Quality and Productivity Improvement of Wax Flowers

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ABSTRACT

Waxflower (*Chamelacium Uncinatum*) originates in west Australia and includes more than 20 species. Waxflower is mainly used as bouquet filler. In Israel there is 200 hectare of Waxflower cultivars grown in open fields with an average annual yield of 350,000 flowers per hectare. The growing processes of Waxflowers are labor intensive, and the large numbers of workers involved in the various operations cause bottlenecks that affect costs and working efficiency. The main bottleneck points are in the sorting and packaging stages that take about 60 - 80% of the total time invested in the production process. Work efficiency improvement is extremely important due to the high dependency and unstable availability of manpower. The objectives of the present study were to improve work methods of Waxflower farms, to increase productivity and quality and to develop an optimal branch cutting methodology in order to maximize the total revenue. The research was performed during the years 2005 – 2006 in two modern farms in the southern part of Israel. The farms consist of 7 and 13 hectare of various species of Waxflowers in open fields. On each farm, work studies and time measurements were performed in the various stages of sorting and packaging, and an optimal brunch cutting methodology was developed. The results showed that the sorting station yield was 1781-2113 flowers per hour depending on the cultivar. As for the binding station, it was found that one-step binding bundles of 25 flowers each is more efficient than binding five bundles of five flowers each (two steps).

Keywords: Waxflower, operational strategy, productivity, quality

1. INTRODUCTION

Waxflower is the generic term for the Geraldton wax, *Chamelaucium Uncinatum*, and other *Chamelaucium* species and hybrids. Together they are Australia's most significant commercial native cut flower and leading export flower. Waxflowers originate in West Australia and include more than 20 species (Growns, 2004). Waxflowers are used primarily as feature fillers due to their long vase life, floral display and high productivity. Waxflowers are grown in many countries for local and international markets. Major production areas include California, Israel, Australia, Peru, Chile, and South Africa. In Israel, waxflowers have been grown since 1971, and are marketed in four branch lengths: 50, 60, 70 and 80 cm. Production areas in Israel include 200 ha for export, mostly through flower auctions in the Netherlands (VBN, 2005). Israel is also the main (90%) supplier of waxflowers to the Dutch flower markets.

The article is based on a study, conducted during the years 2005-2006, that was aimed at increasing crop productivity. Work method analysis is a commonly employed technique designed to improve productivity (Globerson, 2000), whereas the determination of standard times for agricultural work processes, such as harvesting or sorting (Jacob and Geyer, 2006),

is essential to enable efficient labor management (Luxhoj and Giacomelli, 1990; Bechar *et al.*, 2007).

Finding the optimal solution for a given operational situation is a classic industrial engineering problem. By definition, optimal solutions (Taha, 2003) supply the best results, but implementing such optimal solutions can be complicated. The use of optimization in agricultural operations is not frequent due to the lack of complete databases, high variability and low accuracy of the operational, marketing and environmental parameters (Vitner *et al.*, 2006).

The objectives of the present study were to improve work methods used on waxflower farms and to increase productivity and quality in order to maximize total revenue.

2. MATERIAL AND METHODS

2.1 Farm Data

Data were collected on two modern farms in southern Israel. The farms consisted of 7 and 13 ha. of various waxflower species in open fields and employed 8 and 15 workers, respectively. Work studies and time measurements were performed during the sorting and packaging. Layouts (Figs. 1 and 2) and geometries of the packing houses were examined. The waxflower species under investigation were Purple and Erez, whose annual yield is 300,000-400,000 stems per hectare.

2.2 Packing House Layouts

A waxflower packing house consists of several workstations, at where workers and material flow according to the work stages, starting with the cutting and sorting station and ending with the storage of the stems in refrigerators, as follows:

- Length sorting station.
- Grouping into batches of five stems.
- Final binding station.
- Water filling.
- Cellophane wrapping.
- Storing in refrigerators.
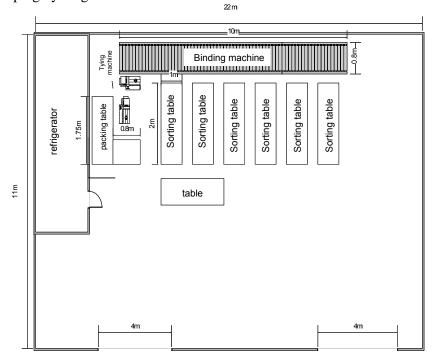- Buffers.

