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Time study on different techniques for nursery pot filling operation

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TIIVISTELMÄ: AIKATUTKIMUS TAIMIKENNOJEN TÄYTTÖTEKNIIKOISTA

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Time study on different techniques in nursery pot filling operation at SUA Training Forest in Northern Tanzania was conducted. The results showed that improved tools and work place design significantly decreased the operation time, hence increased productivity. In addition, worker's comfort was generally increased.

Tutkimus tehtiin Sokoine University of Agriculturen harjoittelumetsässä Pohjois-Tansaniassa. Tulosten mukaan paremmat työkalut ja parempi työolojen suunnittelu vähensivät merkittävästi toimintaan käytettyä aikaa ja nostivat siten tuottavuutta. Lisäksi työntekijän mukavuus yleensä parani. (Käännös toimituksen)

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1. Introduction

Seedlings, produced in the nursery, may be transplanted either as striplings, stumps, bare-root stock, containerized stock, in Swaziland beds, or grown in polythene tubes or other types of containers (Goor and Barney 1968, Sharpe 1971, FAO 1974). Container sowing was originally established by foresters in cold northern climates, where the difficulties of successfully producing and planting conventional bare-root seedlings were substantial (Sharpe 1971). The commonest form of container in tropics is the polythene tube; various sizes may be used depending on conditions. They have replaced containers made of clays, bamboo, baskets, banana leaves, impregnated papers or cards (FAO 1963), and are preferred because among other factors they are cheap (if large quantities are ordered), light, and have no effect on transplant growth.

Plantation forests in Tanzania were mainly established in highland areas where soils were comparatively fertile, and nursery cultural techniques were tailored to produce large healthy and robust seedlings (Procter 1967). During the last three decades the area under plantation management has more than tripled mainly due to increased demand for industrial and traditional timber, and small scale village woodlots hence increased demand for seedlings. The production of nursery stock is a major expense of afforestation (ranging between 5 to 20 percent of total cost depending on the cost of land clearing), thus nursery operations must be planned and managed efficiently (Goor and Barney 1968, FAO 1974).

Work study is a management service based on those techniques, particularly method study and work measurement, which are used in the examination of human work in all its contents, and which lead to a systematic investigation of all resources and factors which affect the efficiency and economy of the situation being reviewed, in order to effect improvement (The Glossary . . . 1969). Determination of task rates, payment systems, mandays and total cost of operations can be determined by using work study results (Wittering 1973, Dykstra 1981).

Time studies are the most common approach in obtaining work measurement data on operations, the purpose being to determine the standard time required by a qualified and well-trained person to perform an operation by a specified method while working under normal conditions (Wittering 1973, Anderson 1976, Currie and Faraday 1977, ILO 1979, Appelroth 1982, 1986). Appelroth (1986) points out that time studies can therefore be used to compare different operations by comparing their observed times, based on the assumptions that: an operator who has carried out the same kind of work for several years will do it in the best possible way, he maintains a constant performance rate typical for him throughout regardless of the type of work, and, all the time an operator spends on breaks is needed for relaxation. Hence, the shorter the observed time for an alternative operation the better that alternative.

Time study data can be subjected to statistical analyses to determine functional relationship(s) between the dependent variable (observed time) and a set of independent variables, hence establishment of models used to predict the times and production rates and unit cost of operations (Gibbson and Rodernberg 1975).

Several reviews have been presented on work studies for logging and log transport operations, and other silvicultural operations (Rowan 1967, Hakkila 1973, Dykstra 1975, 1976, Olsen and Gibbsons 1983, Kellogg and Olsen 1984, Appelroth 1982, 1986 among others), but little has been reported on nursery activities in the tropics. In Tanzania, nursery pot filling is done manually, using the traditional (hand filling) technique, based on task rates which are subjective, and with little or no concern of human engineering (ergonomic) considerations.

This study aimed at elucidating production rates of nursery pot filling under different methods in Sokoine University of Agriculture (SUA) Training Forest, Northern Tanzania.

