Designing and Fabrication of Automatic Root Crop Washer

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Abstract
The Automatic Root Crop Washer is a machine which could find its use in the agricultural fields. The root crops like potatoes, carrots, radish, etc., after harvesting have to be cleaned off the soil and clay particles before transporting them from field to market. Normally the farmers of Punjab (INDIA) follow a traditional method of cleaning the carrots, radish in which the roots are washed manually by hands and feet. Therefore our project was based on giving the best solution to this problem. We have developed a cheap root washer machine which every farmer in India can afford. This paper discusses the detail of that machine. The muddy root crops are put inside the Root Crop Washer drum via an opening provided on circumference. Then the opening is closed using leather belts and locks. Provisions for pressurised water supply inside the Root Crop Washer have been made. The drum is then rotated by a motor and water under pressure is supplied in the drum. Due to the rotation of the drum and the continuous supply of water the soil and clay particles are removed off the root crops. The muddy water falls down through the slits provided in the drum. Hence cleaning the root crops and making them ready for the vegetable market.

Keywords
Root Crop Washer, Radish Washer, Carrot Washer

I. Introduction
The literature survey reveals that many designs have been proposed in the past for the present problem. Likewise we have also tried to develop a design which is reliable, cheap and efficient. 8 farms were visited to conduct case studies of their harvest wash as well as their food safety protocols. We identified the problems that came across while washing crops. The project began with understanding that harvest wash and pack labour is a large percentage for small scale diversified vegetable farms. A problem that was coded, faced by Indian farmers, is washing of the root crops post harvesting. These crops need to be cleaned properly from the soil and clay particles before sending them to markets. When root crops such as sugar beets are harvested, a large quantity of dirt may cling to the surface of the beets and materially increase the weight and displacement of the beets. To remove the dirt and other foreign materials, it has been customary to pass the beets over roll-type cleaners which provide a scrubbing action.[1] Crops are immediately washed off the soil after harvesting because the drying of soil on these crops will contaminate them, which is unfit for consumption.[2]

The traditional approach that is being used by the farmers involves using of big perforated crates or tubs. The soiled crops are put in the perforated crates and are washed manually using a jet stream of water. The crops have to be regularly shuffled with hand for proper cleaning. This has been proved to be a very time consuming process and requires a lot of labour (especially in farms having area>3 ha). Also during the winter season this process becomes very challenging as labourers are constantly in contact with the cold water. A backlog of unwashed crops can often pile up and some are rendered either unfit for sale or unfit for personal consumption. For these reasons we had looked into a mechanised way of washing root crops. With the machine like the Automatic Root Crop Washer we would be able to quickly clean root crops more efficiently and effectively.We wanted to share some best practices for harvest wash and improve the efficiency of farms.

Lisa Kitinoja et al. have reported a traditional methodology in which tanks are mounted on simple washing stand. The tank for washing produce is made from sheet metal. A baffle made of perforated sheet metal is positioned near drain pipe and helps to circulate water through the produce. Fresh water is added under pressure through a perforated pipe, which helps move floating produce toward drain end of the tank for removal after cleaning Fig.1 shows this traditional methodology[3].

Data on performance of root vegetable washer indicated that the different matting surfaces affected the cleaning, washing parameters as shown in Table 1. [4]. In the case of rubber matting of 5 mm thickness, the washing efficiency was found to be good for both carrot and radish. It was found that higher cleaning efficiency could be achieved, that is, removal of fibrous roots for both carrot and radish in mat type washer. However, the bruise index was found to be at the higher side due to the severe bruises observed at the top and tail end of the tubers. This may be due to the bubble like projections in the mat which results in a rough surface. Jayashree and Viswanathan (2010) reported that the bruise index increased with increase in operating drum speed for washing of ginger rhizomes. Though the washing and cleaning efficiency was good using rubber matting but due to the higher bruise index which indicates damage to the tubers, another set of experiments were conducted with plastic matting. In the case of plastic matting, washing efficiency was more for carrot and radish at 3.5 mm thickness compared to 1.5 mm thickness for the same produce. The cleaning efficiency was also more in the case of 3.5 mm thickness for carrot and radish respectively than at 1.5 mm thickness. In the case of 1.5 mm thickness plastic matting, the washing efficiency was found to be on par for both carrot and radish. The cleaning efficiency was found to be 88% for carrot and 85% for radish. The bruise index was less in the case of carrot at 3.5 mm thickness compared to radish at the same thickness of matting. Statistical analysis revealed that there was a significant difference on the performance parameters among the different matting surfaces. The plastic matting of 3.5 mm thickness was good in performance in terms of washing and cleaning of the tubers with low bruise index.

