Rain sensor capsule (RSC) for farmers during un-seasonal rains in post-harvesting period

Singuru Rajesh*

Department of Mechanical Engineering,
Raghu Engineering College, Dakamarri, Bhimunipatnam, Visakapatnam-531 162, Andhra Pradesh, India.
Received: 05-06-2018 Accepted: 06-05-2019 DOI: 10.18805/IJARe.A-5048

ABSTRACT
Farmers are backbone of India and they suffer many hurdles while growing crops. In post-harvesting steps, drying crops plays a major role in grain production. About 70% of the threshed grains are sun-dried in many regions. During sudden rains farmers face difficulty to cover the threshed grains and some of them die because of thunderstorm/lighting with this older methods. It necessitates to design a new system for these conditions instead of older methods. The aim of the project is to provide an innovative design for helping farmers from unseasonal rains easily. The newly modelled Rain Sensor Capsule for farmers, whose operation is compiled by the automatic rain sensor, wooden capsule, controllers and power conversion unit. The capsule is modelled in AutoCAD software package, then a prototype is fabricated and tested.

Key words: Capsule, Drying crops, Post-harvesting, Rain sensor, Threshed.

INTRODUCTION
Agriculture is an important sector of the Indian economy. India’s grain production has progressively improved due to new technology developments. The main steps in agriculture are pre-harvesting, harvesting and post-harvesting. Pre-harvesting includes preparation of soil, sowing, adding manure and fertilizers. Post-harvesting is the stage of crop production immediately after the harvest. It includes handling, sorting, cleaning, packing, cooling, drying, storing, transportation and packing Kiaya, (2014).

Rise in population, reduction of cultivable land along with grain losses are major problems in a developing country like India. The losses in post-harvest is at 10% of the total Sharo et al. (2014). Ramesh, (1999) reported that high wastage and value loss are due to lack of storage infrastructure at the farm level. All of the cereal, oilseed and pulse crops have a narrow range of moistures for optimally-low harvest losses and high crop quality Benasee et al. (2018). The losses during storage are quantity losses and quality losses. Quantity losses occur when insects, mites, rodents, micro-organisms and birds consume the grain. Quality losses occur due to infestation resulting in decreasing moisture, free fatty acid levels, decrease in pH and protein content, etc. Ipsita et al., (2013) stated that quality losses affect the economic value of the food grains by giving low selling prices to farmers. Until now, various drying methods have been used to dry grains, pulses, nuts, fruits etc. The most popular method of drying used by farmers is drying under the sun. Solar energy is considered more applicable to low-temperature in-storage drying systems, which has gained more importance in the last decade for drying grain. In tropical countries like India, a major portion of the crop is harvested under warm and humid climatic circumstances. Farmers dry their crops, grains, pulses, seeds, onions, Shiva kumar et al., (2014) etc., in their yards, on roads and in open space of their fields. Now a days it is difficult to predict the changes in climate especially during rainy season and un-seasonal rains in sunny days. In rainy season it’s very rare that we can find sun rays.

Water level on earth is about 79% and out of this 97% is sea water and rest is fresh water Rajesh et al., (2016), 3% freshwater and the rain water (monsoon climate) in Asian Countries like India will help the farmers during agriculture Rajesh et al. (2017). According to Wallace et al., (1962) rainfall is a major threat to the farmers and their fields; also it leads to infectious diseases and spoiling of grains by generation of moisture. R.V.Selvi et al., (2002) conducted experimentation to determine the effect of continuous and intermittent rains on yield by drenching of crop in dry season. Results showed that shedding and fungi infection of grains. The unseasonal rainfall impact the horticultural and agricultural crops at different stages such as flowering, fruit ripening, pre and post harvesting. Due to un-seasonal rainfall, threshed grains are soaked in rain as depicted in (Fig 1). Wallace et al., (1962) concluded that higher moisture content in grains increases the risk of degrading post-harvest quality and the grains cannot be stored easily (Fig 2). When the moisture of grains exceeds a particular level microflora and mites will multiply and the grains will get spoiled quickly. Due to this, the quality of grain is affected in such a way that farmers have to sell their stocks in market at low prices to meet urgent financial needs.

