Development of Solar Photovoltaic (SPV) Powered Vegetable-cum- Fruit Grader

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ABSTRACT

Power from solar photovoltaic system was used for operation of a grader for grading of fruits and vegetables. A solar panel of 400 W (4 solar modules of 100 W each with open circuit voltage 18 V) was used to operate the system. The direct current (DC) power of the solar panel was used to run the 150 W DC motor of the grader. The grader was tested for grading of potatoes in three sizes. The output capacity of the grader was found as 600 kg/h. A 12 V/7 Ah battery may also be used to operate the grader in the absence of solar energy.

Key words: *Solar energy, Solar PV system, Fruit and vegetable grader*

INTRODUCTION

Grading of fruits and vegetables after harvesting is an essential step in post-harvest management. Grading of fruits and vegetables are done on the basis of physical characteristics like weight, size, colour, shape, specific gravity and freedom from diseases depending upon agro climatic conditions. The known methods of grading of fruits and vegetables are manual grading, and size grading. Grading of fruits and vegetables in the fresh form for quality is essential, as the people are becoming quality conscious day by day. Further, upon arrival of fruits and vegetables at the processing centers, they should be graded strictly for quality. The immature properly, mature and over mature fruits and vegetable should be sorted out for the best attributes.

Grading is sorting of vegetables and fruits into different grades according to the size, shape, colour, and volume to fetch high price in market. Proper grading helps to reduce the losses in the selling price due to presence of substandard products or specimen can be easily avoided. It increases marketing efficiency by facilitating buying and selling a produce without personal selection. Grading enhanced to set good price for graded products. Heavy marketing cost in packing and transportation can be avoided by grading. In grading diseased and defected specimen are not damaged due to contact of diseased specimens and thus gets high price in market. By grading there is fairness to both Buyers and Sellers. Properly graded vegetables and fruits are purchased by the consumer easily without inspection.

Solar Energy is the energy received from the sun that sustains life on earth. For many decades solar energy has been considered as a huge source of energy and also an economical source of energy because it is freely available. However, it is only now after years of research that technology has made it possible to harness solar energy. Solar Energy is already being used successfully in residential and industrial settings for cooking, heating, cooling, lighting, space technology, and for communications among other uses. In fact, fossil fuels are also one form of solar energy stored in organic matter. With fossil fuels making major impact on the environment and raising issues of pollution and global warming, solar energy has increased in its importance to industries and homes. While the reserves of fossil

fuels are restricted, there is no limitation to the availability of solar energy. With improvement in solar energy technology and the increase in prices of fossil fuel, solar energy is gradually becoming more and more affordable. In addition, there is additional cost in the form of importation and transportation, required for oil, coal and gas. A study was conducted on sorting potatoes based on dimension and shape in monochrome system (McClure and Morrow, 1987). A machine vision system was developed for potato grading by image processing (Marchant *et al*, 1988). A system was provided for potato grading based on dimension and shape (Heinemann *et al*, 1996). Their machine vision system consisted of a lighting chamber, camera, sorting unit and a personal computer for image processing and equipment control. For system testing 9.1 kg of pre-graded potatoes in three steps were graded. Precision of this work by speed of three tubers in one minute was 80%, 77% and 88% respectively. In fixed state, the sorting precision was 98%, 97% and 97% respectively. Potato consumption in any form as seed, using for human food, feeding animals or processing operations as chips, conserve operation and so on, are dependant to special conditions which must prepare before those operations. The objective of sorting is preparation of these conditions. By sorting we can grade crops based on size, shape, colour, ripeness, damaging etc. The sorting operation by hand is time-consuming and its efficiency is low and sometimes its cost is high. Mechanical grading can increase the sorting efficiency and the need for workers is decreased. In this method the time and cost is saved. In most applications the solar energy in DC mode is used for various applications. Study was conducted on Solar PV powered cooling system for potato storage (Eltawil and Samuel, 2007). In view of this a study was conducted on utilization of solar energy for operation of a fruit-cum-vegetable grader for grading of fruits and vegetables.

MATERIALS AND METHODS

Energy source: A solar PV panel consisting of 4 solar modules each of 100 W (18 V open circuit voltage) was used (Fig. 1). These modules were connected in parallel to give desired voltage and the current. With this system a total of 12 V, 15 A and 400 W direct current (DC) power was available. A Pulse Width Modulation (PWM) type solar charge controller of 12 V and 40 A capacity was used to supply the controlled DC power of Solar panels to the battery and finally to the grader.

