International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 12, Issue 8, 2020, pp.-9767-9769.
Available online at https://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

DEVELOPMENT OF SOLAR OPERATED DRIP IRRIGATING MACHINE FOR INCREASING PRODUCTIVITY AND PROFITABILITY OF FARMERS UNDER RAINFED FARMING SYSTEM

MEHTA M.L.[1], LOHAN I.[2] AND JAIN M.*[3]
[1]Ex-Director, Central Farm Machinery Training and Testing Institute, Ministry of Agriculture, Govt. of India
[2]Shriram Ideal Senior Secondary School, 125004, Haryana, India
[3]Farm Machinery Testing Centre, Chaudhary Charan Singh Haryana Agricultural University, Hisar, 125004, Haryana, India
*Corresponding Author: Email - mukeshjainhisar@rediffmail.com

Received: April 11, 2020; Revised: April 27, 2020; Accepted: April 28, 2020; Published: April 30, 2020

Abstract: Agriculture and food production, plays an important role in Indian economy, but GDP contribution from dryland agriculture is far less than the expectations as there is no assured return, when rain fails. The area under dryland agriculture is about 60% of total cultivable area. When the crop is 40-50 days and if rain does not come, the crop is under severe dry spell conditions and many times the crop fails and farmer has to suffer heavy losses which is an issue of serious concern. For assured irrigation at this stage, solar operated dripping machine has been found more promising for the farmers engaged in dryland agriculture to save the crop and achieve good returns to lead a comfortable and dignified life. The technology is pollution free and there is no need of electricity or diesel engine. The machine can be installed anywhere in the field and uses drip irrigation technology. The machine can be pulled by any source of power *i.e.*, human or bullock or tractor.

Keywords: *Agriculture and food production, Dryland agriculture, Drip irrigation*

Citation: Mehta M.L., *et al*., (2020) Development of Solar Operated Drip Irrigating Machine for Increasing Productivity and Profitability of Farmers under Rainfed Farming System. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 12, Issue 8, pp.- 9767-9769.

Introduction

Agriculture occupies an important place in Indian economy but GDP contribution has gone down continuously especially from dryland agriculture [1]. It occupies 60% of cultivable land but there is no assured return, when rain fails. Therefore, Agricultural mechanization in dryland agriculture needs to be viewed as a system approach. Rainfed agriculture requires operations to be carried out in a much shorter span of time so as to make use of available soil moisture for sowing after the rain is over.

Agricultural implements and machines enable the farmers to complete farm operations timely and efficiently in terms of work output per unit of time, reduction in efforts and improvement in quality for better response to inputs applied, paramount contribution to multi-cropping and diversification of agriculture in addition to alleviating drudgery associated with various farm operations. In the rainfed agriculture, use of deep ploughing is necessary for increasing percolation rate of rain water. But subsequent post rain farm operations are to be carried over without much disturbing the top soil so as to conserve moisture for a longer period as well as to complete operation at faster rate. Alternatively, raised-bed sowing is being practised in recent developments.

The technology in the world is fast changing and the same is true for agricultural implements and machines. Recently new agriculture machines like rotavator, raised bed planter, sub-soiler, self-propelled reaper, straw combine, grain combine harvester and many other equipment's have been developed and are being used extensively in irrigated agriculture. But in rainfed agriculture, without assured irrigation, their use is limited. Therefore, mechanization technology in dryland agriculture will have to be designed to meet challenge of assured irrigation in order to achieve and sustain high level of land productivity and enhancing the farmer capacity to secure higher return for his labour and investment. The income of farmer/cultivator should increase at a satisfactory rate in order to have rightful opportunity to lead a dignified life and contribute in GDP significantly.

Under the given circumstances, the development of a machine for application of irrigation through drip to mitigate the dryspell conditions of crop when rain fails, after 40-50 days of sowing operated by solar power, which is in abundance, economical and pollution free in place of engine or electric motor is a better option.

Details of solar operated drip irrigating machine developed

Solar operated drip irrigating machine has been developed for the farmers of rainfed area to deal with the severe moisture stress conditions and save the crops. Isometric views of the machine are depicted in [Fig-1] & [Fig-2]. As India receives solar energy in the range of 5 to 7 kWh/m^2 for about 300 to 330 days in a year [2, 3], the use of machine along with technology can bring revolution in dry land agriculture. It works as a crop-saving machine for crops in dry land agriculture. It utilizes solar power to operate the system. The machine can be used anywhere in rural/remote area to avoid crop failure. This revolutionary drip irrigating machine helps the farmers to save their crops by adopting on-surface drip irrigation technology which runs on 100 % solar energy. The inbuilt 500 litres capacity tank with rain water harvesting structure is capable to command 0.4 to 0.8 ha land under rainfed farming system. Therefore, solar operated pumps with assured water storage tank can be a boom for the farmers besides low maintenance, increase in income, increase in yield *etc* [4].

