Solar Powered Grain Turning Wheel Barrow

V.Gowrishankar[1], S.Koushik[2], K.C.Arun[3], M.Sasikumar[4]
[1]Assistant Professor, Dept of Electrical and Electronics Engineering
[2, 3, 4]Dept of Electrical and Electronics Engineering
[1, 2, 3, 4] Kongu Engineering College,Perundurai,TamilNadu,India

Abstract- *Agriculture is the backbone of Indian economy.The rice paddy drying process is one of the most crucial procedures in rice production as it greatly affects the quality of the output as it is used to achieve the correct percent moisture in the paddy.One process in managing the pavement solar drying process involves manually tedding the paddy, which refers to the manual process of turning over and spreading out grain, a process still widely used today by small farmers.This method is labour consuming especially when unexpected rainfall comes.Hence, A Grain tedding and gathering machine is designed for small farmers or rice mill factories to turn over and spread out grains, then pick up the grains to the collector.This mechanical setup will give accuracy to this traditional drying process as it turn around the grains with even drying,maintaining the percent moisture of the paddy and collects the paddy once it has dried. The grain collecting setup comprises of grain collector box, wheels, DC gear motor ,an iron dustpan, a rotating broom, a chain, and a chain conveyor .The input power supply for the mechanical setup is solar powered by means of Boost Converter driving the DC motors for turning and collecting the grains, with increased system efficiency, reduced losses which is stored in batteries.*

Keywords- Agriculture, Sun Drying, Grain Tedding Setup, Boost Converter, Solar Power

I. INTRODUCTION

Agriculture plays vital role in the development of agricultural country. In India about 70% of population depends upon farming and one third of the nation's capital comes fromfarming. Issues concerning agriculture have been always hindering the development of the country. The only solution to this problem is by modernizing the current traditional methods of agriculture. Drying is the process that reduces grain moisture content to a safe level for storage. Drying is the most critical operation after harvesting the crop. Proper Drying will maintain grain quality and minimize losses. Sun drying is a traditional drying method for reducing the moisture content of crops by spreading the grains under the sun. The solar radiation heats up the grains as well as the surrounding air and thus increases the rate of water evaporating from the grains. Purpose-constructed drying floors are commonly used where there is a need to dry large quantities of grain during the season, e.g. at most rice mills. Floors should be constructed to withstand the movement of vehicles and sloped or channelled to hasten the runoff of rainwater. After Harvesting and Drying, Grains are stored in grain storage facility to provide safe storage conditions for the grain in order to prevent grain loss caused by adverse weather, moisture, rodents, birds, insects and micro-organisms like fungi. It is the most common drying method in Asia because of its low cost compared to mechanical drying. It requires little investment and is environmentally friendly since it uses the sun as the heat source and therefore produces no CO2.

But sun drying tends to be labour-intensive and has limited capacity. During good weather conditions, mixing or turning the grain is the most important activity for maintaining good quality. It is not possible during rain or at night. Delays in drying lead to excessive respiration and fungal growth causing grain losses and yellowing.Temperature control is difficult. Overheating of grains can result in low milling quality caused by cracked grains. As long as there is no quality-incentive for better quality rice it will be the preferred method whenever the weather allows. Traditional sun drying can be improved using simple tools and monitoring equipment tools or machines for mixing and collecting grains make labour more efficient. However Equipments have to be produced to cater all types of grains in a simple, efficient manner.

II. SIGNIFICANCE OF THE SYSTEM

The main objectives of the project work is develop a mechanical system to turn the grains for sun drying and collect the grains which is driven by boost converter using solar energy.The following are the objectives to be achieved in developing the system:

- To develop Grains Turning, Collecting machine with use of chain conveyor
- To reduce intensive labour work and time involved in sun drying.
- To properly utilize and convert solar energy.
- To be economical and efficient system for crop management.

- To be a Multipurpose system suitable for rice, wheat, corn and other grain crops
- To be Easy to operate - nudge straight, stirring, collecting, cleaning, ascending, bagging
- To be an eco-friendly system which enrich the agricultural field of our country.

The proposed machine consists of Mechanical Part and Electrical Power Supply Part. Mechanical Setup comprises of grain collector box, wheels, an iron dustpan, a rotating broom, a chain, and a conveyor .Power supply components are Solar Panel, Boost Converter, DC gear motor .A DC switch located on one handle is turned on, the large motor drives the chain in front to drive the rotating broom, the grains are conveyed to the iron dustpan to drive the wheels to move forwards, and meanwhile the small motor behind drives the conveyor to move upwards, the grains are conveyed into the conveyor through the contact between the conveyor and the dustpan, the grains are prevented from falling down and can be safely and quickly conveyed to the portion above the conveyor and drop into collector. Electrical Power supply is given to the setup by solar panel. The solar panel feds the input power to the DC Gear motor through Boost Converter. Boost Converter boosts the requires voltage by supplying efficient power to the DC Gear Motor. The Input power for DC Motor is provided by means of Microcontroller for driving the motors to collect the grains.

