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DEVELOPMENT OF TRACTOR DRAWN ELECTRONIC MULTI-CROP PLANTER CUM FERTILIZER APPLICATOR FOR PRECISION FARMING

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ABSTRACT: ***Electronic planter work with a sensor based battery operated metering system, which adds precision to the work. The sensor system in the machine helps in proper metering of the seeds and thus further reduces the losses. A tractor drawn electronic multi crop electronic planter cum fertilizer applicator was fabricated at Department of Farm Machinery and Power Engineering, CAET, Anand Agricultural University. The developed planter mainly consists of the seed and metering plates and shafts, seed hopper, fertilizer box and electronic components to control seed rate. The sensor system in the machine helps in proper metering of the seeds and thus further reduces the losses. The seed rate was controlled easily with the rpm controller and can be used for a variety of seeds with the change in seed metering plates. The planter was tested and the field observation such as theoretical and effective field capacity, field efficiency, power requirement, fuel consumption, draft, wheel slip and cost of operation was studied.***

Keywords: Planter, sensor, metering, speed, draft.

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INTRODUCTION

Most of the developing countries of Asia have the problem of high population and low level of land productivity as compared to the developed nations. The prime reasons for low productivity are insufficient power availability on the farms and low level of farm mechanization. The planting operation is one of the most important cultural practices associated with crop production. Increases in crop yield, cropping reliability, cropping frequency and crop returns all depend on the uniform and timely establishment of optimum plant populations (**Murray *et al.*, 2006**).

Among the various agronomic practices, planting technique is of considerable importance because of the optimum plant population and also proper use of the land and input resources (**Ali *et al.*, 1998**)

To ensure the high production it is required to sow the high yielding variety of seeds, but without proper placing of seeds timely at desired depth and spacing it is impossible to achieve the higher productivity. Placement of seeds in the optimum living area is important to guarantee high yield and high quality of crops. With uniform spacing, the roots can grow to a uniform size. Thus, to obtain maximum yields, seeds should be planted at the desired spacing and in such a way that all viable seeds germinate and emerge promptly.

Mechanical planters, which are more popular, generally use fluted feed type, internal double run type, cup feed type, cell feed type, brush feed type, auger feed type, picker wheel type or star wheel type seed metering mechanism for placing the seeds furrows at uniform rate and at controlled depth with an arrangement of covering the seeds with soil. But in mechanical metering, the seeds coming in direct contact with the mechanism may get damaged and lost their viability resulting in reduced germination per cent. The mechanical planter may damage up to 71.7% of seed **(Kopak, 1997**). In addition, the mechanical devices in conventional drills are not capable of operating at high travel speed (**Kumar and Durairaj, 2000**). Thus, for higher productivity, the metering unit of a seed planter should be accurate enough to plant seeds to the

required seed distance on a row without causing doubling and missing. As, doubling and missing in the row are unwanted since doubling affects yield and dry matter while missing causes a reduction in yield (**Rintelen, 1971**).

Electronic multi crop planter work with a sensor based battery operated metering system, which adds precision to the work. The sensor system in the machine helps in proper metering of the seeds and thus further reduces the losses. The seed rate can be controlled easily with the rpm controller and can be used for a variety of seeds with the change in seed metering plates. The advantages of the electronic planter as compared to existing multi crop planter are as follows:

1. Timely sowing with proper seed to seed spacing.
2. Wastage of seeds and fertilizer to be reduced.
3. Losses due to slipping and skidding of ground wheel to be minimised.
4. Machine design to be compact & viable.

MATERIALS AND METHODS

The research work for development and design of the electronic multi crop planter was carried out at College of Agricultural Engineering and Technology, Godhra. The fabrication work of the seed and fertilizer metering mechanism was conducted with a view to obtain suitability of the developed multi crop planter cum fertilizer applicator for different crop seeds.

DESIGN CONSIDERATION

It deals with the criteria for design of tractor operated multi crop planter cum fertilizer applicator for precision farming and its functional parts i.e. metering mechanism and seed and fertilizer hopper. The following points were taken into consideration for the design of tractor operated multi crop planter cum fertilizer applicator for precision farming.

