Design and Development of Weed Uprooting Machine

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Abstract— Weed management is one of the tedious operations in vegetable production. Because of labor costs, time and tedium, manual weeding is unfavorable. However, the emergence of herbicide-resistant weeds, environmental impact and increasing demand for chemical free foods has led to investigations of alternative methods of weed control. Most implements employing mechanical cultivation cannot perform weed control close to the crops, and existing intra-row weeders have limitations. A mechanical weeding actuation system was designed, and a prototype was constructed. This actuator was developed to mechanically control intra-row weed plants. Automated, non-chemical, intra-row weed control techniques for commercial crop production systems are an important and challenging task in industrialized countries. This study describes an intra-row mechanical weed knife path control system for transplanted row crops. These co-robots have a symbiotic relationship with a human partner, where, as a team, they combine their relative strengths to jointly perform a task. Such co-robots should be relatively inexpensive and easy to use. In this work, mechanical weed control was achieved by a co-robot actuator that automatically positioned a pair of miniature hoes into the intra-row zone between crop plants. Whatever the different problems faces such as lot of labor costs, chemical problem & food poisons hence, the mechanical weeding actuator consisted of a Mechanical linkage. One of the major challenges in this project was to properly design the actuator and its weeding mechanism for effective intra-row weeds.

Keywords: Weed Uprooting Machine

I. INTRODUCTION

India's diverse climate ensures availability of all varieties of fresh fruits & vegetables. It ranks second in fruits and vegetables production in the world, after China. As per National Horticulture Database published by National Horticulture Board, during 2015-16, India produced 90.2 million metric tonnes of fruits and 169.1 million metric tonnes of vegetables. The area under cultivation of fruits stood at 6.3 million hectares while vegetables were cultivated at 10.1 million hectares.

India is the largest producer of ginger and okra amongst vegetables and ranks second in production of potatoes, onions, cauliflowers, brinjal, Cabbages, etc. Amongst fruits, the country ranks first in production of Bananas, Papayas and Mangoes (including mangos trees and guavas).The vast production base offers India tremendous opportunities for export. During 2017-18, India exported fruits and vegetables worth USD Millions which comprised of fruits worth USD Millions and vegetables worth.

Mangoes, Walnuts, Grapes, Bananas, Pomegranates account for larger portion of fruits exported from the country while Onions, Okra, Bitter Gourd, Green Chilies, Mushrooms and Potatoes contribute largely to the vegetable export basket. The major destinations for Indian fruits and vegetables are UAE, Sri Lanka, Netherland, Bangladesh, Malaysia, Nepal, UK, Saudi Arabia and Qatar. Though India's share in the global market is still nearly 1% only, there is increasing acceptance of horticulture produce from the country.

This has occurred due to concurrent developments in the areas of state-of-the- art cold chain infrastructure and quality assurance measures. Apart from large investment pumped in by the private sector, public sector has also taken initiatives and with apeda's assistance several Centers for Perishable Cargoes and integrated post-harvest handling facilities have been set up in the country. Capacity building initiatives at the farmers, processors and exporters' levels has also contributed towards this effort.

The earliest and the simplest weed control method is manual weed control. This method was and is accomplished by a person bending down and using their hands to pull weeds out of the soil. This method then advanced to hand tools, from using a stick to using a hand-hoe. The labor required for weeding is expensive, time consuming and difficult to organize. Furthermore, problems such as back pain due to frequent repetitive bending caused manual weed control to be avoided. In areas such as India, hoe weeding and hand weeding was banned due to permanent back damage in workers.

