



REVIEW PAPER ON CROP HARVESTING MACHINE

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Abstract — Mechanical cotton cutters, i.e. strippers and pickers are commercially available, but these cannot be used for cotton harvesting from varieties presently grown in India due to design constraints and ergonomic practices. Higher initial cost and field capacity make cotton harvesters unsuitable and unaffordable for small and medium farms. Hence, a comprehensive review of cotton harvesting mechanisms developed till date was carried out. The mechanical cotton picker is a machine that automates cotton harvesting in a way that reduces harvest time and maximizes efficiency. To develop a mechanical cotton picker with the intent on replacing manual worker. The first pickers were only capable of harvesting one row of cotton at a time, but were still able to replace up to forty hand laborers.

Developed agriculture needs to find new ways to improve efficiency for uprooting the cotton crops. One approach is to utilize available information technologies in the form of more intelligent machines to reduce and goal energy inputs in more active ways than in the past. Precision Farming has shown benefits of this approach but we can now move towards a new generation of equipment. The introduction of autonomous system architectures gives us the opportunity to develop a complete new range of agricultural equipment based on small smart machines that can do the right device, in the right place, at the right time in the right way.

Keywords- robots, autonomous, mechanisation, robotic weeding, Phytotechnology Armature

I. INTRODUCTION

A Past Experience: This section highlights the present state of agricultural farm machinery and equipment and land holding which determine agricultural productivity and production.

1) Agricultural Farm Machinery and Equipment: Manual worker takes time and is not effective as they can work for 3-4 hours at a stretch. Even if the land holding is small, it takes two or three days to completely harvest the cotton crop. Also the planting is not done with proper care. Hence the crops are spread with a lot of non-required plants, which grow with the cotton. So to harvest these unwanted crops along with the cotton is a tedious work. Traditional method of cotton harvesting is by manually.

The new thinking of robotic agriculture (agricultural atmospheres serviced by smart machines) is not a new one. Many engineers have developed driverless tractors in the past but they have not been effective as they did not Have the Ability to embrace the difficulty of the real world. Most of them assumed an industrial style of farming where everything was known before hand and the machines could work entirely in already given ways – considerable like a production line. The approach is now to develop smarter machines that are intelligent enough to work in an unmodified or semi natural atmosphere. These machines do not have to be intellectual in the way we see people as intelligent but must exhibit sensible performance in recognised contexts. In this way they should have enough intelligence fixed within them to behave sensibly for long periods of time, unattended, in a semi-natural atmosphere, whilst carrying out a useful task. One way of understanding the difficulty has been to identify what persons do in certain situations and decompose the actions into machine control. This is called behavioural robotics and a draft method for applying this approach to agriculture is given in Blackmore et. al. (2004b).

The method of treating crop and soil selectively according to their needs by small autonomous machines is the natural next step in the development of Precision Farming (PF) as it reduces the field scale right down to the single plant or Phytotechnology (Shibusawa 1996). One simple definition of PF is doing the right thing in the right place at the right time with the right quantity. This definition not only applies to robotic agriculture (RA) and Phytotechnology but it also implies a level of automation inherent in the machines.

Recent agriculture uses a lot of energy. It comes in many forms from fertilizers and chemicals to tractors and fuel. The Phytotechnology approach tries to target the introduced energy to improve efficiency. Chamen (1994) identified that a 75% energy saving can be made in cultivation energy by moving from traditional trafficked systems (255 MJ/ha) to a non-trafficked system (80 MJ/ha). This was for shallow ploughing and did not include any deep slackening. From this we estimate that 80-90% of the energy going into traditional farming is there to repair the injury done by large tractors. It would be much better to not cause compaction in the first place which is one of the reasons that leads us to consider using small light machines. Most of the current machinery is very climate dependant. Tractors cannot drive on soil when it is wet, sprayers cannot work in high winds etc. Perhaps it will be possible to develop lesser, less intrusive machinery that

