

SOLAR POWERED CONSTANT / CONTINUOUS MOVE CENTRAL PIVOT IRRIGATOR

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ABSTRACT

Water efficiency with respect to yield, is a very crucial factor, in agriculture now. In the case of remote fields, due to lack of electricity, it may not be possible to cultivate the fields, even when sufficient water is available. It is very difficult to have the electricity at that location. Solar Powered Central Pivot Irrigator is an ideal for such applications, not requiring any electricity to drive the machine, which can be programmed to irrigate the fields, for predefined time at predefined time even during nights, reducing water requirements still further. The machine will start at pre-programmed set time. Real Time Clock (RTC) takes care of timing issues. One has to only supply water at Pivot point. Water can be pumped from remote area, where water and electricity are available. The machine will stop, automatically, during low water pressure, not counting time, and will resume, moving when water pressure develops again. Constant or Continuous move concept, distributes water more evenly, increasing the yield still further. Since all the towers move all the time, multiple start / stops are avoided, improving the life of the machine substantially, reducing maintenance. The probability of churning of wheels in muddy field is greatly reduced as well. A Slip timer incorporated in the machine takes care of this problem, avoiding excessive water and crop loss.

All other advantages like even distribution of Liquid Fertilizers, Insecticides, and Anti Weeds, associated with central pivot irrigator, increasing the yield are also provided. Lacking calcinations of soil, is one of the major advantages with this system.

Remote uncultivated undulated areas without tedious & expensive preparation with predefined slopes are brought under cultivation, delivering extra yield to the tune of 150-180% with additional extra 30-40% coverage area, with the same volume of water uses and pumping costs, due to reduced water requirements. The machine is tested with 27 Degree slope. Since no trenches required, we get additional coverage area of 15-20%, adding the yield still further.

Sometimes due to uncertainty in rains, and climate change, we may be required to make double sowing, which can be avoided by this machine. It was seen in the year 2008, it rained in the first week of June, as usual, but it skipped for next 4-5 weeks. Since the machine was installed, the field was watered, avoiding any loss. The yield was normal.

As regards to farming community is concerned, one is not required to toil, watering the fields, in hot scorching heat, thus improving the standard of living of both farmer and farm labour.

Key Words: Solar power, Central Pivot, Constant Move, Slip Timer, Even distribution of water, yield.

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The machine has a Centre Pivot with 2,3,4,5,6 & up to 7 Spans or Towers each of 27 -33 meter long depending upon the size and shape of farm revolving around it. Area Covered, with tentative water discharge is illustrated in Table1. The water discharge can be modified by using different Sprinkler Combination. Water is applied at this stationery Pivot point. Coupler with Rubber Boot avoids leakage, while whole water carrying structure is rotating. All towers have stable 'A' frame, 48 Volts 100 Watt, Geared DC Motor, coupled to a Heavy Duty Gear Box, driving the wheels with Tractor Tyres. The last Tower designated as End Tower, moves at maximum speed of about 2meters / Minute, and can be reduced to 10% with the help of setting, in order to increases the water discharge.

An extra 6 meter cantilever portion at the End Tower covers, extra area without adding any drive, frame and other components making it very cost effective. The end gun is optional, and is really useful to cover the corners in the case of non circular fields.

101mm, Hot Dipped Galvanized pipe carries water for irrigation, and rotates with supporting iron pipe stable structure, Hot Dip Galvanized or Epoxy / Powder Coated. The machine is installed at site with Nuts & Bolts. All the towers are coupled to each other with Flexible leak proof coupler, and can move in all X, Y & Z planes by about 7.5 to 9 Degrees, without any structural instability. The controller stops the machine immediately the Misalignment goes beyond this point. Goose Necks at calculated predefined points, with heavy adjustable pendants to suit the crop and cropping pattern, holds Sprinklers. The distances between two sprinklers and discharges through the same are designed for even distribution of water throughout the covered area. Thus discharge from the sprinkler near the Pivot point is quite low small as compared to next one, as it has cover water to smaller area. The Sprinkler at the end point spreads maximum water. The sprinklers require quite low water pressure, reducing the overhead on the Pump.