1. Timely sowing with proper seed to seed spacing.
2. Wastage of seeds and fertilizer to be reduced.

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3. Losses due to slippage and skidding of groundwheel to be minimized.
4. Proper metering of seeds and fertilizer helps to maintain the desired agronomical requirement of crop

DEVELOPMENT OF MULTI CROP PLANTER CUM FERTILIZER APPLICATOR

The developed multi crop planter for five rows was fabricated consisting five seed hoppers on a single mild steel sheet and it was attached to the fertilizer box for easy and compact design for better reliable. The detailed design and functional components of the metering mechanism were carried out. The design of the following components was carried out:

- ✓ Metering mechanism
- ✓ DC motor
- ✓ Design of seed hopper
- ✓ Design of fertilizer box
- ✓ Supporting frame for the metering unit
- ✓ Electronic control unit

Metering Mechanism

Metering mechanism is regarded as the heart of planter as it regulates the proper metering of the seed at desired spacing and pre-determined seed rate.

The metering mechanism employed in the experimental setup consisted of metering discs, shaft for metering discs, metering shaft for seed, metering shaft for fertilizer, seed hopper, fertilizer box and power transmission system.

Metering discs are made up of high density plastic having a diameter of 100 mm. The cells on the disc were shaped according to the physical dimensions of the seeds like groundnut, maize, soyabean and pigeonpea which were taken for experimental purpose.

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Table 1 Dimensions of the metering disc

Specifications	Groundnut		Maize		Soybean		Pigeonpea	
	Physical property	Cell Size	Physical property	Cell Size	Physical property	Cell Size	Physical property	Cell Size
Length (cm)	1.5	1.7	1.2	1.4	0.6	0.8	0.8	1.0
Breadth (cm)	0.6	0.8	0.4	0.6	0.6	0.8	0.8	1.0
Thickness (cm)	0.6	0.8	0.6	0.8	0.6	0.8	0.6	0.8
No. of cells	-	10	-	10	-	10	-	10

(a) (b) (c) (d)

Fig. 1 Metering Discs for (a) Groundnut (b) Maize (c) Soyabean (d) Pigeonpea

Shaft for metering seed disc was made up of high carbon shaft of 18 mm diameter with one bevel gears of 18 teeth riveted on it and an external thread was made on the extreme side

upto a distance of 27 mm for fitting nut. The shaft was fitted to the inclined metering disc through a cast iron bush of 19 mm.