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can allow more tasks to be carried out in marginal circumstances. An example might be an autonomous seeder that could function well, while the earth is still wet in the springtime, provided that the soil engagement mechanism is suitable arranged. This would permit the seeds to be planted when optimal for the crop and not be limited by the soil's capability to support the tractor. Safety is another significant factor. Any self-directed vehicle is going to go wrong at some time and the chance of catastrophic failure should be minimised within the design process. A small light vehicle is by default safer than a large one. Redundant, selfchecking systems should be built into the system architecture to permit graceful degradation. The vehicle should be in continual communication with the base station, giving data about present conditions and contexts. Many of the design parameters are discussed in (Blackmore et al. 2004a) this approach may not be economically acceptable in many broad acre crops but will certainly be more attractive in high value crops where a smart machine can replace expensive repetitive labour. If this approach were taken, it would look that the crop production cycle could be reduced to three stages: Seeding, Plant care and (selective) harvesting.

II. Literature Review

Christopher Molica's [1] project was completed by the students of Worcester Polytechnic Institute. They have formed a small scale harvester which was joined reaper and binder. This machine was established concerned to the small scale grain growers.

Yuming Guo's [2] paper explains the relation between the stalk strength and the cutting force that is required for cutting the soybean. The paper was supportive in guiding on the calculations front. Defines the strength of various crops and compares it with the soybean. This relationship helps in giving a rough idea about the cutting speed required to cut the cotton or Pigeon pea crop.

N. S. L. Srivastava [3] checked in the interests of the farmers and the difficulties they face while harvesting and keeping the agriculture field. This paper was an in depth study of the farming conditions of the farmers and their basic problems.

Indian Government Analysis [4] was the survey finished by Indian Government in the financial year of 2015-16. This survey was intended to analyse and gather the data related to the problems and problems faced by the Indian farmers.

Asia and Pacific Commission on Agricultural Statistics 23rd Session Siem Reap, Cambodia, 2630 April 2010 [5] was intended to discuss the features of small scale farmers across Asia. This commission recognizes the problems faced the average land holdings and the average income of the small scale farmers.

S. S. Kohli [6] in 2015 describes Mechanical cotton cutting tools or harvesters, i.e. strippers are commercially available, but these cannot be used for cotton harvesting from varieties presently grown in India due to design constraints and ergonomic practices. Higher initial cost and field capacity make cotton cutting tools or harvesters unsuitable and unaffordable for small & medium farms. Hence, a comprehensive review of cotton harvesting mechanisms developed is carried out.

III. Problem Statement:-

Recently observed that there is shortage of skilled labor available for agriculture. Because of this shortage the farmers have transitioned to using harvesters. These harvesters are available for buying but because of their high costs, they are not affordable. However, agriculture groups make these available for rent on an hourly basis. But the small holding farm owners generally do not require the full-featured combine harvesters. Also, these combine cutters (Harvesters) are not available in all parts of rural due to financial or transportation reasons. Thus, there is a need for a smaller and effective combine harvester which would be more accessible and also considerably cheaper. The mission is to create a portable, user-friendly and low cost small harvester. These problems gave the basic idea about what was required in the current situation. The idea was to create a machine which is cheap and will reduce the labour required to harvest crops. This machine has the ability and the economic value for fulfilling the needs of farmers having small land holdings (less than 2 acres). This machine is cost effective and easy to maintain and repair for the farmers.

IV. Methodology

With the demand for the grains on rise, the aim was to fabricate inexpensive reaper collector for increasing the economy of small scale farmers. For the fulfilment of this aim, it is decided to follow following steps:

1. Discussion with the local farmers who have small scale land holding and enquire about the harvesting practices and the crops produced and emerging trends in crop harvesting.
2. Talk with agricultural equipment manufacturers to get information about various equipments that are available and are in demand.
3. Refer various international papers in small scale harvesters produced earlier.
4. Design of reaper collector harvester.