A logic Controller installed at the Pivot Point controls all the Irrigator operations. Five (5) Numbers of Forty (40) Watts Solar Panels are installed near the first 'A' frame, while Five (5) Numbers of Sixty Five (65) VA, Deep discharge; Tubular Batteries and a Solar Battery Charger are stationed on the 1st Tower. All the safety features like Reverse Battery, Reverse PV, Over/Under Voltage cut-offs, Overload, are incorporated and are indicated by various LEDs. Generally the machine works on 60 Volts DC, nominal supply, but can operate safely between 52 to 70 Volts. Three Tower 120 meter machine installed at National Research Centre for Onion & Garlic, Rajgurunagar, was tested for more than 20 Hours, without any solar charging. The typical operational modes are indicated in Table 1, whereas Area coverage in indicated in Table 2.

Machine operates in modes like

Auto Restart	ON	Stops the machine and pump under Low voltage condition. Once power is restored, machine resumes operation.
	OFF	Once machine has stopped, it must be restarted manually.
Auto Reverse	ON	System oscillates between two end limits.
	OFF	System travels to one end and stops.
Wet / Dry	WET	Machine starts pump, checks water pressure and continues to work. This feature is most useful when pump stops due to power failures, loss of water or Pump Failure.
	DRY	Mainly used during alignment, parking and diagnostics.
Misalignment		If any tower alignment is off by 7.5 degrees; machine & pump are shut off. System must be manually aligned before restarting.
All above conditions are indicated by bright LEDs on the Main Panel at the pivot point.		

SOME COMPONENTS OF MACHINE

Logic Controller

1. A Microcontroller based unit with Real Time Clock (RTC)
2. Non Volatile (NV) RAM for 24X7X365 Real Time Operation
3. Generates 4-20 mA source proportional SPEED settings
4. 20X4 Alphanumeric backlit LCD Display indicates the status of the machine and used for programming and diagnostic purposes.
5. Operational parameters can be programmed with 16 Key keyboard
6. Sensors provides boundary locations to stop the machine during non circular fields
7. Senses points to START / STOP, End Gun under command.
8. Receives Misalignment / Slip timer signal and stops the machine immediately.
9. Operates on 52 – 70 Volts DC

End Tower Controller

1. Microcontroller Base Unit
2. The Motor Speed is Governed by Current Loop Signal of 4-20mA.
3. Constant Speed (Regulation) is maintained with voltage variation of 50-72 V, uphill and downhill slopes of 25 Degrees (Tested) through Feedback arrangement.
4. CW and CCW End Limit Switches are being routed through the same
5. Moves the Machine in Clockwise or Counter Clockwise as per the signal received.
6. Operates on 52 to 72 Volts DC

Standard Tower Controller

1. Common controller to all Towers except the end tower.
2. Synchronous Speed of the tower is adjusted by the DIP switches and depends on the total number of towers and their respective position from the Pivot Point
3. This avoids Zigzag or Snaky action
4. A specially integrated Sensor detects its position with respect to the next Tower
5. The sensing angle is generally of 3 to 3.5 degrees for control purposes.
6. The sensing angle is 7.5 degrees for Misalignment purposes.
7. If a particular Tower is lagging behind, the controller brings it back to the pre-set synchronous speed, by moving it at full speed, and stops if leading ahead.
8. The continuous Feed Back Loop makes the system stable
9. Works on 52-70 Volts DC

AGRICULTURE BENEFITS

1. WATER

- 1.1) Saves More than 40- 50% water. Great improvement
- 1.2) Pumping cost is reduced greatly
- 1.3) Watering during night reduces water requirements, still further.

- 1.4) Water can be applied either in large quantity with bigger gaps or in small quantities, with small gaps, suitable for particular crop, depending on soil and atmospheric conditions.
- 1.4) Appropriate sprinkler package for appropriate crop.
- 1.5) Water Application is adjusted with variable speed. More water, lower the speed and vice-versa.
- 1.6) Water can be applied any time of the year, even during extended time to rain, after first shower. (We had to do this during June 08 at Rajgurunagar)

2. THE YIELD

- 2.1) 160-220% yield, due to EVEN DISTRIBUTION OF WATER, FERTILIZER, INSECTISIDES (80-100% above normal)
- 2.2) 10 -15% extra yield, with extra coverage area, otherwise lost in trenches, channels, furrows, brought under cultivation.
- 2.3) Yield is faster by 1-2 weeks.
- 2.4) Hilly, Uneven Portions of field brought under Cultivation, increasing the yield still further. Our machine can cover uphill and downhill portion slopes up to 20-25 degrees.
- 2.5) END GUN covers the Corners in case of Square / Rectangle fields.