*Corresponding author’s e-mail: rajeshsinguru@gmail.com
During intermittent and unseasonal rains farmers were trying to place covers/tarp on the paddy kept in the field during post-harvesting (Fig 3), but not succeeding due to strong winds and rains. In the mean time they were struck by lightning Khatun et al., (2016). In the month of May, 2018 nearly 80 people lost their lives in five states of India due to lighting and thunderstorms in which 8-10 farmers died because of above case. This needs a new safe capsule, which continuously monitor the rain and protects drying grains, from getting wet during unseasonal rains without any human being involvement. We choose this project as it is a major problem in the many regions of India and this RSC is designed to overcome the challenge.

**MATERIALS AND METHODS**

Chaudhary et al., (2011) stated that Precision Agriculture (PA) model various techniques available to monitor and control the required environmental parameters for the particular crop by using wireless sensors to assist in data collection, irrigation, controlling rainfall information to farmers, etc. Before starting the project, a survey is conducted in different regions of India on the problems of un-seasonal rains faced by farmers while drying crops during post harvesting time. The following are the details of the survey in (Table 1 and Table 2). Different technologies are developed in this precision agricultural model. Some of them are Detection techniques of rainfall and wind direction within small regions Rao et al., (2012); Rain Sensitive Triggering System for Windshield Wiper Motor, Ucar et al. (2001); Sensor based automation based on irrigation, Lailhacar et al., (2008); Intelligent automatic door system, Badave et al.,

**Table 1:** Problem Survey-1 Unseasonal rains and hailstorms on 15th March 2015 in Bajithapur Village, Khateswar, Qutubgarht, Delhi, India.

| Farmer Name | Age | Problem faced due to un-seasonal rains | Suggestions on our RSC |
|-------------|-----|---------------------------------------|-------------------------|
| Shyam Lal   | 55  | I have just one acre. Unseasonal rain and hailstorms have destroyed my crops. | If government will give subsidy I will buy it. |
| Jagadish   | 30  | I own 14 acres of agriculture land and put Rs.25000 per acre every year. I lost everything. | This can protect drying grains |
| Bhagat Singh | 56  | This village area has around 3,500 acres of agricultural land. I have lost 1/4th of my standing crops. On the top of that, fertilizers and pesticides are getting expensive. | If it is low cost it will be fine. |

**Table 2:** Problem Survey-2 Unseasonal rains and hailstorms on November 2015 affected crops in Gopalapenta Village, Narasannapeta, Srikakulam, Andhra Pradesh, India.

| Farmer Name | Age | Problem faced due to un-seasonal rains | Suggestions on our RSC |
|-------------|-----|---------------------------------------|-------------------------|
| B. Eeswar Rao | 47  | Each bag of wet grains have to be sold at a loss in market | This loss on crop money can be compensated by providing rain protecting system by the Government |
| R. Prabhakar | 45  | It was becoming difficult to protect my threshed grains during these rains | Device can improve productivity |
| S. Chakrapani Swamy | 50  | Many insects will attack on wet grains during storage | Bring it into product, it will help us a lot |
The proposed methodology involved in this project is integrated and optimized from advanced technologies. RSC consists of a capsule, boosted with rain sensor to detect change in climate, which will help farmers in protecting threshed grains against un-conditional rain challenges. The capsule opens and closes based on rain sensor connected to Microcontroller which is linked with DC motor to which a pinion gear, of a rack and pinion mechanism, is mounted. The block diagram (Fig 4) displays the operation.

MODELLING OF RAIN SENSORED CAPSULE

Initially we listed different types of design attributes required for capsule. By analysing the attributes we developed new models of RSC to solve farmer’s problems during sudden and un-seasonal rains, out of which the capsule main frame is a fixed frame (Fig 5(a)). Two new designs of the closing mechanism of the capsule are developed in AutoCAD software package. These are as follows.

1. Capsule with sliding doors (Fig 5(b))
2. Capsule with rolling sheets (Fig 5(c))

Dimension and specifications of capsule main frame in (Table 3)

MATERIALS AND MANUFACTURING METHOD

The Rain Sensor Capsule (RSC) mainly comprises capsule, rack and pinion mechanism, rain sensor, DC motor and microcontroller with power conversion circuit.