A. Conducting Interviews with Farmers: The design of this device was to be based on the demand for a compact and affordable harvester. This demand could have been seen only with personal interaction with small scale farmers. Most of the farms are small scale farms. The purpose of this visit was to see and enquire about the harvesting machines that are being used by the farmers. The following queries were asked to the farmers:

- [1] What are the machines available for harvesting?
- [2] What do these machines cost?
- [3] Are these machines feasible for small scale farms?
- [4] What are the traditional techniques used for harvesting?
- [5] Can a small harvester collector be able to satisfy the increasing prices of labour?
- [6] What is the labour cost for harvesting, as it is the most labour intensive work?

These questions gave the basic thinking about the situation of small scale farmers. We came to know the needs and the requirements of the farmers.

B. Consulting Agricultural Machines Manufacturer: I Visited the Agro shop about the manufacturability for the harvester. Padgilwar Agro shopd have been providing agricultural equipments. I interrogated them about to get the basic thinking about the manufacturing Instruments that are available. The following questions were asked to get a generalised idea about the various types of manufacturing equipment.

- [1] What are the Instruments manufactured for the farmers today?
- [2] How many No. of these manufactured equipments are available for small scale farmers?
- [3] Why are there no small scale harvester collector manufactured for farmers?
- [4] Why does the company ask local farmers while designing a new product?
- [5] What difficulties are faced while designing a machine based on the needs of the farmers? All these questions were noted and notes were collected for further study.

V. Establishment (Terms in Farming)

5.1 Seed bed preparation

Cultivating is one of the most important primary cultivation processes and has been carried out since the start of civilization. It is effectively the inversion or mixing of topsoil to make a suitable seed bed. It also has the ability to bury surface crop residues and control weeds. A small robot utilising current technology does not have the energy density to sustain cultivating over a large area due to the high levels of energy needed to cut and invert the dense soil. Secondly, the draft force required to plough also needs relatively high weight to give traction. Maybe we would leave it at that, but by considering what the plant, or in this case the seed actually needs, we can approach the problem in a different way. The seed requires contact with the soil moisture to allow uptake of water, it requires stability to hold the growing plant and a structure that allows the roots to develop and the shoots to grow. A answer is twofold. Firstly if we do not compact the soil in the first place there is less need for energy inputs for remedial loosening. Natural soil flora and fauna can be encouraged to handle the soil to give a good structure. This is one of the reasons to opt for smaller machines. Secondly, if the majority of the soil rooting depth is acceptable, then only the local atmosphere of the seed needs to be conditioned before seed placement, which will take a lot less power. Add to this the ability to place nutrients in the correct proximity to the seed we can improve the early phase of formation. This system has many of the advantages of direct drilling but incorporation of previous crop residues may still cause a problem although removal of crop residues is an option.

5.2 Seed mapping

Seed mapping is the concept of recording the geospatial position of each seed as it goes into the ground. It is relatively simple in practice as an RTK GPS is fitted to the seeder and sensors placed below the seed chute. As the seed drops, it cuts the infrared beam and triggers a data logger that records the position and orientation of the seeder. A simple kinematic model can then compute the actual seed position (Griepentrog et al. 2003). The seed coordinates can then be used to target subsequent plant based operations.

5.3 Seed placement

Rather than just keeping record the position of each seed it would be better to be able to control the seed position. This would allow not only allow the spatial variance of seed density to be changed but also have the capacity to alter the seeding pattern. Most seeds are dropped at high densities within each row, whilst having relatively more space between the rows. From first agronomic principles, each plant should have equal access to spatial assets of air, light, ground moisture, etc. Perhaps a hexagonal or triangular seeding pattern might be more capable in this context. If appropriate controls are fitted to allow synchronization between passes, then there is the possibility to plant seeds on a regular grid that can allow orthogonal inter-row weeding. Tests of such a machine will be carried out at KVL.