III. LITERATURE SURVEY

The project deals with Grain Collecting Techniques, we have studied through a quite lot of research papers to get basic idea.

Edwin DC et al[1],describes the design of tedding mechanism for grain sun drying. Different designs include a tossing design, a plow design, a vacuum design, and a sweeper wheel design. The selected mechanism was fabricated and tested for its effectiveness. Results show that the model can sweepup and collect grains laid on a pavement with an error of less than 3%.

Sony P. Aquino et al [2]designed, fabricated, and tested a simple mobile engine-driven pneumatic paddy collector made of locally available materials using local manufacturing technology for collecting and bagging of paddy dried on concrete pavement. The pneumatic paddy collector had the following major components:radial flat bladed type centrifugal fan, power transmission system,bagging area, frame and the conveyance system. Results showed significant differences on the collecting capacity, noise level, and fuel consumption when rotational speed of the air mover shaft was varied.

Sudhakar H Set al[3],explains the Improvement in the efficiency of conversion of solar energy by tracking the maximum power point of a PV module. Various types of MPPT charge controllers are available in the market. A dc-dc converter is an important component of a SPV system as it acts as an interface between the load and the SPV module. These dc-dc converters enhance the performance of the MPPT algorithms leading to an improvement in the overall efficiency of the SPV system. This paper presents the modelling and simulation of one diode equivalent circuit of solar photovoltaic module using MATLAB/SIMULINKTM along with the boost converter which gives an efficiency of 93.29%.

TesfayeOlanaTerefe[4],designed Manually Operated Reaper Machine using tyre with wheel, shaft with gear & bearing, frame with shaft, gearbox placement and belt driving mechanism, the cutting blade positioning and means of motion transferred to it, and etc. of the reaper machine to carry out the cutting operation properly.

IV. METHODOLOGY

The Fig.1 explains the overall working of Grain Turning Wheel Barrow.DC supply is given as Input from Photovoltaic Solar Panel to the Boost Converter through solar Controller.Solar Controller extracts the maximum available power from PV module by making them operate at the most efficient voltage (maximum power point)The Input DC Voltage is stepped up to Higher Voltage and the output voltage is given to the DC Motor Load.

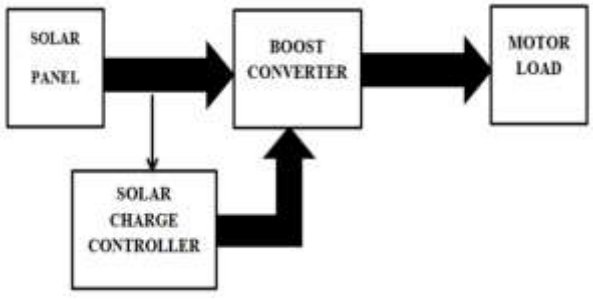

Fig 1. Block Diagram of Grain Turning Machine

Fig.2 shows the detailed description of working of Grain Turning Machine. Input electrical power will be provide to the entire system by means of solar panel acting as renewable energy. Solar PV Panel will Supply the input power which will be transmitted to Boost Converter by means of Solar Charge Controller using ATMEGA Microcontroller which provides control action of the Boost converter. The

Output power for motor will be fed to DC Gear Motor by DC Switch

The Mechanical Setup of the project is shown which consists of Chain Conveyor with DC Geared Motor. The setup is fitted with movable wheels. In order to turn the grains for tedding, at the front system is fitted with Rotating Broom type setup with strings. When first DC Switch is turned on, the Broom rotates there by turning the grains. The chain conveyor fitted with metal plates carries the turned grains by switching on the second switch.

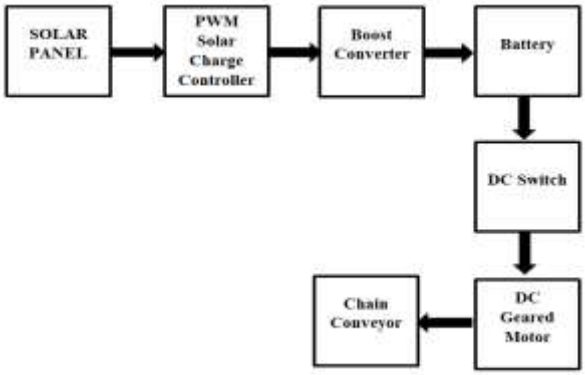

Fig 2. Process Block Diagram

Need for Solar Power

Energy demand is increasing rapidly. So there is a mismatch between generation and requirement, leading to load shedding problems in many parts of the world. To fight against this situation, we have to focus our attention on use of renewable energy sources. The integration of power electronics with renewable energy sources such as solar and wind has a vast potential to meet the energy Solar photovoltaic systems are becoming more popular compared to wind power plants due to availability of abundant solar irradiation throughout the year and decreasing cost of PV panels. In renewable energy projects, use of power electronics devices plays an important role.