![Farmers covering grains with tarp during sudden and unseasonal rain (Source: google images).](image)

![Block Diagram of RSC.](image)

![Dimensions and specifications of capsule main frame.](image)

![Fig 5: (a) Capsule main frame; 5(b) Capsule with sliding doors; 5(c) Capsule with rolling sheet.](image)
Capsule: Country wood is used in fabricating capsule frame. Country wood has good strength properties and easy workability. Despite its widespread cultivation on plantations countrywide, it is less expensive.

Closing shutter mechanism: Rack and Pinion gears are used in this mechanism to convert rotational motion to linear motion. The flat toothed part is the rack and the gear is the pinion (Fig 6). The rack has teeth cut into it and they mesh with the teeth of the pinion gear. Rack and pinion gears provide a less mechanical advantage than other mechanisms, but greater feedback and steering sensation, which is important for us. As the gear turns, it slides the rack either to the right or left, depending on which way the wheel is turned.

Rain sensor: A rain sensor is a switching device activated by rainfall. The device is connected to a microcontroller that causes the system to shut down the doors of capsule in the event of rainfall. The rain is detected by detecting the change in resistance of the sensor Joshi et al., (2013).

DC motor: A DC motor (Fig 6) is designed to run on DC electric power that converts electrical energy into mechanical energy. A DC motor’s speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings.

The modelling designs of rain sensor capsules are to be fabricated as per the dimensions. The fabrication of Rain sensor capsule include manufacture of the following:

Wooden capsule (Fig 7): The country wood of dimensions (1.5m X 0.3m) for the outer frame of the capsule and the thickness of wood frame is 0.06m. Plywood Sheet of 0.06m thickness and 0.9m² (1.5m X 0.6m) area fixed at the back of frame. A guide way of 0.06 m on the side of the wooden piece for rack and pinion sliding over wooden capsule (1.5m X 0.6m X 0.3m).

Rack & pinion attachment: Rack gear of length 0.06 m is attached on both inner upper sides of length of the capsule. Pinion is aligned with motor for moving to and fro of the shutter. Wooden plank of length 1.5m & breadth 0.6m is taken as shutter for closing upper surface. Shutter is attached with flat rack gear for forward and backward movement when it aligned with pinion.

DC motor & rain sensor: A DC motor of 10 rpm is placed at side of the capsule which is aligned to a pinion gear. Rain sensor of micro controller is kept open to sense the rain and give signals to the input module.

Circuit connection: The components were and once the connections are fixed then to the circuit plate connection...
RESULTS AND DISCUSSION

Entire RSC set up is tested in an artificial intermittent rain surrounding. In this project, the RSC is boosted with the use of rain sensor to detect change in climate. During the test whenever the rain droplets falls, the sensor will be shorted and this sensor is the input to the Microcontroller (Fig 7), used for required operation (opening and closing of door). It is operated by AC power supply and this AC is converted into DC for which the voltage must be stepped down. So, this work is done by the power supply unit. The sensing system consists of a microcontroller based circuit fixed on the capsule which is linked to a DC Motor on which a pinion gear, of a rack and pinion mechanism, is mounted. The outputs of the microcontroller are the relays and the motor which works based on the contacts of the relays, then the motor will rotate in clockwise and anticlockwise to shut and open capsule door with the help of rack and pinion mechanism. When rain sensor detects rain, the motor will rotate clockwise and the door will be pulled in, to protect grains. When the rain stops, the motor rotates anti-clockwise and the door will open. The capsule, which opens and closes based on rain sensor is made of wood and supported with iron frame; light in weight and easy to operate by Indian farmers. Farmers are safe from the struck death of sudden thunderstorm / lightening while they are closing with tarps and plastic covers in the fields over threshed grains.

CONCLUSION

This paper entitled Rain Sensor Capsule (RSC) for Farmers is a step towards assisting farmers in protecting grains, crops from unseasonal rains and thunderstorm. The post harvesting losses strategy should be better integrated with technical line-up to provide advices and affordable solutions to farmers. It benefits to consumers from reducing post harvesting losses include lower prices and food security. The modelling designs of Rain Sensor Capsule (RSC) for Farmers are fabricated as per the dimensions. Rain sensor installed and checked with the perfect running of sliding mechanism. As a future scope these model can be used in the bigger way at Green houses for shade net movement, house hold purposes, North-Eastern states of India and at frequently thunderstorm occurring areas.

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