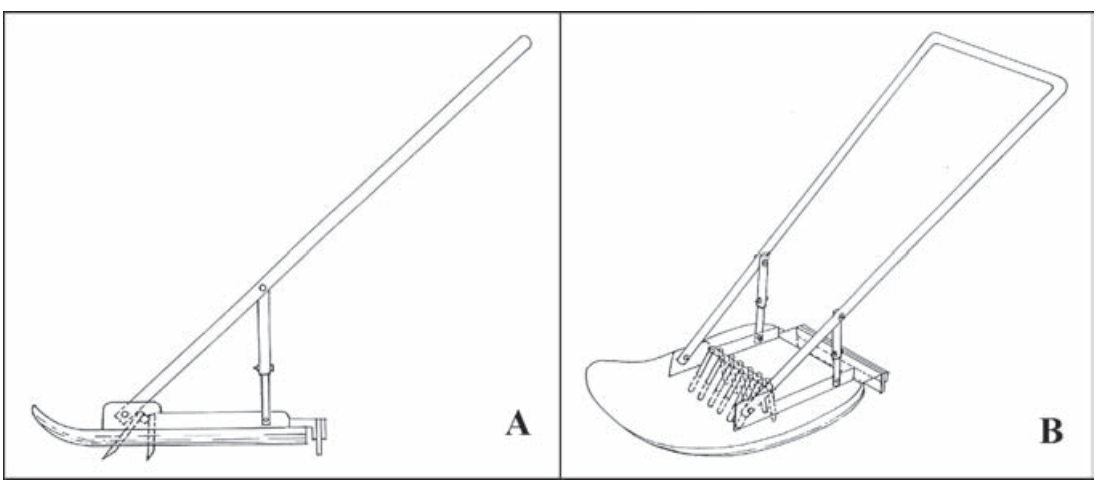

Figure 1 Side view (A) and frontal-above view (B) of hand weeder 1.

1.4 Hand weeder 4 (blade and rake; with wheel) The structure of hand weeder 4 (Figure 4), in general, was the same as that of hand weeder 3, except the rubber band at the rear of the chassis was replaced with a wire rake.

1.5 Hand weeder 5 (blade and blade; with wheel) The structure of hand weeder 5 (Figure 5), in general, was the same as that of hand weeder 4, except the wire rake was replaced with another double edged steel blade. The planes of both blades and of the chassis were parallel.

2. Tests of hand weeders

When hand weeder 1 had been developed, it was tested in the crop field having young weeds growing up. Hand hoes were also tested for comparison, and the tests were done for weeds growing between crop rows only. Results were checked, ease of use and implement preferences were asked; then the improvements followed. When weeds in the fields started coming back, the retest followed along with hand hoes. The tests characterized an iterative process.

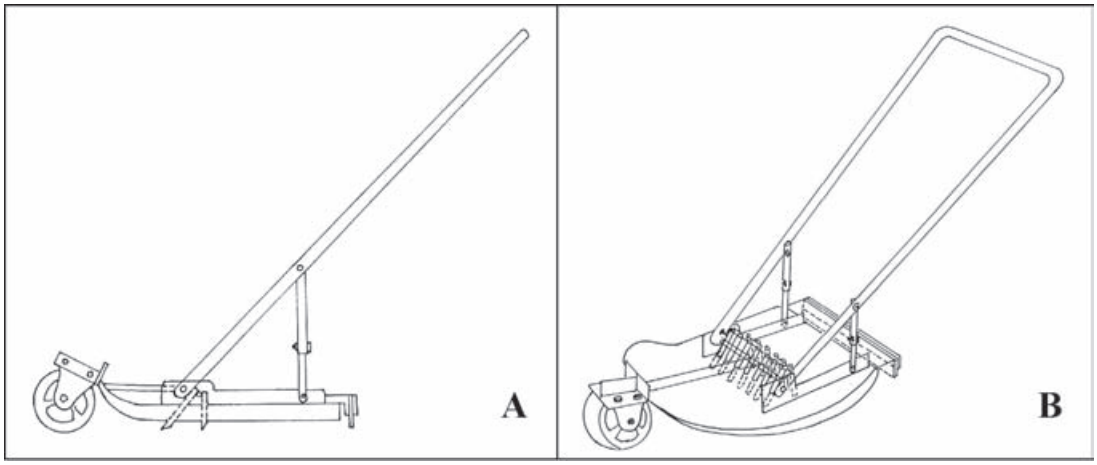

Figure 2 Side view (A) and frontal-above view (B) of hand weeder 2.