The Automatic Root Crop Washer that we have developed provides a solution to the problem of the farmers reducing the labour requirement and the time of the farmers. The labour is reduced significantly as for the proper running it requires only one person. Automatic Root Crop washer can wash about 10-15 kilograms of harvested crops in a couple of minutes. Also it does not rely only on electric power; it could be driven manually with the help of a handle provided. There is also provisions made in which root crop washer can be run using tractors in farms with the help of suitable belts. At last, looking upon the Indian weather conditions, it is a lot more comfortable for farmers to work even in extreme climatic conditions.

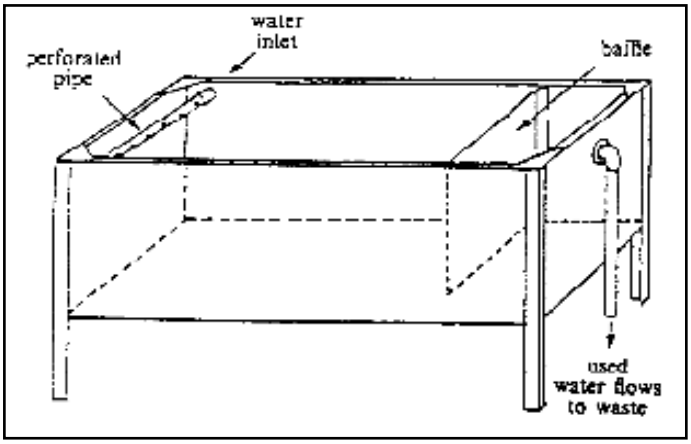

Fig. 1: One of the Traditional Method

Table 1: Washing & Cleaning Efficiency for Type of Matting

Type of matting	Vegetables	Washing efficiency (%)	Cleaning efficiency(%)	Bruise index
Rubber, 5mm Thickness	Carrot	95±0.70	90±0.94	30.5±0.82
	Radish	96±0.47	87±0.69	32.0±0.71
Plastic,1.5 mm Thickness	Carrot	95±0.71	88±0.70	1.5±0.05
	Radish	95±0.51	85±0.74	6.1±0.16
Plastic, 3.5 mm Thickness	Carrot	97±0.47	91±0.70	1.25±0.10
	Radish	96±0.94	90±0.94	6.05±0.13

II. Materials & Methods

It consists of a wooden drum made of wooden planks with some horizontal spacing between them for the passage of contaminated water all along its circumference. An opening is provided on circumference from where the crops are loaded/ unloaded. Fig.2 shows the cross-sectional view of the wooden drum used in the Automatic Root Crop Washer. A hollow shaft runs along the centre of the drum. This shaft has holes in it and is used for sprinkling pressurised water inside the drum. This shaft is mounted on bearings on both sides and rotates with the drum. We get the water supply with the help of water pump which is kept in a water reservoir. One side of the pump is dipped in reservoir and other side is connected to shaft via mechanism in which part connected to shaft is free while the other one is fixed with the pump. On the other side of the drum a high torque motor is attached which rotates the drum with reliable speed. A 0.75kW (1 hp) electric motor is attached to the chassis of the root crop washer. A V–belt transfers power from the hydraulic motor to the pulley on one of the roller. This whole system is mounted on a stand. Three leather belts with locks along the circumference of the drum are provided to lock and to prevent the opening of the drum during its rotation.