2. Material and methods

The work study was carried out at the SUA Training Forest, Meru Forest Project, Northern Tanzania. The forest, located about 3° South of Equator and 36° East, lies at an altitude range of 1800–2200 m above sea level with a mean annual rainfall of 1000 mm that falls mainly during March to June.

Nursery pot filling operation was usually done on a task rate, of between 600–800 pots per manday; the average pot size measured 10 cm diameter and 9.7 cm length. Standard soil mixture for raising seedlings was used.

An experienced worker, who was used to pot filling by the traditional technique, was chosen for the study. Time study of the pot filling operation was conducted for three different techniques referred to here as (I) traditional (hand filling), (II) scoop and stool and (III) scoop, chair and table. The study covered 22 days, distributed to 6, 8 and 8 for the respective techniques. The three techniques were described as follows:

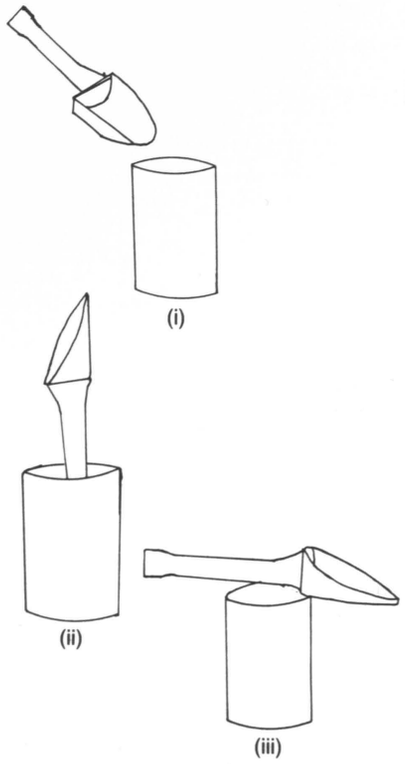

Fig. 1. Sequence of activities using the scoop.
(i) = Pouring soil in the tube
(ii) = Compacting the soil
(iii) = Levelling the soil

(I) *Traditional* (hand filling): no improvement was made and the worker was required to fill and compact soil by hand. The worker usually squatted or sat on a low-level object at the gathered nursery soil. The sequence of activities in pot filling included:
i) picking and opening the pot,
ii) while holding the opened pot on one hand the other hand was used to collect and fill the pot,
iii) fingers were used to compact the soil, while the palm was used for levelling.

(II) *Scoop and stool*: a scoop, locally made from scrap tin material and fitted with a 23 cm wooden handle, was used to fill, compact and level the soil (Figure 1). The scoop had a soil holding capacity of about 0.25 kg, and had a diameter of 10 cm at the widest point. In addition, the worker was provided with a 35 cm high wooden stool to sit on.

(III) *Scoop, chair and table*: in addition to the scoop used in (II) a standard chair (with backrest) and table (Grandjean 1980) were provided. The soil mixture was heaped on one side of the table and the empty prepared tubes at some points within easy reach.

For all the three methods, the filled pots were placed in a wheelbarrow.

The time under study was work place time which was segregated into effective and delay times (after Nordisk . . . 1978). In the time study the observed time was measured in centiminutes by the flyback timing. The following times were distinguished:

1. *Effective time*
i) Picking and opening: time taken to pick and open the polythene tube;
ii) Filling and compacting: time to pour and compact soil into the tube;
iii) Placing pot: duration taken to place the filled pot onto the wheelbarrow.

2. *Delay time*
(a) Avoidable (unnecessary) delays
i) Talking: stopping work and talking to other persons not involved with the task;
ii) Pot bursting: occurred when the soil was improperly compacted;
iii) Selecting pots: time to select required sized-pots;
iv) Leaving work place: unofficially leaving the work place
v) Idle time: identified as no activity done
vi) Others: research delays
b) Unavoidable (necessary) delays
i) Arranging pots: time required to arrange pots on the wheelbarrow
ii) Gathering soil: soil far from reach was gathered into heap to facilitate picking.
iii) Transfering pots: time to transfer filled pots from work place to sowing site.
iv) Others: personal needs, rest pauses

3. Results and discussion

The mean productive and delay times for each of the techniques are presented in Table 1.