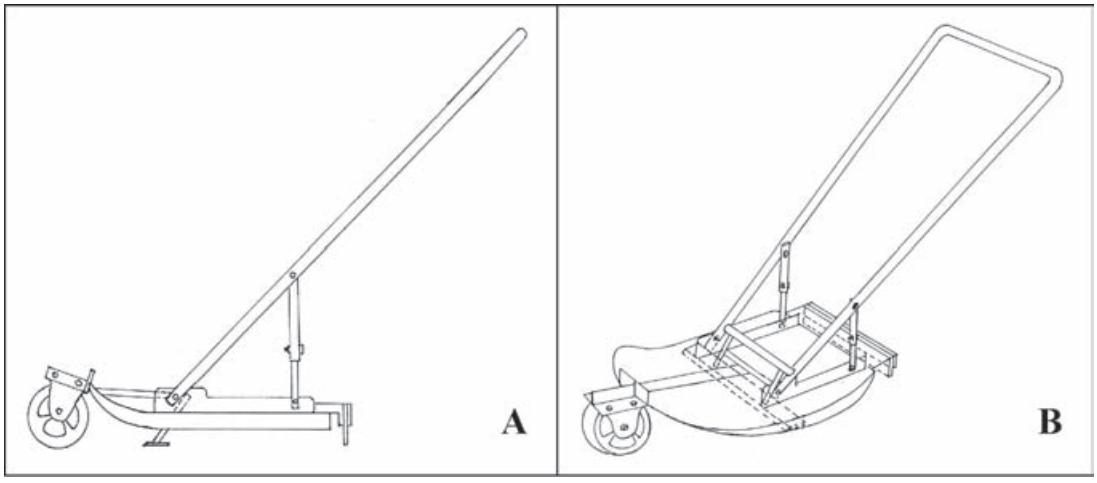

Figure 3 Side view (A) and frontal-above view (B) of hand weeder 3.

In each test, a stop watch was used to time the weeding time, and a hand tally was used to count the number of cycles (lift-scrape for hoe, pull-push for weeder) in each row. When done, results were checked, and opinions were asked for each implement. Samples of weeds were occasionally collected for dry matter measurement. Spring scale was used to measure the force needed to move the implement (spike tips or blade rim just under soil surface). A special ruler was developed to measure the optimal height of the weeder handle bar for the workers wearing shoes.

RESULTS AND DISCUSSION

1. Hand weeders Toilet lid and seat (upside down) was used as a chassis of a hand weeder for its suitability, since it had a relatively flat shape, additional parts could be installed easily. In addition, special parts could also be installed to the straight rear part conveniently. The width of the lid fitted well to spaces between crop rows (50-75 cm) popularly used by the farmers. The oval shape of the lid (frontal part and both sides) minimized the impact when moving, thus reducing

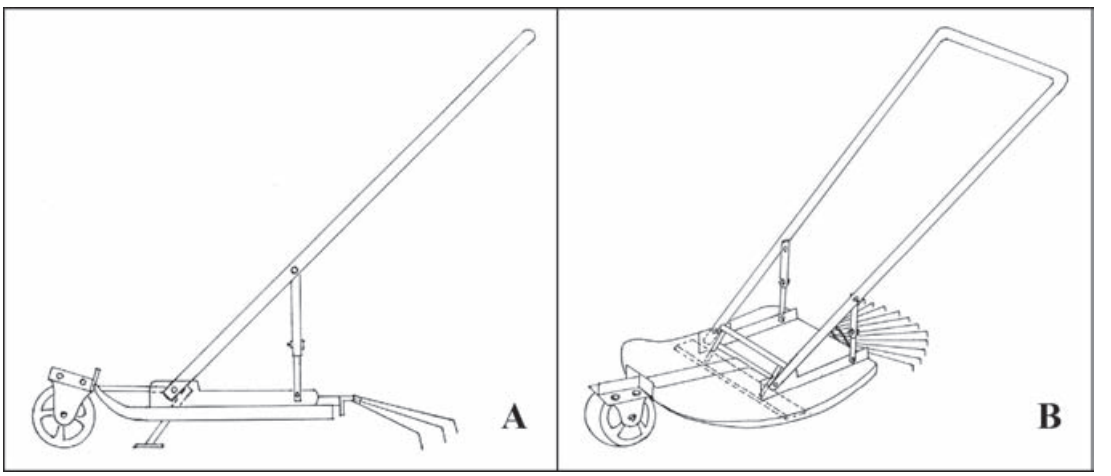

Figure 4 Side view (A) and frontal-above view (B) of hand weeder 4.