The crops are loaded in the drum through the door provided. After loading, the door is closed and locked. The water pump is now connected to the hollow shaft through a pipe and L-shaped pipe joint. The electric motor and water pump are switched ON simultaneously. A small pulley of 2″ diameter is mounted on the shaft of the motor. The small pulley is connected to a larger pulley of 9″ diameter via a V belt. The larger pulley is connected to the shaft of the drum which is further connected to the wooden drum. When the motor is switched ON the drum starts rotating. Pressurised water is sprinkled on the root crops kept in the rotating drum. Due to the rotation of the drum and sprinkling of pressurised water, the soil and clay particles are separated from the crops, thus, giving them a fine finish. Small pebbles and contaminated water falls down through slits. Operator keeps the drum rotating until the crops are washed properly. This time of rotation depends on the quantity of crops kept in the drum. After sometime the motor and water pump are switched off. Now crops are put in crates for transportation which are free from dirt particles. Also the water with dirt particles from washer can be reused for irrigation. An experiment was performed on this in which results shows that there is no significant difference between crops irrigated with grey water and that receiving regular tap water [5].

The material used for the drum of root crop washer is wood. The inner surface of wooden planks is covered by plastic mats. There were other material options like rubber for matting but the plastic matting is preferred. Specifications of the machine, motor and pump are shown in Table 2, Table 3 and Table 4 respectively.

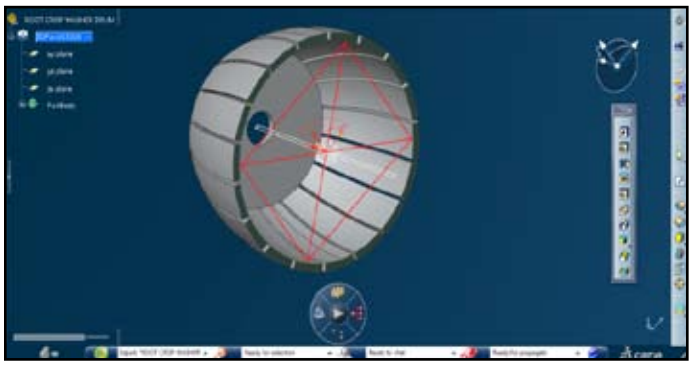

Fig. 2: Shows the Cross-Sectional View of the wooden Drum Used in the Automatic Root Crop Washer

Table 2: Specification of the Machine

Length of the Drum	39″
Diameter of the Drum	19.8″
Diameter of the Small Pulley	2″
Diameter of the Larger Pulley	9″
Diameter of the Shaft	1″
Length of the Shaft	56.5″
Height from the ground	46.9″
Material of inner matting	Plastic

Table 3: Specification of the Motor

Sr. No.	Particulars	Value
1.	Length (mm)	2743
2.	Width(mm)	1219
3.	Height(mm)	1524
4.	Roller Diameter(mm)	457
5.	Roller Length(mm)	770
6.	Horse Power	1 HP
7.	R.P.M	1440 r.p.m
8.	Gear Ratio	20:1
9.	Power	0.75 KW

Table 4: Specification of the pump

Model No.	Power Consumption	Voltage	Max. Head	Max. Flow
MSP 300	7W	AC 220	1.2m	500L / H

III. Results and Discussions

The Automatic Root Crop Washer was put to a test against the labourers in the agricultural fields. Both the Automatic Root Crop Washer and the labourers were given some quantity of harvested root crops and the time taken by each of them was noted corresponding to the quantity of root crops washed.
The results were noted and a graph of quantity vs time is plot as shown in the fig. 3.

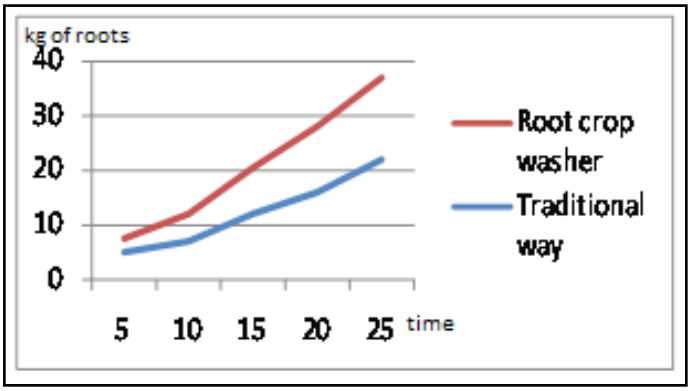

Fig. 3: Quantity v/s Time

From the above graph it is clear that the Automatic Root Crop Washer proved to be more efficient than the traditional approach used saving the cost of the labour and time. Also many further modifications can be made on this washer like installing a dryer within the drum which will help in drying of the crops within the drum so that no time is wasted in drying them before sending them to the vegetable market.

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