Before the existence of chemical weed control, mechanical weed control was the best option to solve issues related to manual weeding. In mechanized agriculture, there were times where weeding tools were pulled by draft animals such as buffaloes and horses, which now in the developed world have generally been replaced by tractors. There are various types of mechanical weeding implements in the market that use three 3 main techniques: burying weeds, cutting weeds and uprooting weeds. The burial of weeds through the action of tillage tools, and is usually done during land preparation. For cutting and uprooting weeds, there are two types of machinery available: inter-row weeders and intra-row weeders. Inter-row weeding is a weeding method that accomplishes between-planting row weeding, while intra-row does within-planting-row weeding. Mechanical inter-row weeders such as inter-row cultivators, rotary cultivators and basket weeders are available in the market. Inter- row cultivators and rotary cultivators are agriculture implements that consist of suspended cutting blades that perform weed control action. The basket weeder is an implement consisting several rolling rectangular-shaped wires, forming a round basket. The efficacy of the weeding operation often depends on factors such as plant height, rooting depth and forward speed. More aggressive operations, generally result in higher weed control efficacy, but often increase the risk of damaging crop plants. In modern agricultural systems, chemical-based weed control is widely used. The implementation of conservation tillage practices to promote soil quality, to minimize soil erosion, or to simplify crop management has increased reliance on herbicides. The appearance of herbicides in the mid-20th century contributed to a decreased reliance on mechanical weeders. Automation

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should be the next step ahead for the rotating tine concept since it has produced very good weed control efficacy. In addition, automation can help reduce issues such as labor, human intervention and time consumption associated with manual weed control. Current automated weeding machines have not employed electrical power for the rotating tine weeding mechanism. Electronic control could provide more precise and reliable response with low maintenance.

The research documented in this thesis investigated intra-row weeding using a rotating tine weeding mechanism that was powered electrically. Different parameters that could affect weed control efficacy were studied. This research will be useful for researchers that would like to further investigate automated intra-row weed control. Vegetable growers can use the information in this thesis to identify the correct settings for intra-row weed control, specifically when using rotating tines mechanisms for weed removal. Agricultural machine manufacturers can also benefit from the research to produce better.

A. Objective

According to the different problems and information we get during our visit, we should come to know about actual field requirements, the specifications or characteristics and some other different parameters which we have to consider during design and manufacturing of our project. On this basis we have selected our objectives to create an efficient machine in agricultural sector. The "Design and Development of Weed Uprooting Machine" intra-row mechanical weeding in vegetable crop production should satisfy the following objectives:

1) To optimize cost.
2) Efficient weed cutting.
3) Small scale farmers can't afford big setups hence we can design small setup, so that farmer can afford it.
4) Manual setup is able to cover distance up to 2 feet on

1) Different Types of Weed Cutte

There are several methods that can be used for weed control. Manual weed control is a method using bare hands or handheld tools to uproot weeds, while mechanical weed control involve the use of machines to perform weed control. Chemical weeding uses herbicides to control weeds, and biological weed control applies other organisms for weed control.