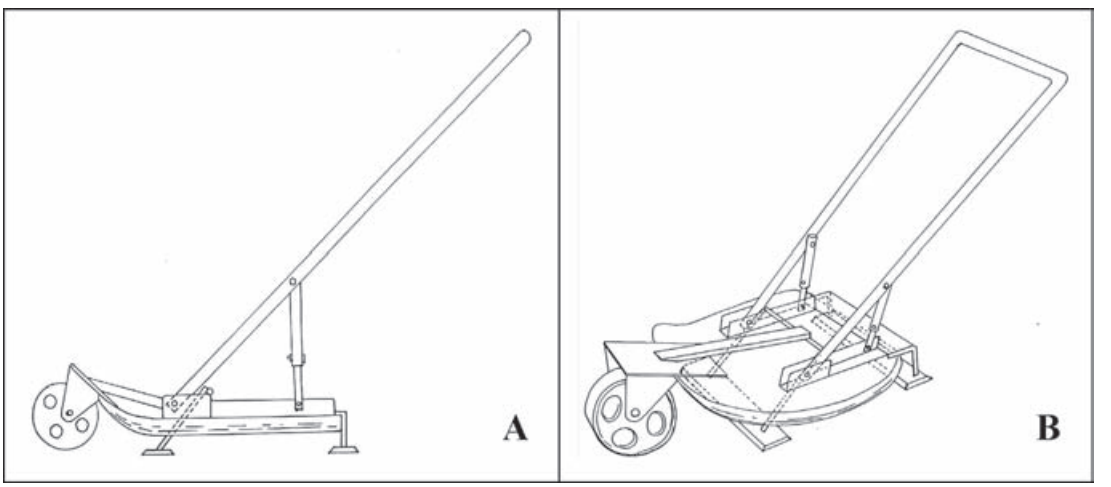

Figure 5 Side view (A) and frontal-above view (B) of hand weeder 5.

crop damages. The smooth curved surface of the toilet lid reduced the friction when moving. It also acted the same as the bottom of a wood plane, thus controlling the depth of spikes and/or blades while working. Another important feature was toilet lid and seat could be purchased elsewhere, even the damaged ones could also be used to make this hand weeder.

Five models of hand weeders (Figures 1-5) were developed consecutively according to the information gained from the previous model; they were as follows.

In theory, the above hand weeders worked the same as other mechanical devices. That is, the handle bar was a lever. This helped extending the force from the user to the chassis and then to the weeds and to soil surface respectively. Whereas, the spike and blade acted as a wedge "eating" into the soil, this was, in fact, an inclined plane.

2. Tests of hand weeders When a hand weeder had been developed, it was tested in a peanut and/or corn fields having young weeds growing up. The majority of weeds were bermuda grass (*Cynodon dactylon* (L.) Pers.), nutsedge (*Cyperus rotundus* L.) and pigweed (*Amaranthus gracilis* Desf.); average dry matter of all weeds was 80-130 g/10m^2.

It was first hoped that hand weeder 1 (Figure 1) could be used satisfactory in sandy soils like the Roi-et soil on campus and nearby. Since this sandy soil surface was relatively flat after a rain or irrigation, no soil clods obstructing the movement of this weeder with a smooth curved bottom. Apart from the action of the spikes underneath, it was also expected that the friction caused by the weeder bottom would damage young weeds to some extent.

After the test, however, the users were not quite satisfied with this weeder, even though it worked much faster than a hand hoe (Table 1). They felt that it could not move conveniently, since the spikes underneath scratched soil surface and entangled weeds. The bottom of the toilet lid should have added more friction as well. In the following force test, the force needed to pull hand weeder 1 started moving was almost the same as that needed for other models with a front wheel.

The results from hand weeder 1 showed that some weeds, mostly young weeds and above ground parts of bermuda grass, got off soil surface. However, weeds like nutsedges, escaped through the gaps between spikes. The rubber band at rear helped scraping weeds to some extent. It might have better result if the band length extended a bit longer.

Since it was felt that hand weed 1 created more friction when using; a swivel wheel was fitted in front of the chassis. Then this turned into hand weeder 2 (Figure 2) with a hope that it should

Table 1 Time (mean ± SD) taken by various hand weeders to weed out a 10 meter^2 row and number of runs; weight of the equipment, force needed to pull the equipment started moving, and number of cycles (lift-scrape or pull-push) taken to finish up weeding the 10 meter^2 row.

Equipment	Test		Weight (kg)	Pull force (kg)	Cycles taken /10 m^2
	Time taken (min. sec)/10 m^2	Number of run			
Hand hoe (standard)	2.59 ± 1.13	54	1.8	4.8 ± 0.8	343.7
Hand weeder 1	1.38 ± 0.21	28	8.9	8.4 ± 0.9	92.5
Hand weeder 2	1.39 ± 0.11	19	11.3	8.0 ± 1.4	92.9
Hand weeder 3	1.1 ± 0.7	15	10.5	8.6 ± 0.8	91.3
Hand weeder 4	1.54 ± 0.7	10	10.8	8.1 ± 0.7	89.7
Hand weeder 5	2.6 ± 0.17	25	11.9	8.2 ± 0.7	92.2

work easier. However, after testing for sometime, the users could not tell whether hand weeder 2 worked better or not. Table 1 shows that time taken for weeding and force needed to pull this weeder started moving were similar to those of earlier hand weeder 1.