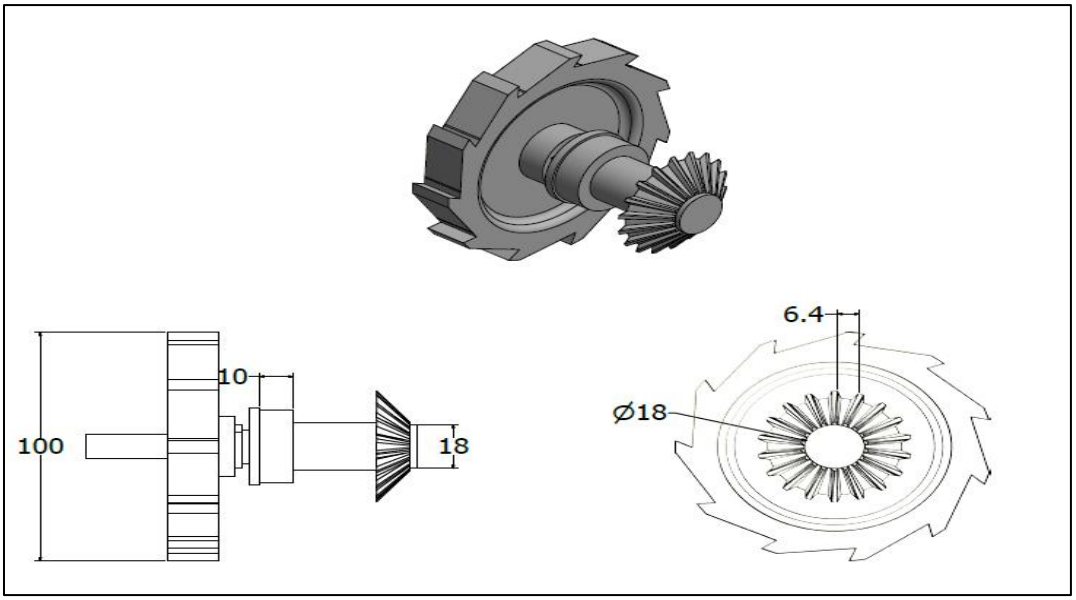

Fig. 2 Shaft with seed metering disc

Seed metering shaft was used to provide drive for seed metering mechanism and it was made up of using a bright bar shaft with length 1100 mm and diameter of 16 mm. It was fitted with five numbers of 18 teeth bevel gear at an equidistant of 158 mm.

Fertilizer metering disc and shaft were used for metering fertilizer application. The fertilizer metering unit consists of fertilizer metering disc, a shaft to rotate the metering plate and the fertizer outlet pipe. The vertical disc was made up of high density plastic fitted on shaft. An aluminum alloy shaft of 630 mm was fitted to the fertilizer hopper with the help of plastic bush and the discs were fitted upon it. The other end of the shaft was fitted with a sprocket to provide power transmission from the motor through chain drive to drive the metering plate. An aluminum alloy square shaft was selected for metering mechanism in fertilizer application. The dimensions of this shaft was 630 × 15 × 15 mm^3 and both end of the shaft are turned to round shape in lathe machine. The shaft was fitted with rotor and bush for fertilizer application.

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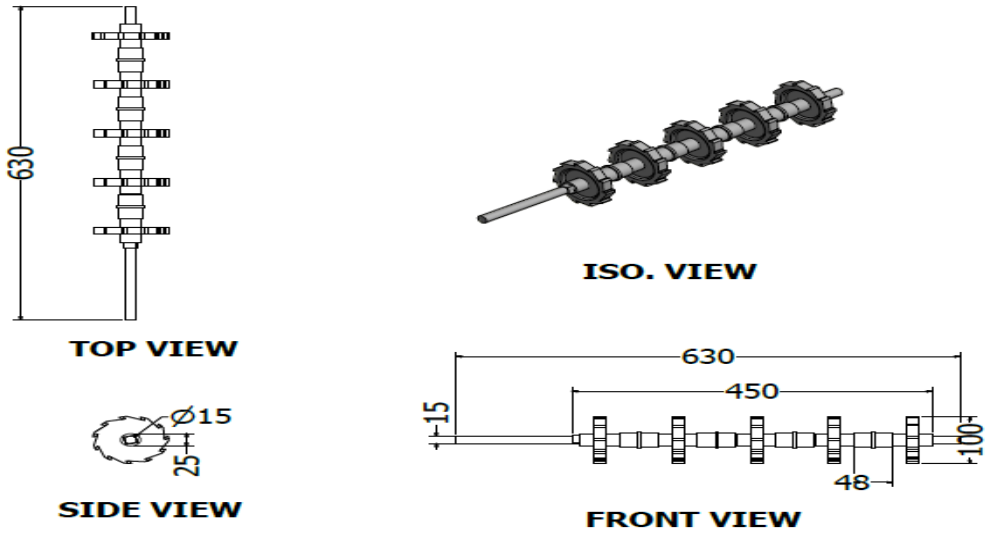

Fig. 3 Fertilizer shaft with metering disc

DC Motor

A DC motor was used to drive the seed cum fertilizer metering mechanism. The torque required to rotate the main drive shaft for seed and fertilizer was determined using pulley-belt system and it was found to be 25 kg-cm. The shaft of the motor was externally threaded so it was fabricated as a internally threaded shaft to fit the motor shaft. The gear sprocket was attached to the motor shaft.

