Commonsense Greenhouse Mechanization: Lower Labor Input

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Labor efficiency is something to strive for whether you operate a greenhouse by yourself or hire many employees. A good starting point for evaluating labor efficiency is to collect data on which operations require the greatest amount of time. Transplanting, hand watering, plant selection for shipping and moving plants into and out of the growing area are often the greatest labor users. These tasks are the ones that should be evaluated first to see if improvements can be made.

Equipment is available for almost all the tasks that take place in the greenhouse but not all tasks should be mechanized, especially for the grower with only a small amount of growing area. Some of this equipment is very expensive. Other machines have use only a few days out of the year. Purchasing decisions need to be made only after considering many factors. Consider the following basic principles when making decisions.

- **Keep things simple.**
- **Analyze your needs thoroughly. Design your facility for efficient materials and plant movement**
- **Storage – a place for everything and everything in its place.**
- **Mechanize or automate jobs that are repetitive, tedious or time consuming. Install equipment that reduces peak period labor requirements.**
- **Select equipment that will pace workers.**
- **Reduce the amount of walking that employees have to do.**
- **Standardize your operations.**
- **Consider alternatives to purchasing equipment.**
- **Select equipment that is manufactured with standard parts.**
- **Train employees for the tasks they are to perform.**
- **Employee comfort and safety is important.**

The following review of basic greenhouse operations gives some pointers on equipment and methods to improve efficiency.

Let Controls Make the Decisions
Growers spend a considerable amount of time making routine decisions. Do the plants need to be watered? Should the vents be opened? Is it time to draw the shade or energy curtain? Simple, low cost devices, such as electronic controllers, time clocks or alarms can make these decisions for you. Controllers and computers can integrate environmental factors and keep a history of crop growing conditions.

Media preparation
Most growers purchase bagged or baled prepared media. A bale breaker/fluffer can save considerable time and provide a more uniform mix.

Container filling
Purchasing prefilled containers is an alternative that may be less expensive than hand filling or owning expensive container filling equipment. Containers are delivered to your greenhouse on shrink-wrapped pallets when you need them.

A simple flat filler can be made by attaching two short belt conveyors together side by side in an **X** configuration. One conveyor is fitted with a hopper at the lower end that holds about a bale of growing mix and a chute at the top end to direct the mix to a grated work table about 3' above the floor that supports the container. Excess material falls onto the second conveyor that carries it back to the hopper. Each conveyor has a separate motor. The speed of the conveyors can be controlled by a variable speed motor. The unit can be mounted on a frame with wheels for portability.

Plug extractors – these low-cost devices loosen the plugs from the tray for easy handling saving considerable time. Standardization of the plug tray is important as a pin plate is needed for each size of tray.

Watering tunnel – a low-cost watering tunnel can be made using two or three fan type nozzles attached to a piece of PVC or metal pipe that is suspended over a chain or roller conveyor. Water is supplied to a solenoid valve that controls the flow. A lever type microswitch activates a 24 volt solenoid valve that turns the water on whenever a flat or pot is conveyed under the nozzles. A transformer converts 120 volt electricity to 24 volts to reduce the potential for shock. The excess water can be collected with a pan and piped to a drain or the unit can be placed directly over a drain in the floor.

Workstation design
A workstation is an area where an employee does a series of repetitive tasks such as transplanting, potting or preparing plants for shipping. The layout of this area can have a large influence on efficiency. A good layout where everything is within easy reach can decrease the labor needed by as much as one-half over a poor layout that requires walking to get materials or to set plants into the growin area.

For example, a good transplanting rate for 48 cell flats is 20 to 25 flats/hour. Based on a $10/hr labor cost, the cost of transplanting 10 flats/hr is $1.00/flat, 15 flats/hr - $0.68, 20 flats/hr - $0.50 and 25 flats/hr - $0.40. Workstation efficiency pays.

The top of the work table should be at elbow height. Height adjustment should be provided for different size workers. It is best to provide for both standing and sitting positions as greater efficiency is achieved when workers change positions.

The reach from the normal arm rest position to get materials should be limited to a 24" radius to the side and front for women and 27" for men. The work area is best if within 16" to 24" of the resting elbow position.

A work station space of 3' x 3' is adequate for most operations. Space to the rear and sides can hold prefilled containers, a cart for placing transplanted containers and movement of the worker. Where multiple stations are employed, a belt conveyor to the front of the workers will carry the completed containers to an area where they can be loaded onto carts for transport to the growing area.