The users were not quite satisfied with the spikes scratching weeds; so blade, for scraping, came in as a replacement. This model, hand weeder 3 (Figure 3), gave a better result with smoother performance compared to hand weeders 1 and 2. Weeds scraped off the soil were similar to that of hand hoes. The blade cut weeds at soil surface the same as a hand hoe; and sometimes grasses with roots pulled off the ground. For nutsedges, the blade also cut only the leaves leaving their tubers underground the same as using a hand hoe.

Table 1 shows that hand weeder 3 tended to work faster than hand weeders 1 and 2. When compared to a hand hoe, this model worked almost three times faster within an equivalent area.

A try with hand weeder 3 was done by replacing the rear rubber band with a wire rake; this, then, turned into hand weeder 4 (Figure 4). It was hoped that the fitted rake would help collecting weeds together. However, after testing in the field, this model did not work satisfactory. Apart from the oversize of the rake, the pullback stroke tended to stumble periodically. This can be seen from the time taken which tended to be longer compared to the previous models (Table 1).

Since the users tended to be more satisfied with hand weeder 3; another double-edged blade was fitted at the rear. This was hand weeder 5 in Figure 5. This model was intended for a pull-push alternatively fashion when weeding. It was expected that both edges of both blades would cut and scrape the weeds more effectively. It was also noted that the pullback stroke tended to cut off and scrape weeds better, probably due to the physical dexterity.

Hand weeder 5 was designed to use both edges of the blades; this resulted in a longer time taken in each pull-push cycle. Consequently, the total time taken for this weeder was longer than that of the previous four models. However, it still worked faster than a hand hoe (Table 1).

Even though hand hoes can be used in almost every field condition; namely heavy soils to friable sandy soils, smooth surface to furrows, and rowed crops to no pattern at all (Carruthers, 1985); they take too long time. For the test plots with sandy soil, relatively smooth surface, and rowed crops, all of these hand weeders took shorter working time compared to hand hoes. Weeders 4 and 5 with double-edged blades worked equally well as hand hoes in spaces between crop rows. Whereas, hand weeders 1 and 2 with spikes and a rubber band were acceptable for germinating and young weeds, but were not good enough for established weeds and weeds with tubers. However, spiked weeders also acted as soil cultivators increasing soil aeration and creating soil mulching for moisture conservation. This should be beneficial to the growing young crops in the dry season.

All hand weeders could work very close to crop rows without damaging the crops. This was due to the oval shape of the chassis made of toilet lid. Moreover, all models did not have movable part, except a swivel front wheel, this resulted in a very low maintenance as well.

3. Fatigue from using hand weeders

Using hand weeders should not cause more fatigue than using hand hoes, even though the weeders were heavier and needed more pull force (Table 1). This was due to the different styles of working. A user applied almost equal force from both left and right sides of the body to a weeder with minimum back bending, while he tended to bend his neck and back when using a hand hoe. Furthermore, the height of the weeder's handle bar could be adjusted corresponding to the user's preference, thus, reducing fatigue from working. Data collected from 15 male farmers indicated that the suitable height of the handle bar was 96.3 ±

5.2 cm above ground.

Table 1 also shows that, within the equal working areas, using a weeder took less pull-push cycles compared to lift-scrape cycles for a hand hoe. This lower number of movement cycles and the better body posture while working should be of help to the farmers.

CONCLUSION

Hand weeders developed in this project, especially model 5, gave similar results as hand hoes for getting rid of young weeds growing between crop rows but with a shorter working time. This hand weeder was small in size, relatively cheap, and could be made locally.

ACKNOWLEDGEMENT

This project was supported by the Faculty of Agriculture, Ubon Ratchathani University.

LITERATURE CITED

Carruthers, I. 1985. **Tools for Agriculture: A Buyer's Guide to Appropriate Equipment**. Russell Press Ltd, Nottingham.

Martens, K. and M.H. Martens. 2005. **Look, Ma! No Weeds: Early Season Weed Control**. http://www.newfarm.org/features/2005/0105/earlyweeds/index1.shtml (August 2006).

Wongpichet, K., S. Wongpichet, S. Thani, K. Raoprasert, K. Choprakarn and S. Palasarn. 2003. Set of basic equipment for peanut seed production. **Thai Agricultural Research Journal**. 21(2): 115-135. (in Thai with English abstract)