Design of Seed Hopper

A trapezoidal shaped seed hopper was designed. It was made out of mild sheet. The hopper was inclined at angle of 45° from the horizontal to facilitate metering mechanism. A MS sheet of 79 cm x 48 cm was bent to angle of 45° as it is the best angle of repose for different seeds. This inclination angle helps in designing of the inclined metering mechanism of seeds. A MS sheet of 1.5 mm thickness with 79 cm x 28 cm was welded at distance of 22 cm from the

point of inclination and this plate consists of small rectangular shaped passage 5 cm x 5 cm for seed passage to the inclined plate. Another MS sheet of 3 mm thickness with 79 cm x 28 cm was welded to make a rectangular box. Triangular shaped MS sheet of base 22 cm and height 28 cm were welded from sides to form a complete 5 number of seed hoppers.

Design of Fertilizer Box

The fertilizer box was fabricated by using a MS sheet of 1.5 mm thickness. A box of rectangular in shape with trapezoidal bottom made up with MS sheet. The dimensions of fertilizer box 260 mm × 220 mm × 207 mm. A rectangular bottom and shutter was provided at the bottom of the box which was used for controlling the fertilizer flow and diverting the fertilizer to the metering mechanism. A rectangular bottom and shutter was provided at the bottom of the hopper which was used for controlling the fertilizer flow and diverting the fertilizer to the metering mechanism. Plastic boots were provided at bottom of the fertilizer hopper to connect the fertilizer tubes.

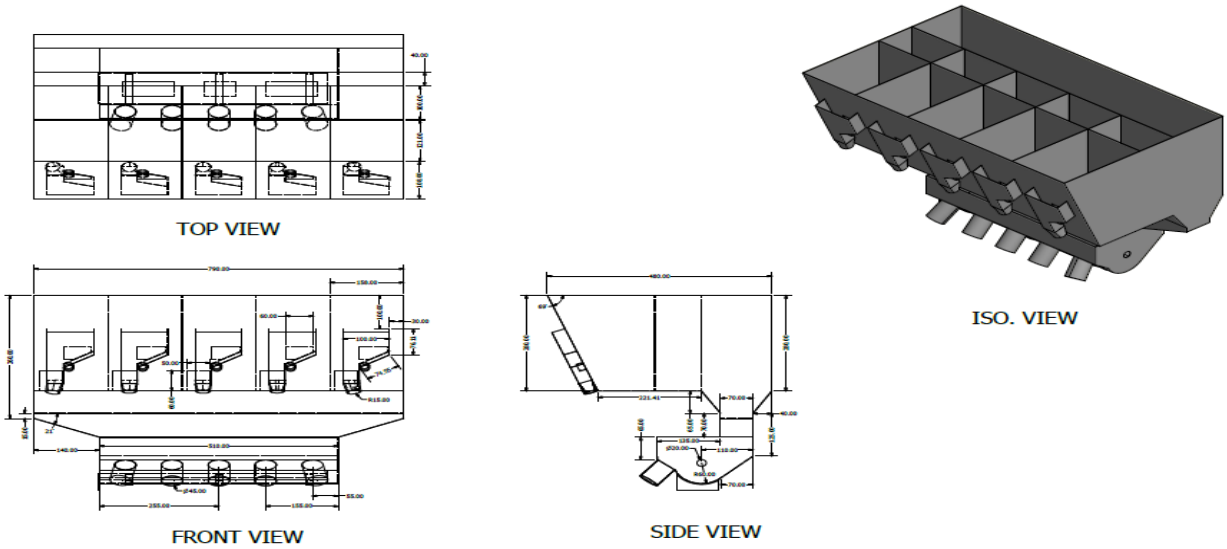

Fig. 4 Detailed view of seed cum fertilizer hopper

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Supporting Frame for the Metering Unit

A supporting frame for metering mechanism was made to provide support the seed and fertilizer box. This was made up from angle iron of 4 mm thickness. A rectangular shaped stand was prepared having length of 80 cm, width of 50 cm and height of 90 cm respectively. At each tip of the stand a rectangular shaped MS flat of length 15 cm and width 7 cm with two holes of diameter of 1.5 cm at the centre was provided to fix the stand on the cultivator.