5.4 Reseeding

Reseeding is the concept of being able to recognize where a seed was not planted, or that a crop plant has not emerged and a machine can automatically place another seed in the same position. This concept could be extended to resettling a seedling instead of a seed if the surrounding plants are too far advanced. A reseeders would have the ability to insert individual seeds/plants without disturbing the surrounding yield. Conventional seeders could not then be used as they create continuous slots in the soil. A punch planter could be developed to fulfill this role, or better still adapt another

transplanter to deal with one seedling at a time. Prior local micro-cultivation could be achieved by using a targeted water jet (or gel) to pierce the soil and soften it ready for the seedling stocks. Figure 1, show a transplanter adapted to get a seeding mat. The seeding mat can also include crop nutrients. If this concept became efficient enough, it could also become the main seeder as well. Figure 1. Japanese transplanter adapted to take a seed mat, Seed mat with rice seeds and fertilizer embedded in card Rice seedlings ready for transplanting.

VI. Crop care

6.1 Crop investigation

One of the main operations within good management is the ability to collect timely and accurate information. Quantified data has tended to be expensive and sampling costs can quickly outweigh the profits of spatially variable management. (Godwin et al. 2001) Data collection would be less expensive and timelier if an automated system could remain in the crop carrying a range of sensors to assess crop health and status. A high clearance platform is needed to carry instruments above the crop canopy and utilise GPS. Smaller sub canopy machines have been developed in student competitions. Examples of both types of machines are shown in Figure 2. Figure 2. (Left) Portal crop scouting platform (Madsen and Jakobsen 2001), (Right) Sub canopy robot ISAAC2 built by a student team from Hohenheim University The portal robot shown in Figure 2, has been extensively modified and rebuilt and has been used to provide automated crop surveys (Bak and Jakobsen, 2003). A range of sensors have been fitted to measure crop nutrient status and stress (multi spectral response), visible images (pan chromatic), weed species and weed density.



FIG.1



FIG.2

6.2 Weed mapping

Weed mapping is process of recording the position and preferably the density (biomass) of different weed species using aspects of machine vision. One method is to just record the increased leaf area found in weedy areas as weeds are irregular and the crops are planted in rows (Pedersen 2001). Another more accurate method is to use active shape recognition, originally developed to recognise human faces, to classify weed class by the shape of their outline (Søgaard and Heisel 2002). Current research has shown that up to 19 species can be recognised in this way. Colour segmentation has also shown to be helpful in weed recognition (Tang et al. 2000). The final result is a weed map that can be further interpreted into a treatment map.

6.3 Robotic weeding

Knowing the position and severity of the weeds there are various methods that can kill, remove or retard these unwanted plants (Nørremark and Griepentrog 2004) Different physical methods can be used that rely on physical interaction with the weeds. A typical example is to break the soil and root interface by tillage and promote wilting of the weed plants. This can be reached in the inter row area easily by using classical spring or duck foot tines. Intra row weeding is more difficult as it requires the position of the crop plant to be known so that the end effector can be steered away. Within the close-to-crop area, tillage cannot be used as any disturbance to the soil is likely to damage the interface between the crop and the soil. Non contact methods are being established such as laser treatments (Heisel 2001) and micro-spraying. Controlled biodiversity is an opportunity that could be realised with robotic weeding. Non-competitive weeds can be left to develop when they are at a distance from the crop. This is part of the project design parameters for the Autonomous Christmas Tree weeder being developed at KVL. (See Figure 3) Figure 3. (Left) The autonomous Christmas tree weeder, (Right) Young Christmas trees with patchy weeds.

6.4 Micro spraying

Within the close-to-crop area, more care must be taken not to damage the crop nor disturb the soil. One method of killing weeds close to the crop plants is to use a micro spray that delivers very minor amounts directly on to the weed leaf. Machine vision can be used to understand the position of an individual weed plant and a set of nozzles mounted close together can squirt an herbicide to control unwanted plants on to the weed. Tests have shown that splashing can be reduced when a gel is used as a carrier rather than water (Lund and Sogaard 2005). Other trials have shown that when the right cost of herbicide is placed in the right way at the right time, the usage of herbicide can be drastically reduced to about 1 gram per hectare for an infestation of 100 weeds per square meter (Graglia 2004). A micro spray system is currently under development at DIAS Bygholm, in Denmark.