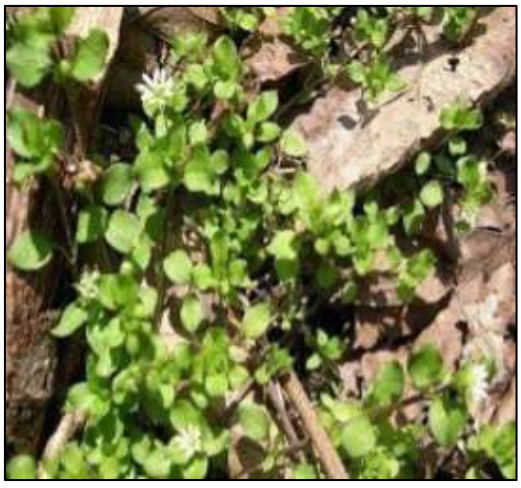

Fig. 1: common chick weed

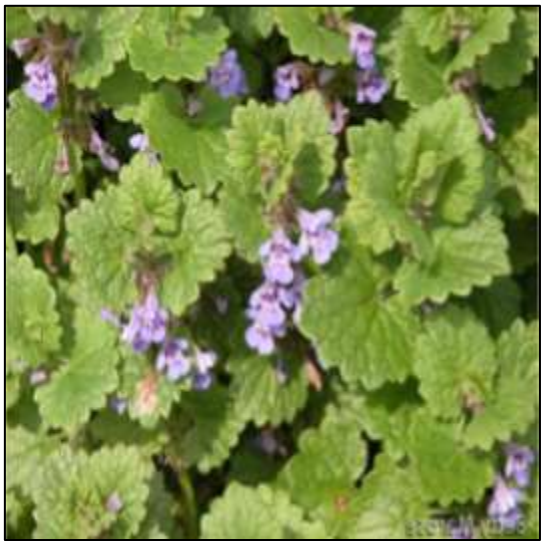

Fig. 2: common spurge

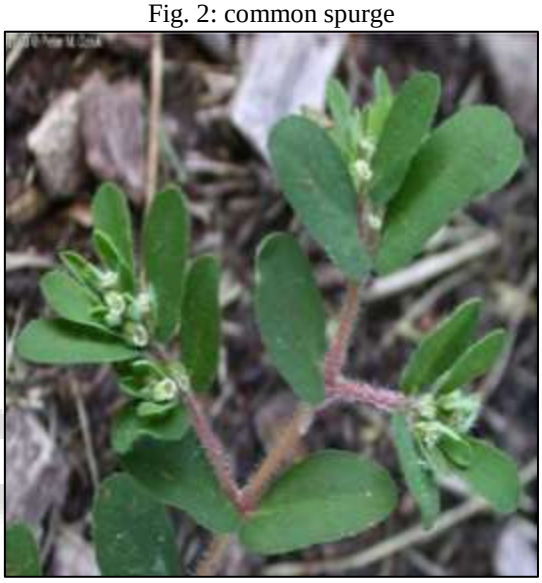

Fig. 3: carpet weed

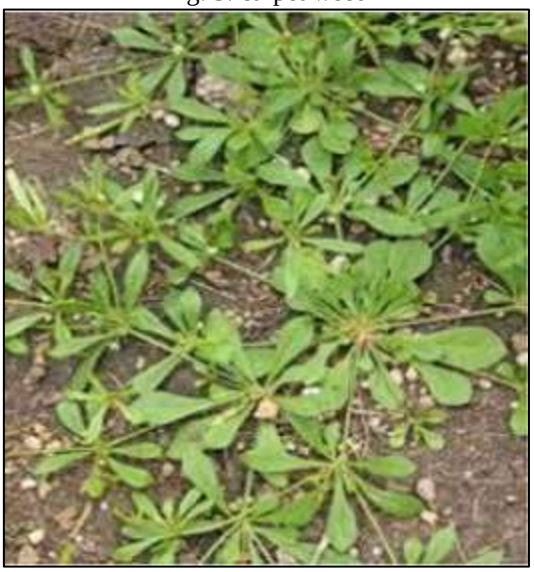

Fig. 4: ground lvy

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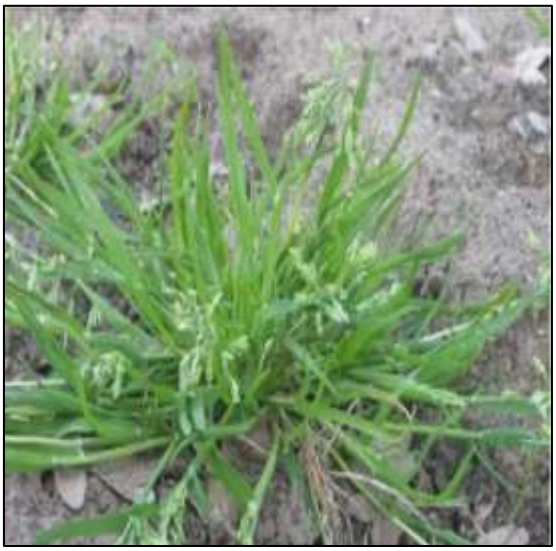

Fig. 5: Annual blue grass

Fig. 6: crab grass

2) Manual Weed Control:

The earliest and the simplest of all technologies was manual weed control. Manualweed control started with farmers using their hands to uproot the weeds. The technology then advanced to hand tools, from using a stick to using a hand-hoe. Manual weeding using human hands, provides a very effective weed control, but requires substantial human effort and energy. 12 hours per hectare, and onions required the highest time for hand weeding operation, 158 hours per hectare. A cause for this low weeding rate for onions compared to other crops like asparagus was that onions have a smaller crop canopy, which allows more sunlight to penetrate onto the soil, thus creating a higher probability for emergence weeds. Weed Science Society of America (WSSA) and American Farm Bureau Federation (AFBF). Slaughter indicated that hand weeding eliminated production, mainly due to workers mistaking weeds for crop plants or missing weeds. It was also reported that manual weeding using long-handled hoes would damage the crops while also missing some of the weeds. Hoeing is also time-consuming and can lead to back injuries to workers. Earlier in India, manual hoes were used primarily for weeding most vegetable crops. Farm workers complained of suffering permanent back injury due to extended periods of hoe weeding. As a result, in 1975, hoe weeding was banned by the India. Industrial Safety Board. The ban was then extended to hand weeding in 2004, by the India Occupational Safety and Health Standards Board because of concerns for farm laborer health. Nevertheless, organic crop growers were exempted from this ban because hand weeding is one of few weed control options available to them in the context of their chemical-free practices.