Electronic Control Unit

The electronic unit consists of

1. Arduino Uno Board
2. Inductive Proximity Sensor
3. Potentiometer
4. Motor driver

Arduino Uno was used as a microcontroller board based on the ATmega328P (datasheet). ATmega 328P helps in storing the coded programme in it and execute its function according to the user's programme.

Inductive Proximity Sensor is a non-contact electronic proximity sensor. It is used for positioning and detection of metal objects. The sensing range of an inductive switch is dependent on the type of metal being detected. It uses the principle of electromagnetic induction to detect or measure objects. The sensor develops a magnetic field when a current flows through it; alternatively, a current will flow through a circuit containing an inductor when the magnetic field through it changes. This effect can be used to detect metallic objects that interact with a magnetic field.

Potentiometer was used to regulate the rpm of the motor as it acts as a variable resistor or rheostat. It acts as a voltage divider used for measuring electric potential (voltage); the component is an implementation of the same principle, hence its name.It was operated by a mechanism that can be used as position transducers as well as control the rpm of the dc motor for operation.

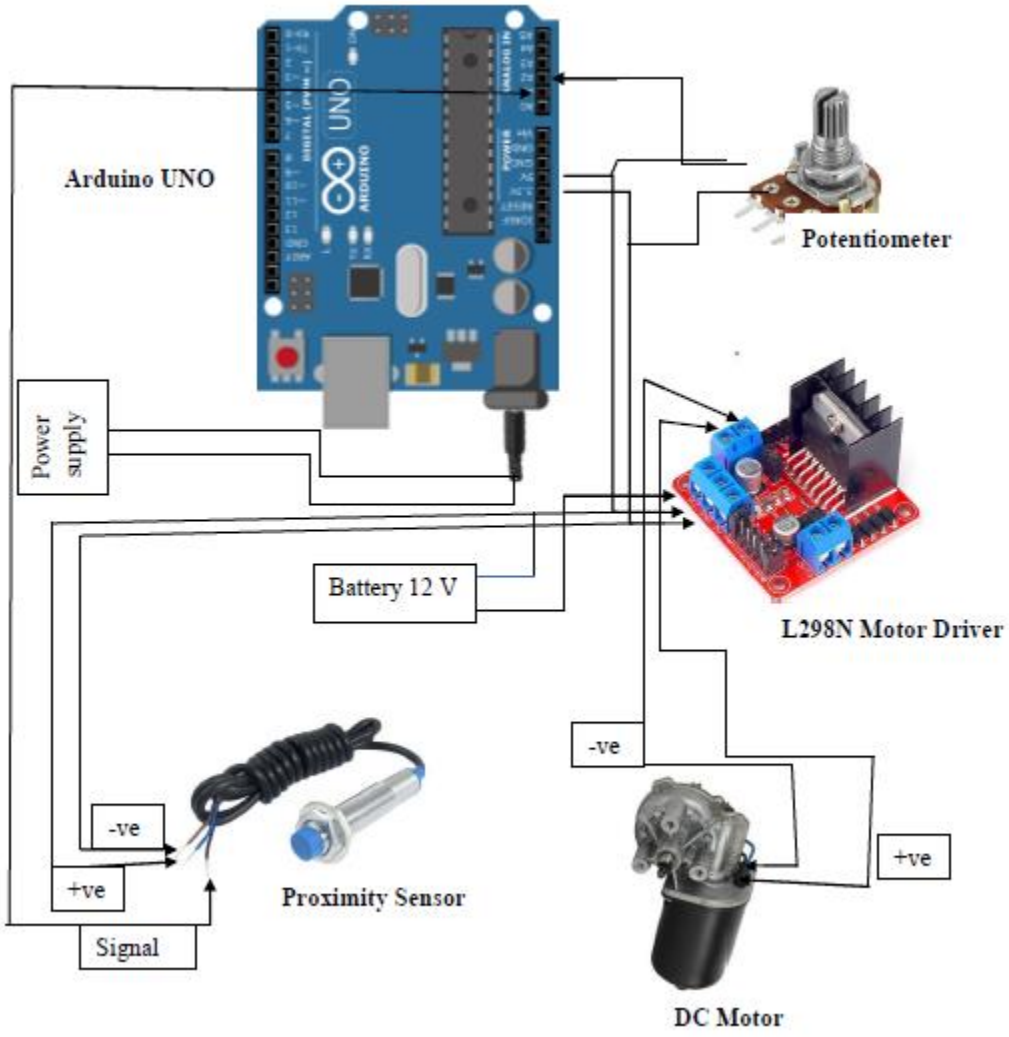
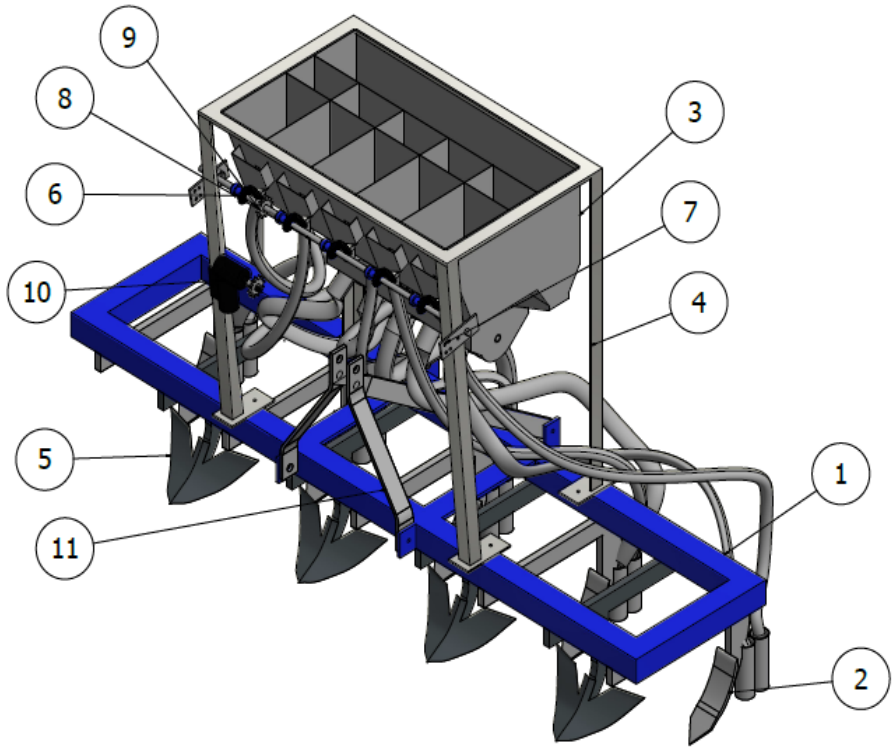