Vegetable-cum-fruit grader: The machine consists of two fixed belt made of canvas (Fig. 1). On these belts plastic pipes are placed at desired spacing. The spacing of upper and lower belts was 4.5 cm and 3 cm respectively. These belts are supported

Fig. 1: Solar panels with fruit-cum-vegetable grader

and driven with steel rollers. A 12 V 150 W DC motor was used to drive the reduction gear in 1:19.5 ratio. The power from the gear was given to belts. With the help of the reduction gear the rpm of the belt was reduced to 14 rpm for smooth grading operation. The speed of belt was 7.8 m/min. The belts move in same direction and at same speed. Depending upon the requirement of size of the material to be graded the spacing of the belts can be changed. This machine is best suited for efficient grading of round shaped potato, onion and other fruits.

Four solar modules (100 W/18 V open circuit voltage each) were used to operate the system. These modules were connected in parallel to obtain 12 V at load. **The direct current (DC) power of the solar panel was supplied to the 12 V/150 W DC motor through a 12 V/ 7 Ah battery. With the operation of DC motor the machine was made operational. The machine was tested for grading of potato.** Hourly variation of voltage and current for operation of Solar powered fruit-cum-vegetable grader is shown in Fig. 2.

RESULTS AND DISCUSSION

It is seen from the Fig. 2 that the voltage and current decreased with decrease in solar intensity with time. A sample of 10 kg of potato was used for grading. The potatoes were graded in three sizes. The largest, medium and the smallest size of potato graded were 4.550 kg, 5.150 kg and 0.300 kg respectively. The time taken for grading of 10 kg potato was 1 min. The capacity of the machine was found as 600 kg/h. One person is required to work on this machine. The voltage at load (V_L) was found as 13.12 V and the load current (I_L) was found as 10 A. The machine can also be operated directly with 12 V, 7 Ah battery in the absence of availability of the solar power.

CONCLUSIONS

Based on the above study, it may be seen that the solar energy can be utilized efficiently for successful operation of a fruit and vegetable grader at a very little operational cost in a pollution free environment. It is particularly very useful for application in rural areas, where power supply is erratic/not available, for meeting out the demand of grading of fruits and vegetables. Once the initial cost of installation is met, the electricity generated by solar panels is free of cost. In a stand-alone solar power system one doesn't have to pay any utility bills.

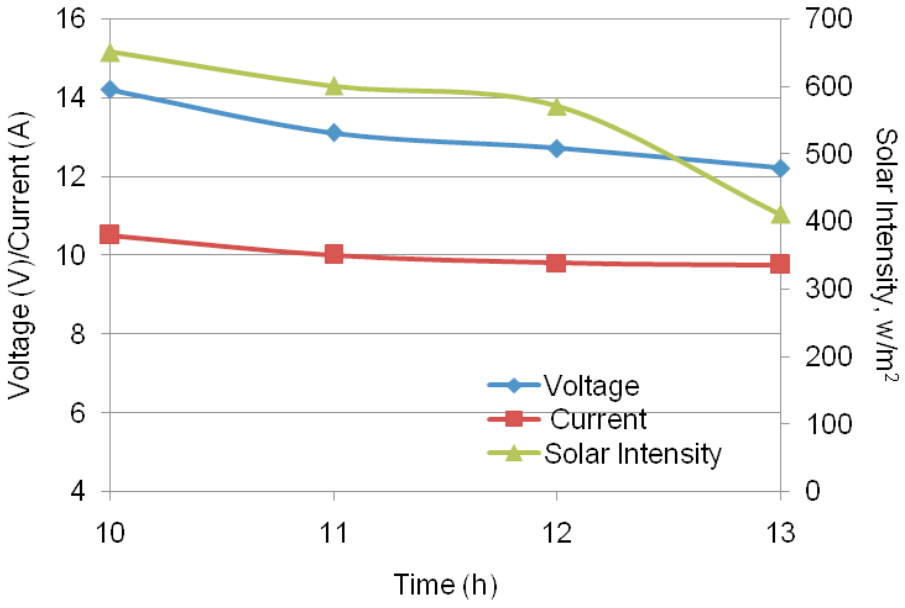

Fig. 2: Hourly variation of voltage, current and solar intensity for operation of Solar powered Fruit cum Vegetable grader

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