Constructional details

The machine consists of solar panel, electrical battery, DC motor with monoblock pump, charger controller, tyres, chassis with water storage tank, hitching system and transport wheel. The technical specifications of the machine are tabulated in [Table-1]. The machine can be transported by single bullock or two persons or tractor through proper hitching system.

Table-1 *Technical specifications of solar operated drip irrigating machine*

Item	Detailed specifications
Type	Solar operated
Source of power	Solar panel and Battery
Solar Panel	Two numbers with 250W per panel
Main Frame	Fabricated with iron pipe in box shape with 500 litres capacity water storage tank and can be transported through provision of two round plates with grooves which rotates on each other in the machine and can be pulled by single bullock or human power or tractor power
Rain water harvesting structure	A smooth channel alongwith the solar panel around the machine with inlet pipe to the water storage tank has been provided.
Water storage tank	500 litre capacity
Motor with pump (Monoblock)	500 litres capacity DC motor with pump provided
Solar Battery Charger	12V Size is provided
Tool Box	Tool Box has been provided to store drip irrigation materials, spanners, *etc.*
Battery	12V 155AH
Drip Irrigation system	Main pipe of 32 mm (50 feet) and lateral pipe of 16 mm (1000 feet) has been provided
Tyres	Pneumatic 4 nos. size 5×19

Fig-1 Front Isometric view

Fig-2 Rear Isometric view

The machine can be suitably parked near the field in such a way that solar panel works efficiently. The DC motor operated monoblock pump fitted with water storage tank will supply water with pressure to the drip irrigation system in order to give irrigation water to the roots of individual plants.

Solar Operated Micro Irrigation Applicator converts grid operated pump into solar operated pump which provides high and reliable output even in remote area. Moreover, multi crops can be grown, because of availability of assured irrigation throughout the year with low maintenance cost, long life, no fuel or electricity cost and zero pollution. The details of different components used in the machine are given below:

1) Solar panel
2) Controller
3) Mono block pump set
4) Battery
5) Water storage tank
6) Drip irrigation system
7) Tyres
8) Body with rain water harvesting structure
9) Hitching system

Solar Panels

Solar panels are used as alternate source of energy to produce sufficient and reliable electricity, directly from solar radiation to battery and then for operation of irrigation pump for suction and delivery of water to drip irrigation system.

Solar Panel size (mm)

No. of panel: 2
No. of cell: 60
Power per panel: 250 watt
Total power available: 500 watt

Controller

This is a voltage or current regulator to charge the battery and to save it from over charging. The charger controller lowers the voltage and current as soon as the battery becomes full. These are smart charger, microprocessor controlled compact unit. A wide range of 12V battery chargers are available in the market. The multipurpose charger can be used for 12V battery and is smart enough to recognize the type of lead acid battery connected to it. There is no need to fear for overcharging or undercharging of the battery. The system without batteries do not require charger controller.

Monoblock Pump set

The DC motor operates the pump-set through battery and supplies irrigation water with pressure to drip irrigation system. The specifications are:
DC motor power: 500W
RPM: 3200
Inlet diameter (mm): 32.5
Outlet diameter (mm): 32.5
Voltage: 12V

Battery

Type: Lead acid
Capacity: 155 AH
Voltage: 12V

Water Storage Tank

Material: MS sheet
Capacity: 500 litres

Drip Irrigation System

Diameter of main pipe (mm): 32
Diameter of lateral pipe (mm): 16
Material of pipe: LDPE

Tyres
Type: Pneumatic
Size: 5 × 19
Total: 4 nos.
Ply rating: Front 10; Rear 6.

Body with rain water harvesting structure
Main Frame: MS Box Type
Dimensions (mm): Length 4200
Width 4500
Height 2300
Mass (kg): 450

Hitching System
It can be pulled by one bullock with suitable beam or with human power or tractor power.