Fig. 5 Circuit diagram of electronic control unit

The designed components of multi crop planter-cum-fertilizer applicator were assembled to a cultivator with three point linkage having a length of 200 cm in order to set the furrow openers for planting. The width was limited to 46 cm to set the seed and fertilizer box. The supporting frame consisting the metering mechanism used in the seed hoppers as well as fertilizer box was fitted to the middle of main frame. It was fixed in such an alignment so that every seed and the amount of fertilizer are directly comes out in the seed and fertilizer tube respectively. The height of the cultivator was maintained at 32 cm from the ground level.



PARTS LIST	
PART NO.	PART NAME
1	Base Frame
2	Furrow Opener with Boot
3	Seed cum fertilizer hopper
4	Stand
5	Triangular Tyne
6	Bevel Gear
7	Pedestral
8	Seed Metering Shaft
9	Sprocket
10	DC Motor
11	Three Point Linkage

Fig. 6 Isometric view of detailed multi crop planter cum fertilizer applicator

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(a)

(b)

Fig. 7 (a) Front View and (b) Side View of developed multi crop planter cum fertilizer applicator

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Table 2 Detailed specification of the developed planter

Sr. No.	Particulars	Specifications
1	**Name of the equipment**	Tractor operated multi crop planter cum fertilizer applicator
2	**Type of action and its detail**	
	Action	Mounted
	Power source	Tractor
3	**Metering mechanism**	
(a)	**Metering disc**	
	Material of construction	Plastic
	Diameter	100 mm
	No. of cell	10
(b)	**Shaft for metering seed disc**	
	Material of construction	MS circular rod
	Diameter	18 mm
	Bevel gear material	Aluminium
	Thread portion	27 mm
(b)	**Seed metering shaft**	
	Material of construction	Steel Bright bar
	Length	1100 mm
	Diameter	16 mm
	Bevel gear (5)	18 Teeth
(c)	**Fertilizer metering disc and shaft**	
	Material of construction	Aluminium alloy
	Length	630 mm
	Diameter	15 mm
	Rotor	5
	Length of rectangular section	450 mm
	Length of bush	48 mm
(e)	**Motor**	
	Type	DC Motor
	Voltage	12 V
	RPM	115

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	Weight stall torque	25 kg-cm
	Dimensions	Shaft diameter – 8 mm (with external thread) Shaft length - 15 mm
4	**Seed hopper (Each)**	
	Material of construction	MS sheet of 1.5 mm thickness
	Length	158 mm
	Width	100 mm
	Height	280 mm
	Volume	4424 cm^3
	Capacity	4 kg
5	**Fertilizer box**	
	Material of construction	MS sheet of 1.5 mm thickness
	Length	790 mm
	Width	150 mm
	Height	280 mm
	Volume	33180 cm^3
	Capacity	40 kg
6	**Supporting frame for the metering mechanism**	
	Material of construction	MS angle
	Length	800 mm
	Width	500 mm
	Height	900 mm
7	**Electronic Components**	
(a)	**Arduino Uno**	
	Microcontroller	ATmega328P – 8 bit AVR family microcontroller
	Recommended InputVoltage	7-12 V
	Analog Input Pins	6 (A0 – A5)
	Digital I/O Pins	14 (Out of which 6 provide PWM output)
	DC Current on I/O Pins	40 mA
	DC Current on 5V Pin	50 mA
(b)	**Proximity Sensor**	
	Type	Inductive

	S_n (Operating distance)	20 mm
	OD	30 mm
	Voltage	5-40 V DC
	Maximum Load	200 mA
(c)	**Potentiometer**	
	Resistance	10 Ω ± 20%
	Rated Power	0.5 W
	Total Rotation	300° ± 5°
(d)	**Motor Driver**	
	Type	L298N
	Logical Voltage	5 V
	Drive Voltage	5-35 V
	Logical Current	0-36 mA
	Maximum Power	25W
	Dimensions	43 x 43 x 26mm
	Weight	26 g
8	**Cultivator**	
(a)	**Tyne**	
	Material of construction	High carbon steel
	Shape of tyne	Duck foot shaped
	Operation	Tillage
(b)	**Furrow opener**	
	Material of construction	High carbon steel
	Length	265 mm
	Width	70 mm
	Thickness	8 mm
(c)	**Boot**	
	Material of construction	MS sheet
	Length	140 mm
	Width	160 mm
	Circular Hole	2 number each of 55 mm

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REFERENCES

[1]. Murray, J. R., Tullberg, J. N. and Basnet, B. B. (2006). Planters and their components, types, attributes, functional requirements, classification and description. *Australian Centre for International Agricultural Research*, 135-137.

[2]. Ali, M., Khalil, S.K, Ayaz, S and Marwat, M.L. (1998). Phenological stages, flag leaf area, plant height, and leaves per plant of corn influenced by phosphorous levels and plant spacing. *Sarhad Journal of Agriculture*, 14:515-522.

[3]. Kopak, R. (1997). Effect of planting method on yield and growth dynamics of potatoes grown from mini tubers. *Zeszyty Problemowe Postepow Nauk Rolniczych*. 439: 281-287.

[4]. Kumar, V. J. F. and Durairaj, C. D. (2000). Influence of head geometry on the distributive performance of air-assisted seed drills, *J. Agric. Eng. Res.*, 75: 81-95.

[5]. Rintelen, P. (1971). Eon Handbook use production static and economic, DLG VERLAG, Frankfurt. *Fruits and Vegitable Sector TEDO*. 243 - 251.