3) Mechanical Weeding:

As agriculture became more mechanized, weeding tools were developed that were pulled by draft animals such as buffaloes and horses. As time progressed, these implements evolved and were adapted to tractors as the source of draft. There are many of mechanical weeders in the market that can use three main physical techniques for controlling weed: (1) burying weeds, (2) cutting weeds and (3) uprooting weeds. Burial of weeds is accomplished through the action of tillage tools and is usually done during land preparation when soil conditions are enhanced through tillage. The goals of tillage include reducing the soil strength, covering plant residue, rearranging aggregates and also removing weeds. Cutting and uprooting weeds are performed by mechanical tearing and breaking the weeds from the soil, and is usually done by mechanical cultivation after the crop is planted and has emerged. The majority of the manufacturers who sell mechanical weeders, produce weeders that are designed to control weeds between rows, or in the inter-row. There are only a few machines that are designed to do within crop row weeding, or intra-row weeding.

4) Mechanical Inter-row Weeding:

This type of weed control is generally widespread and used by farmers who do not use herbicides. The objective of inter-row cultivation is to cultivate as much of the inter row area as possible without damaging the crop. Cultivation can destroy weeds by completely or partially burying weeds, uprooting and breaking the weed root contact with the soil. However, there are limitations using this method. Weed control can only be done during the early crop stages because limited tractor and cultivator ground clearance and machine-plant contact may potentially damage the crop foliage at later growth stages. However, in spite of these limitations, there is a wide selection of cultivation implements that can be used for mechanical inter-row weeding. Inter- row cultivators are the most common machine used for mechanical weed control. This agriculture implement consists of cultivating tools mounted on a toolbar that either rotate or sweep to move soil, bury, cut or uproot the weeds (Fig. 2.1). The sweeping type cultivators use triangular-shaped or duck foot-shaped blades that are swept under the soil but near the soil surface. The blades vary in width, from as small as 5.1 cm (2 in.) to as large as 71.1 cm (28 in.). This type of cultivator does not require any PTO power. Recommended travel speeds for sweep type cultivators are 6.4 km/h to 11.3 km/h. Another type of cultivators are rotating type cultivators such as rotary tilling cultivators and rotary tillers, which are commonly used for inter-row weed control. However, the latter machine is more expensive, since it has been designed for multiple functions.

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Fig. 7: Inter-row rotary cultivator for inter-row weed control