An alternate work station is a portable transplanting table that is placed in the greenhouse next to where the containers will be grown. The table should be kept close to the growing area to reduce walking with the containers. Prefilled containers can be supplied on pallets near the work area.

Carts and wagons

The use of carts can speed up handling and reduce the labor needs. One person can push a cart loaded with 40 to 60 flats from an efficient transplanting area to the growing area next to where they will be placed.

Purchase carts that will roll easily through access doors. A paved walkway down the center of the greenhouse will make movement easier. An alternate is to install steel tracks in the aisle for the cart to roll on. Select a cart that has large wheels. One that has fixed casters in the center of the cart with a swivel caster in the center of each end will allow the cart to be turned within its own length. Tire size should be at least 2" wide by 6" diameter for use on paved floors and 2-3/4" wide by 10" diameter for use on unpaved areas.

The cart shelves should be made of a lightweight material that is strong enough to carry the load without sagging. A sheet metal or plywood shelf allows easier loading then a wire mesh material. Shelves should be removable and adjustable for different size plants.

There are many types and styles of wagons that are available for greenhouse use. Most contain pneumatic tires for transport over unpaved surfaces. The standard wagon has a fixed rear axle and pivoting front axle on a fifth wheel. Where wagons will be used in tandem in narrow aisles, select a tracking design where both axles are connected together and one wagon will follow in the track of the other.

Where the distance between the work area and the greenhouse is greater than two hundred feet, carts and wagons should be pulled in tandem in multiple units to save time. An electric cart or garden tractor can provide the power.

Conveyors

An alternative to moving plants on carts is a trolley conveyor. The system consists of a tubular or angle iron track suspended from the greenhouse or headhouse frame and a trolley-mounted rack that is pushed along manually. Suspending the track over the benches and plants means that no additional aisle space is needed. Curved sections of track are used to get around corners. Switches may be located anywhere in the system to allow transfer from one track layout to another.

The rack should be designed with removable shelves for different size plants. It will hold from 20 to 40 flats at one time. Several racks can be connected together for movement over long runs. Cost of the system is about $3 - $5/linear foot.

Growing Trays

The tray system saves considerable labor as the plants don't have to be carried to a cart or conveyor. Trays are usually loaded with potted plants or flats in the headhouse then moved to the greenhouse When ready for marketing, they are moved to the shipping area. Tray size is usually 5'to 6' in width and 8' to 20' long. The trays should be designed to fit the type of growing container that you use and the space available in the greenhouse. They can also be designed for an ebb and flood system with recycled water.

Two types of tray transport systems are common. The roller conveyor system uses flat bottom trays that ride on trolley wheels or fixed casters attached to support rails. The trays are guided by the design of the support wheels attached to the rails.

In the second system, the rollers are attached to each tray and ride on the smooth pipe rails. One set of rollers provides the guidance and the other is for support.

Transport cart - To get the trays from the headhouse to the greenhouse, a transport cart can be used. This low-cost cart travels in an aisle along the end of the tray lines. A tray to be moved is rolled onto the cart and locked in place. The cart follows a guide rail to the headhouse or shipping area.

Transport conveyor – This system uses rails with attached plastic trolley wheels to move the trays. The system is designed to support flat bottom trays. An alternate system uses rails that support trays with wheels mounted to the underside.

Watering Boom – for uniform watering it is hard to beat a watering boom. Booms can be simple devices made to operate from a winch pulled cart that supports the boom over the plants. They can also be suspended from track mounted to the overhead trusses. Commercial booms generally have computer control that allows double watering, skipping sections, and multiple nozzles that change the rate of application. Supplemental lighting can be mounted on some booms.

Plant spacing robot

A recent addition to greenhouse mechanization is the plant spacing robot. Its basic use is to move plants that are pot to pot to a wider spacing. It can be programmed for several spacings. Production is about 175 - 200 pots/hour or slightly less than an employee but it doesn't take breaks or lunch periods. It will work inside or outside and reduces pot handling costs by about 50%.

Shipping Efficiency

The following ideas can help improve shipping efficiency.

- Select a team of two or three employees to gather and prepare an individual truck load. They should be experienced in plant identification and loading.
- Label or tag plants when they are transplanted to reduce labor during shipping.
- Limit the number of container sizes and shapes that you use to make load assembly easier. This also reduces the inventory that has to be carried.
- Develop a plant location identification system that reduces the time needed to find plants.
- Market plants by full carts or pallets to reduce errors in both assembly and delivery. It also makes invoicing easier.
- Shrink wrap carts and pallets to contain plants and reduce damage.
- Purchase a hydraulic tailgate to speed loading and unloading of carts.