2.3 Work Methods

Work stages in the packing house were defined, and time measurements were taken. It was found that the work-flow and material handling are similar on both farms, resulting in similar layouts of the work areas. Figures 1 and 2 illustrate both packing house layouts.
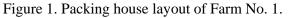
The branches are brought to the packing house by the tractor; branch piles are unloaded from the cart and transferred to the refrigerated room for temporary storage. Then, piles are transferred to the length-sorting station. Branches are sorted into four stem length categories: 50, 60, 70 and 80 cm and placed in four temporary storage areas, respectively. Stems are then transferred to the binding workstation. Stems in length categories of 60, 70 and 80 cm are bound into batches of five stems each, and then five batches are bound together to create bundles of 25 stems each, wrapped with cellophane paper, put into buckets and delivered to

the refrigerated room. Stems 50 cm long are bound directly into bundles of 25 stems each. The length-sorting station steps are as follows:

• Transfer from refrigerated room to sorting station.

• Branch splitting.

• Grouping by length.

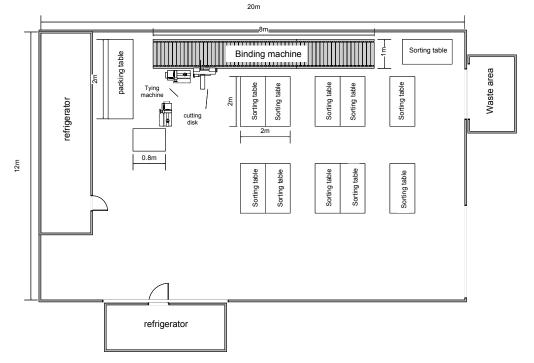Figure 1. Packing house layout of Farm No. 1.

Figure 2. Packing house layout of Farm No. 2.

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The binding station steps are as follows:

- Counting - groups of 5 stems for length categories 60, 70 and 80 cm, and groups of 25 stems for the 50 cm length category.

- Bundling - Binding is accomplished using a tying machine.

- Wrapping - Each tied bundle in length categories 60, 70 and 80 cm is wrapped in a cellophane bag.

- Placing in bucket.

2.4 Work and Time Measurements

In this research, work studies were performed by means of direct measurements and work sampling techniques (Barnes, 1980). Time measurements were made using work study software developed for handheld computers (Bechar *et al.*, 2005).

3. RESULTS

The results are based on data collected and measured on the farms under study. These farms represent a typical waxflower production process in the State of Israel.

3.1 Current Method

3.1.1 Length Sorting Station

Figure 3 presents the stem length distribution of the split branches. This distribution is a result of the cultivar's life-cycle stage in the plot, the workers' splitting abilities and the farmer's marketing strategy. In the case of the Erez cultivar, the distribution observed may indicate that the plot was relatively new or recently harvested, thus about 50% of the stems were 50 cm long. In the case of the Purple cultivar, on the other hand, the farmer's strategy was to market the maximum number of 80 cm long stems and therefore there are less stems of shorter lengths.
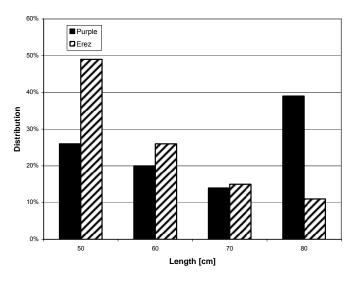

Figure 3. Stem length distribution for Erez and Purple cultivars.

A comparison of the major operations performed during the sorting stage (Fig. 4) indicates that the splitting and length sorting operations require, respectively, 27% and 14% more time for the Erez cultivar than for the Purple cultivar. The differences may be partially explained by the different number of stems produced from the branches. The Purple cultivar yields an average of 2.36 split stems compared with 2.43 for the Erez cultivar.

The workers' average yields during the sorting stage were 1781 stems per hour for the Erez cultivar and 2113 stems (19% higher) for the Purple cultivar.
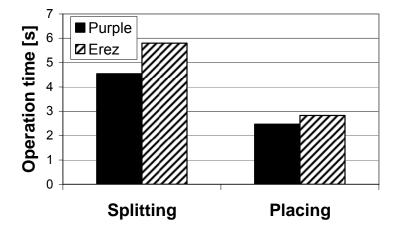

Figure 4. Major sorting operation times for Purple and Erez cultivars.

3.1.2 Binding Station

Two working methods were examined with respect to the binding stage: 1) Teams of five workers, whereby three workers count and place groups of five stems on the conveyor, another worker binds them together to form a bundle of 25 stems and the fifth worker wraps each bundle in cellophane paper and places it in a bucket; 2) Teams of six workers whereby four workers count and place groups of five stems on the conveyor, one worker binds them together to form bundles of 25, and one worker wraps them in cellophane paper and puts them in buckets. Results indicate that increasing the number of workers counting and placing stems on the conveyor, increases the waiting or non-productive time by 7% (Fig. 5) and decreases the yield per worker.