II. LITERATURE REVIEW

1) G.selvakumar, .dhanasekar, stated in this paper that "Design and Fabrication of Manually Operated Double Wheel Weeder", Weed control is the one of the most important problem that will reduce the farmer interest to continue cultivation. The aim of the work is to construct and develop the powered weed to provide the best opportunity for the crop (groundnut and tomato at initial level) to establish itself after planting and to grow vigorously up to the time of harvesting. The weeder driven by man to move in forward direction and the blade is attached at rear end is placed at the roots of weeds, once wheel get rotated then the blade starts cutting the weeds and once the operation is completed the weeder is shifted next row, like this the complete land of cultivation is made as weed free. Main advantage is reducing labor cost by reducing the number of labors, less time consumption. The operation is made to be simple that even any can handle, by handling it without any stress. [1]
2) S. Annadurai et al. said that, to propose a weed detecting robotic model for sugarcane fields that uses a fuzzy real time classifier on leaf textures. The differentiation between weed and crop and weed removal are the two challenging tasks for the farmers especially in the Indian sugarcane cultivation scenario. The automatic weed detection and removal becomes a vital task for improving the cost effectiveness and efficiency of the agricultural processes. The detection of weeds by the robotic model employs a Raspberry Pi based control system placed in a moving vehicle. An automated image classification system has been designed which extracts leaf textures and employs a fuzzy real-time classification technique. Morphological operators are applied to extract circular leaf patterns in different scales from the leaf images. An optimal set of features have been identified for the characterization of crops and weeds in sugarcane fields. A weed detecting robotic prototype is designed and developed using a Raspberry Pi micro controller and suitable input output subsystems such as cameras, small light sources and motors with power systems. The prototype‟s control incorporates the weed detection mechanism using a Raspbian operating system support and python programming. [2]
3) D.C. Slaughter et al. said that, intra-row weed control techniques for commercial crop production systems are an important and challenging task in industrialized countries. This study describes a fully automatic intra-row mechanical weed knife path control system for transplanted row crops. A real-time kinematics (RTK) global positioning system (GPS) was used to automatically detect crop planting geopositions and to control the path of a pair of intra-row weed knives travelling between crop plants along row centerline. RTK-GPS was utilized for auto guidance in seedbed preparation, and with automatic on-the-fly tomato geoposition mapping during transplanting. Trials in a Californian processing tomato field demonstrated that the intra-row weed knives successfully circumvented all 682 tomato plants in the study with no crop fatalities in trials conducted at continuous forward travel speeds of 0.8 and 1.6 km/h. Field trial results showed that the GPS-based control system had a mean error of 0.8 cm in centering the actual uncultivated close-to-crop zone about the tomato main stems with standard deviations of 1.75 and 3.28 cm when travelling at speeds of 0.8 and 1.6 km/h, respectively. Maintenance of the size of the operator's selected closet- crop zone size was within ±0.5 cm of the target size on average with a standard deviation of 0.94 cm at 0.8 km/h and 1.39 cm at 1.6 km/h. These results demonstrate the feasibility of using RTK-GPS to automatically control a the path of mechanical weed knives operating in the intra-row zone between crop plants for automatic mechanical intra-row weed control in sustainable row crop production systems.[3]
4) David C. Slaughter et al. said that, this work describes the development and in-field assessment of an automatic intra-row, hoe-based weeding co-robot system with real-time pneumatic hoe actuation based on an accurate odometry sensing technique. The US National Science Foundation has identified a need for robots (called co-robots) that serve as co-workers and work beside, or cooperatively with, people. These co-robots have a symbiotic relationship with a human partner, where, as a team, they combine their relative strengths to jointly perform a task. Such co- robots should be relatively inexpensive and easy to use. In this work, mechanical weed control was achieved by a co-robot actuator that automatically positioned a pair of miniature hoes into the intra-row zone between crop plants. The design was tested in a precision transplanted row crop and may also be suitable for direct seeded row crops. Corobot cost was minimized by limiting the system to a single, simple

A. Future scope

1) Study on the most suitable tine design for achieving the best weed control efficacy.
2) Study the performance of the prototype with actual soil conditions used in vegetable farms.
3) Study the performance of the prototype after integrating with a mechanical linkage Cam and Follower system for weed-crop cutting.

B. Advantages

1) Soft handling of the material.
2) cost is less than other devices available in market.
3) Any type of material can be handle easily.
4) Manpower requirement is minimum.

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5) This system is safe and clean in use.

III. CONCLUSION

From these project we have conclude that whatever the different problems: Given below can be solved- Our goal is to build a system which is efficient to perform a various applications with the help of Weed Uprooting Machine. With the scope of improvement, the project we are doing to fulfil the demands of agricultural applications. The main objective of our project was to fulfil the need of farmers suffering from the problems of increasing cost of chemical Fertilizar, labour cost and availability as it is operated by single person. With this Weed Uprooting machine we are trying percentage reduction in time required for Weed cutting and reduction in labour cost as compared to conventional method. Also we should manufacture it in such way to reduce the initial cost of the machine.

- The labor required for weeding is expensive, time consuming and difficult that's way we should try to manual.
- However environmental impact and increasing demand for chemical free foods has led to investigations of alternative methods of weed control.
- Whatever the different problems faces such as lot of labor costs, chemical problem & food poisons hence, the mechanical weeding actuator consisted of a Cam-Follower system

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