3. POWER

- 3.1) Machine works on SOLAR energy, thus no Electrical Power needed, operation is free from Power Cuts, Failures, Maintenances & Shortages.
- 3.2) Solar Powered charged Storage Batteries allows the machine to be operated any time, even during nights.
- 3.3) No need to carry dangerous Underground / Overhead high tension expensive wires, cables at remote fields. Thus really remote fields become cultivable.
- 3.4) Problem creating Collector Rings, are avoided. We need Collector Rings if we use Electrical Power entry, and the machine moves all 360 Degrees.

4. SUITABLE FOR CROPS

Wheat, Corn, Maize, Potato, Onions, Tomato, Garlic, Peanuts Soybean, Cotton, Chana, Sunflower, Fodder, Tobacco, All VEGETABLES AND PULSES, and MANY MORE

5. BENEFITS TO FIELDS

- 5.1) No Calcinations, avoids degradation of Soil
- 5.2) No Erosion of Soil, at all
- 5.3) FERTILISERS in Liquid form can be applied with water.
- 5.4) INSECTISIDES in Liquid form can be applied with water.
- 5.5) ANTI WEED in Liquid form can be applied with water.

6. OTHER BENEFITS

- 6.1) Expensive and tedious Preparation of field, maintaining proper slopes etc. essential in the case of flood irrigation, is not required. Sometimes this may not be possible all.
- 6.2) Laborious, troublesome and tedious, watering process in HOT & SCORCHING sun is avoided, improving the operating standards of Farmers and Farm Labour.
- 6.3) Skilled Farm Labour is not needed.

- 6.4) Crops are less susceptible to Viral Attacks
- 6.5) Farmer can cultivate third cash crop, with saved water

7. THE MACHINE

- 7.1) Suitable for 5 TO 30 Hectors, farms with variable number of spans, and adjustable length of any span
- 7.2) Long Life – More than 25-30 years
- 7.3) Low Cost on Long Term basis
- 7.4) Very low, almost not required to maintain. No hidden operational costs
- 7.5) Machine can be operated any time once installed.
- 7.6) Machine can climb up or down, safely up to 3-5 feet height difference in two fields, (20-25 Degree slope) thus very useful in any Indian conditions, bringing every inch of farm under Cultivation.
- 7.7) Machine can be Towed to next neighbouring field, after one rotation, increasing the total coverage area by 2-4 times.
- 7.8) Variable Speed Drive (10-100%) makes it adaptable for convenient water management. Reduction in speed increases water distribution, and vice versa
- 7.9) Feedback control for Every Tower makes the linear speed constant even during heavy slopes, and low / high Battery Conditions.
- 7.10) Microcontroller based operation for Highest Reliability
- 7.11) Special Sensor installed at each Intermediate Tower, controls the machine with in 3.5 degrees of misalignment.
- 7.12) Constant/Continuous movement is achieved with help of self calculated pre-programmed synchronous speed, improving the distribution of water more evenly, reducing stress on the structure, increasing overall life of the machine
- 7.13) Controls the End Gun operation for watering corners
- 7.14) Real Time Clock (RTC) for precise timing control
- 7.15) Suitable Alphanumeric, backlit LCD Display and LEDs indicates proper working of the Pivot.
- 7.16) Programmability offers great flexibility in operation.
- 7.17) Total completed running Hours in one Rotation are displayed.
- 7.18) End Limit Switches makes it suitable for Non Circular Fields.
- 7.19) Slip Timer incorporated in Standard Controller STOPS the machine, in case one pair of wheels starts churning in mud, due to excess water. This avoids excessive water at one location of farm, probability of misalignment and wearing of Tyres.

CENTRAL PIVOT & DRIP IRRIGATION

- 1. Preparation:** It is essential to install and remove the system every time, for each crop. Central Pivot, once installed, can be used any time for 25-30 years.
- 2. Maintenance:** Central Pivot does not need any replacement of any parts. It is required to replace about 10-15% of the material every time, in the case of Drip Irrigation.
- 3. Life:** Generally the life of the Drip Irrigation is about 6-8 years, as against 25-30 years in case of Central Pivot.
- 4. Durability:** Since the Live Stock (Bulls, Dogs, Cows, and Goats) moves in our (Indian) fields, they damage Drip Irrigation System. This is not the case with Pivot, as it is a rigid steel structure.
- 5. Price:** Price of the Drip Irrigation is about slightly less.

- 6. Coverage:** The Drip Irrigation can be put to use for particular size of the field. This is, not the case with Pivot. The coverage area can be increased by towing the same.
- 7. Epidemics:** As water is spread from top, like rain, it is less susceptible to epidemics, due to washing out of germs.