6.5 Robotic irrigation

A robotic irrigator in the form of a mechatronic sprayer (to simulate a travelling rain gun) was developed to apply variable rates of water and chemigation to predefined areas. The trajectory and sector angles of the jet were measured by stepper motors and could be adjusted according the current weather and the desired pattern by a small computer. When the airborne water was blown down wind, the jet angles could be adjusted to compensate by measuring the sudden wind speed and direction (Turker et al. 1998). This system could not only apply the required water in the right place but could irrigate into field corners.

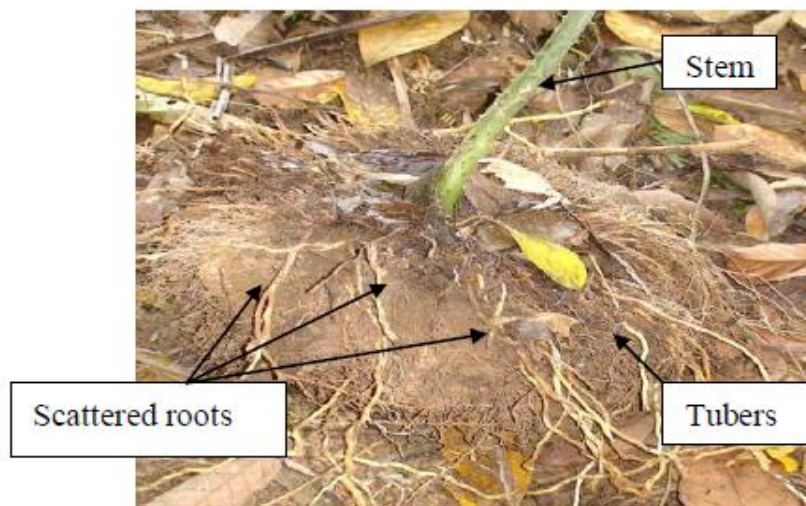
6.6 Selective harvesting

Selective harvesting covers the concept of only harvesting those parts of the crop that meet certain quality thresholds. It can be considered to be a type of pre sorting based on sensory perception. Examples are to only harvest barley under a fixed protein content or join grain that is dry enough (and leave the rest to dry out) or to select and harvest fruits and vegetables that meet a size criteria. As these conditions often attract quality premiums, improved economic returns could justify the additional sensing. To be able to carry out selective harvesting efficiently, two criteria are needed; the ability to sense the quality factor before harvest and the ability to harvest the product of interest without damaging the remaining crop. Most agricultural equipment is getting bigger and hence not matched for this approach. Smaller more versatile selective harvesting equipment is needed. Either the crop can be surveyed before harvest so that the information wanted about where the crop of interest is located, or that the harvester may have sensors mounted that can ascertain the crop condition. The selective harvester can then harvest that yield that is ready, while leaving the rest to mature, dry, or ripen etc. Alternatively, small autonomous whole crop harvesters could be used to selectively gather the entire crop from a selected area and move it to a stationary processing system that could clean, sort and maybe pack the produce. This is not a new idea, but updating a system that used stationary threshing machines from many years ago. On the other hand a stripper header could be used to only gather the cereal heads and send them for threshing.

VII.Types of New Concepts:-

By observing above robotic agriculture machines for crop harvesting are very efficient but not affordable for small farmers. A best alternative should be introduced which is cost effective also.

So I think Pneumatic operated machine is to be design & manufactured for cotton crop uprooting operation.