No significant difference was found between the counting and placing time of stems in the 60, 70 and 80 cm categories. Stems 50 cm long are bound into bundles of 25 stems in one single step. The results show that there was no significant difference in the total time required to count and place a total of 25 stems of whatever length. However, the results presented in Figure 6 show that counting 25 stems in one single step takes 30% more time than counting five stems five times. Nevertheless, placing 25 stems at once is 66% faster than placing five stems five times. So although the total time is almost the same, binding 25 flowers (in one single step) saves the worker the time required to bind together five batches of five stems.
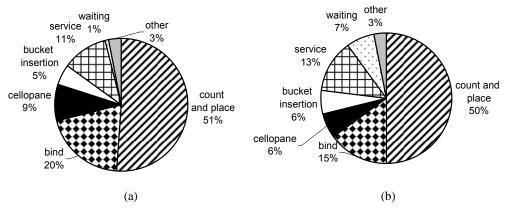
Figure 5. Proportions of work element times at the binding station for teams of (a) five workers vs. (b) six workers.
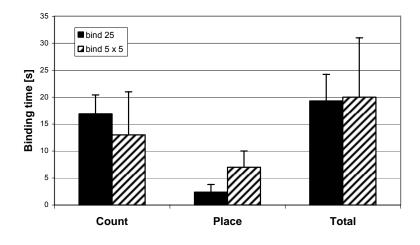

Figure 6. One-step binding of 25 stems vs. binding of five groups of five stems.

3.2 Alternative Methods

An alternative packing method was developed and tested. According to this method, all branches were sorted into lengths of 50, 60, 70 and 80 cm and cut to their final length automatically by the machine. Stems 80 cm long were immediately bond into groups of five during the sorting process itself and placed on the binding machine. Stems 50 and 70 cm long were treated as in the current working method. Stems 60 cm long were counted into groups of 25 stems after completing the sorting process and placed on the binding machine.

Table 1 details the times elements of the current methodology versus the alternative one. The average time it took to sort a stem according to the alternative methodology was 15% shorter than according to the current methodology. The total time required to process a stem during the sorting and packing stages was, on average, 14% shorter (6.92 s according to the alternative method vs. 8.1 s according to the current methodology). Figure 7 presents the total sorting and binding times for both methodologies, for the various stem lengths.

Table 1. Work element times according to the current and alternative methodologies.

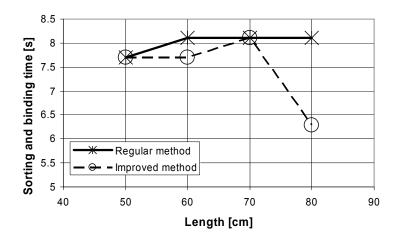| Elements	Current Method [s]	Alternative Method [s]
Average sorting time per stem	7.31	6.28
Counting five stems	2.63	6.94
Counting 25 stems	16.9	33.27
Placing and binding five stems on sorting machine	1.34	2.48
Placing and binding 25 stems on sorting machine	2.39	3.43

Figure 7. Sorting and binding times for the current and alternative methods, for stems of different lengths.

4. DISCUSSION

It was important to study the waxflower crop since about 92% of the yield is exported to the Netherlands and cost of delivery to that market is naturally higher than to the local market.

The alternative method examined during the sorting and binding stages increased the yield and reduced the average work time per stem by 14%.

Implementation of the alternative work methods requires no special effort or infrastructure, and thus can be implemented immediately with no additional costs.

5. Acknowledgements

6. REFERENCES

Barnes, R. M. 1980. *Motion and Time Study Design and Measurement of Work*. New York, Wiley.

Bechar, A., D. Dayan, S. Schmilowitch, Y. Moskovitch and Y. Edan. 2005. A Pocket-Pc-Based Platform for Agricultural Work Study Measurement. In *Proc. of the 35th International Conference on Computers and Industrial Engineering* 269-274. Istanbul, Turkey.

Bechar, A., S. Yosef, S. Netanyahu and Y. Edan. 2007. Improvement of Work Methods in Tomato Greenhouses Using Simulation. *Transactions of the ASABE* 50(2):331-338.

Growns, D. 2004. Waxflower. The New Crop Industries Handbook. *Rural Industries Research and Development Corporation.* RIRDC Pub. no. 04/125:476-485.

Globerson, S. 2000. *Operations management and performance improvement*. Cherikover Publishers Ltd., Tel-Aviv. (In Hebrew).

Jakob, M. and M.Geyer. 2006. The Influence of Machine speed on Human Performance for Simple and Highly Repetitive Work Processes: A Pilot Study. *Agricultural Engineering International: the CIGR Ejournal* 8.

Luxhoj, T.J., and G.A. Giacomelli. 1990. Comparison of labor standards for a greenhouse tomato production system: a case study. *International Journal of Operations and production Management* 10(3):38-49.

VBN. 2005. Turnover realized in import cut flowers. VBN Annual Report 21.

Taha, H.A. 2003. *Operations research: An introduction*. 7th Ed., Prentice Hall, New Jersey.

Vitner, G., A. Giller and L. Pat. 2006. A proposed method for the packaging of plant cuttings to reduce variability. *Biosystems Engineering* 93(3):353-358.