Salient features of the machine
1 It is capable to deal with the severe moisture stress conditions of the crop and works as crops saving machine in dry land agriculture under rainfed farming system.
2 Machine can be pulled/transported by any of the following sources
- Single bullock
- Human Power
- Tractor Power
3 Machine works with solar energy, so there is
- No pollution
- No electricity required
- No engine or gen-set required
4 Machine can be installed anywhere in rural/remote area to avoid crop failure in dry land agriculture.
5 It works on drip irrigation technology and is in line with the Government policy "Per Drop More Crop".
6 Drip irrigation system can be installed on the surface itself and can be carried out after the work is over from safety point of view.
7 Rain water harvesting structure has been provided to store water in order to avoid dependency on outside water.
8 Battery of 12V 155AH has been provided for regular supply to the machine operation.

Directions to use
For best use, the machine should be operated, when the sun shine is decreasing, preferably in the evening hours (after 3 pm) to avoid burning of roots due to moisture stress conditions and warm water due to hot weather especially in summer season. The solar panel should face towards the sun during installation of machine on the farm. The farmers must ensure 500 litres water in the storage tank either through inbuilt water harvesting structure or other means for irrigation as and when required to avoid any moisture stress conditions in the crop. If the farmers is not in a position to store the water through rain water harvesting, then the farmer has to bring water through transportation of this machine or should arrange through water tanker on custom hiring basis. Drip irrigation material and other items after the use, should be kept in tool boxes as provided in the machine to avoid any theft *etc*. Rain cover should be used after day work for long lasting life of the machine. Training to use the machine and technology in dry land agriculture is essentially required. Daily maintenance of machine and cleaning of solar panel is recommended.

Conclusion
The solar operated dripping machine is suitable for increasing productivity and profitability of farmers under rainfed farming system with the following specific advantages. The solar energy which is available in abundance and economical has been used. The development of solar operated drip irrigating machine helps the farmers on the rainfed area to deal with severe moisture stress conditions and save the crop. This will fulfil our social responsibilities as well as economic development in our country. Supply of water to drip irrigation system already installed in the field to maximize water application efficiency. Alleviation of drudgery and generate good income, especially for the farmers engaged in agriculture under rainfed farming system. Serves the farmers even in remote area where there is no electricity or diesel engine or gen-sets etc.

Application of research: The development of solar operated drip irrigating machine will be of great help to the dryland farmers to save the crop which is under severe dryspell conditions.

Research Category: Dryland agriculture

Abbreviations: GDP: Gross Domestic Product, ha: hectare, DC: Direct Current, kWh/m^2: Kilowatt per square metre, W: Watt, V: Volt, AH: Ampere Hour
mm: millimetre, Nos: numbers, RPM: Revolutions per minute,
LDPE: Low density poly ethylene

Acknowledgement / Funding: Authors are thankful to Farm Machinery Testing Centre, Chaudhary Charan Singh Haryana Agricultural University, Hisar, 125004, Haryana, India

****Principal Investigator or Chairperson of research: M. L. Mehta**
Ex-Director, Central Farm Machinery Training and Testing Institute, Ministry of Agriculture, Govt. of India
Research project name or number: Research station study

Author Contributions: All authors have equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Farm Machinery Testing Centre, Chaudhary Charan Singh Haryana Agricultural University, Hisar, 125004, Haryana, India

Cultivar / Variety / Breed name: Nil

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

References

[1] Anonymous (2019) Conserve Water Appeal. Mann Ki Baat by Narendra Modi, The Hindustan Times dated 1st Aug., 2019
[2] Kumari P., Veerangouda M. and Palled V. (2017) *The souvenir of 51st Annual convention of Indian Society of Agricultural Engineers (ISAE) and National Symposium on "Agricultural Engineering for Sustainable and Climate Smart Agriculture" held at COAE&T, CCSHAU, Hisar from Feb*, 16-18, 2017.
[3] Rai M., Mehta R.K. and Yadav R.D.S. (2017) *The souvenir of 51st Annual convention of Indian Society of Agricultural Engineers (ISAE) and National Symposium on "Agricultural Engineering for Sustainable and Climate Smart Agriculture" held at COAE&T, CCSHAU, Hisar from Feb,* 16-18, 2017.
[4] Kumar S., Sidhpuria M.S., Jhorar R.K. and Singh K. (2017) *The souvenir of 51st Annual convention of Indian Society of Agricultural Engineers (ISAE) and National Symposium on "Agricultural Engineering for Sustainable and Climate Smart Agriculture" held at COAE&T, CCSHAU, Hisar from Feb*, 16-18, 2017.