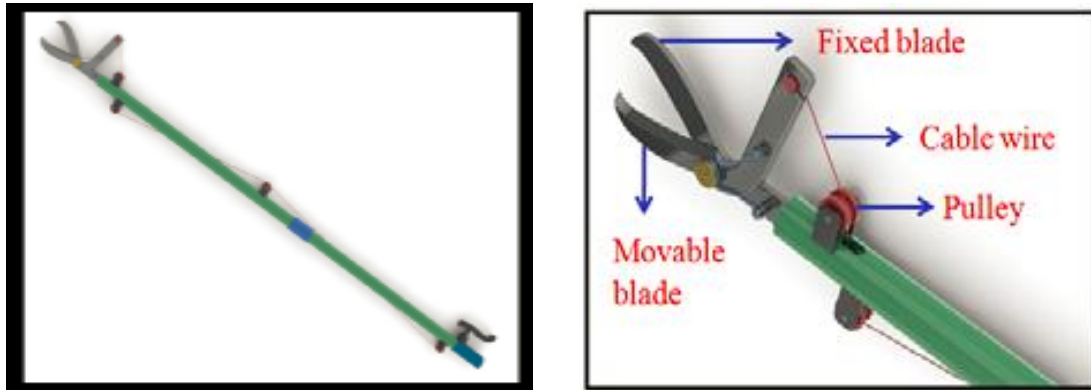


From above figure it is observed that uprooting is not that easy task by doing manually. If it is in large acres then it is very hectic. So I decided pneumatic plucking machine is to be made.

It offers required force in minimum effort & air available free of cost hence it is cheap also.

7.1 Following are the various proposed concepts are used for Precision farming:-

Concept 1:-



The main device used in this concept is pulley mechanism. While pressing the lever from the bottom, the brake cable pulls back & the upper blade moves towards to the fixed blade and does the cutting. The top portion or the cutting part of the apparatus consists of two sharp blades. The blade which is inserted into the pipe is fixed and the other one is the movable. The blade which is joined with a lever is in turn connected to a pulley by using wire. The hand lever for operating the equipment is given at the lower portion. In this concept, several small pulleys are given. This may lead to repeated damage and non functioning causing repair and maintenance.

Concept 2:-

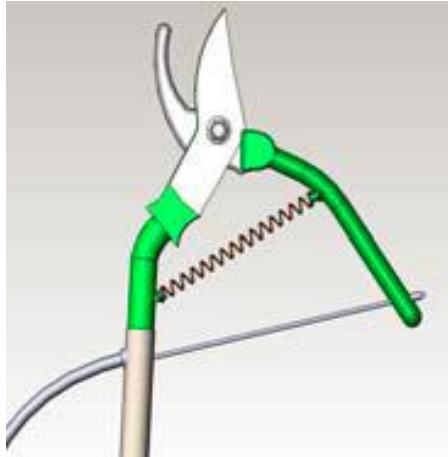


In this concept, while operating the lever down the threads gets pulled back causing the edges of the cutter to come closer. Thus the cutting of peppercorns is done. In this concept, player type working mechanism has been introduced with torsion spring. The cutting blade is made of cast iron. The sharp edges are so planned to facilitate easy holding of peppercorns. . The handle is made of aluminum. A lever is provided at the edge for easy operation. This concept seems to be simple and compact. The wires are hidden and cause no discomfort, but the positioning of the sharp edges creates inconvenience.

Concept 3:-



In this concept a cable wire is connected from the hand operating part to the cutting portion. When the hand lever is pressed, the spring gets compressed resulting in the cutting of peppercorns. It is having a simple mechanism and low technology. It is very simple to operate i.e. the braking mechanism of bicycles have been evolved. The cutting portion has been so shaped that holding of the stalk is possible with this shaped cutter. Though this mechanism is familiar no such equipment is so far designed.



Cutting Portion

This concept is based on the braking mechanism of bicycles. So it is very convenient in its application.

VIII. Conclusions

This paper has set out a vision of how aspects of harvesting, crop production could be automated in the future. Although existing manned operations can be efficient over large areas there is a potential for decreasing the scale of treatments with self-directed machines that may result in even superior efficiencies. The development process may be incremental but the overall concept requires a pattern shift in the way we think about mechanization for crop production that is based more on plant needs and novel ways of meeting them rather than modifying existing techniques.

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