The proportion of unproductive time occupied by avoidable delays were about 2, 5 and 6 per cent for techniques I, II and III respectively.

Figure 2 shows the mean productive times. There was a statistically significant difference (at 0.05 probability level) between the mean productive times for the different techniques, suggesting that the improved techniques resulted in reduced pot filling time; consequently higher production rates could be realized.

Among the work elements, filling and compacting the soil was the most time-consuming, averaging between 60–65 percent of the total work place time. The average time for this activity was greater for the traditional than for the other methods, although the worker was used to it. The use of the scoop in techniques II and III not only reduced the time to fill and compact (mainly due to its greater soil-holding capacity), but also increased the worker's comfort; with hand filling the worker generally complained of pain in the fingers, mainly due to compacting.

From the worker's viewpoint, both sitting positions in techniques II and III were more

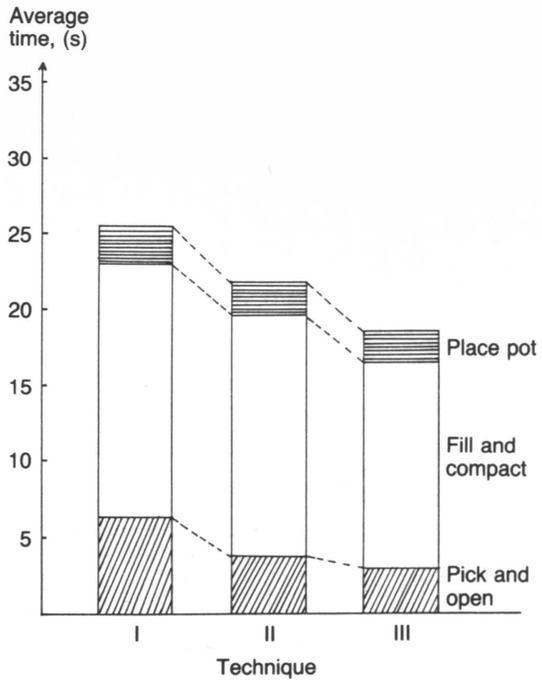

Fig. 2. Distribution of average productive time for each technique.
I = Traditional technique
II = Scoop and stool technique
III = Table, chair and scoop technique

Table 1. Productive and delay times in each technique.

Technique	I				II				III			
Time element	Pick and open	Fill and compact	Place pot	Total delays	Pick and open	Fill and compact	Place pot	Total delays	Pick and open	Fill and compact	Place pot	Total delays
Mean (s)	6.4 (22.6)*	16.7 (59.6)	2.2 (7.6)	3.0 (10.3)	3.8 (15.4)	15.9 (65.3)	2.0 (8.3)	2.7 (11.0)	2.9 (13.6)	13.6 (62.4)	2.0 (9.2)	3.2 (14.8)
Standard Deviation (s)	1.27	2.75	0.42		1.15	2.59	0.15		1.00	2.12	0.04	
Number of samples (n)		3528				5366				5044		

*) Values in parentheses indicate the percentage to workplace time.

preferable to squatting (technique I), with technique III being more comfortable; (in technique I the worker often complained of backache and leg muscle cramps). It has been reported that among other factors improvements in work place design, incentives, and motivation generally resulted in gradual and predictable improvements in productivity (Dykstra 1983).

Based on the time study results in Table 1, the mean productivities were estimated at about 850, 1020 and 1140 pots per manday. These results suggest that although the present subjective task rate was close to the findings of the study for the traditional method, management can generally realize greater productivity with more worker's comfort with improvement in working tools and work place design.

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