The major role of Power Electronics is as follows:

1) To maintain the required current and voltage, and with regulation improve the overall efficiency. Several non-isolated dc-dc converters have been employed. Buck, buck-boost, boost and Cuk topologies with suitable modifications can be employed for this purpose.
2) Interfacing the dc output of the PV system to the grid or the load, this includes dc-dc-ac and dc-ac-ac conversion.

Boost Converter

A Boost Converter (step-up converter) as shown in Fig.3 is a power converter with an output DC voltage greater than its input DC voltage. It is a class of switching-mode power supply (SMPS) containing at least two semiconductor devices (a diode and a transistor) and at least one energy storage element. Filters are made of capacitors (sometimes in combination with inductors) are normally added to the output of the converter to reduce the output voltage ripple. The switch is typically a MOSFET,IGBT or BJT.

The conventional boost converter which could be used in many power electronic applications, for example in regulated DC power supplies, and in photovoltaic systems. The value to stepping up a low DC input voltage to higher DC output voltage of desired load. The converter has two mode of current operations, discontinuous current mode (DCM) and continuous current mode (CCM).

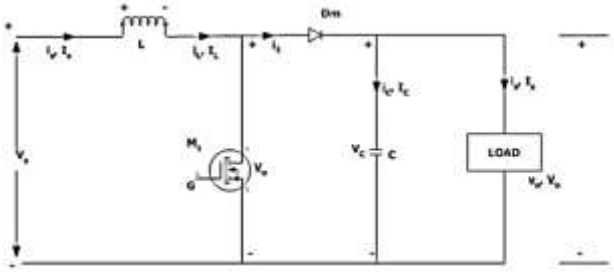

Fig.3.Circuit Diagram of Conventional Boost Converter

Modes of operation of boost converter

The function of boost converter can be divided into two modes, Mode 1 and Mode 2.

Mode 1:

Mode 1 as represented in Fig.4begins when transistor M1is switched on at time t=0. The input current rises and flows through inductor L and transistor M1.

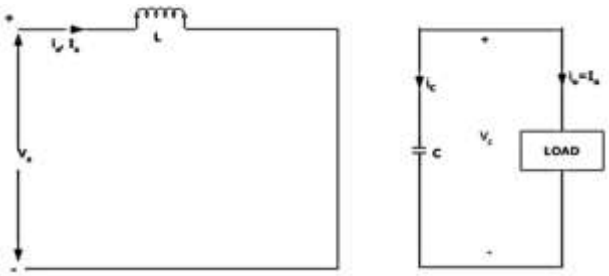

Fig.4 Mode 1 operation of boost converter

Mode 2:

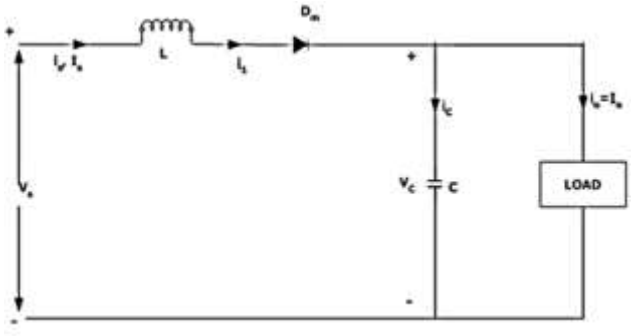

Fig.5. Mode 2 of operation of boost converter

Mode 2 as represented in Fig.5 begins when transistor M1is switched off at time t=t1. The input current now flows through L, C, load, and diode Dm. The inductor current falls until the next cycle. The energy stored in inductor L flows through the load.

Waveforms of Boost Converter

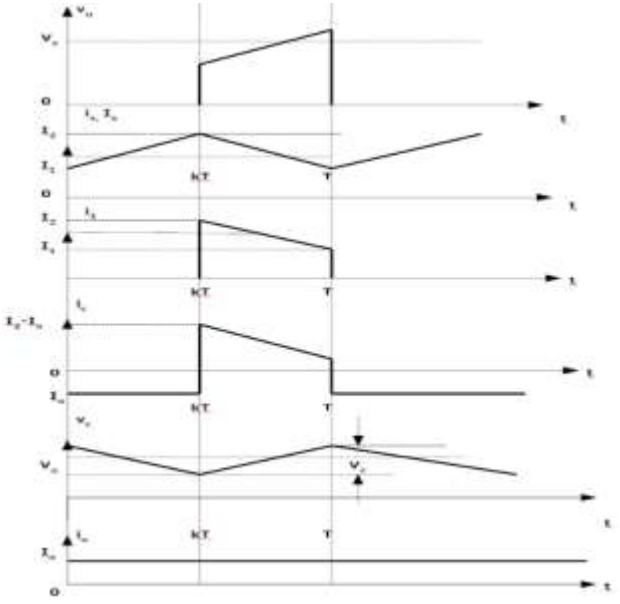

Fig.6 Input and Output Waveforms of Boost Converter

The General Waveforms of the Boost Converter which includes Input Current, Input Voltage, Inductor Current, MOSFET Current, Capacitor current and Load Current and Source Voltage are represented in Fig 6 above.

Design equations of boost converter

The following are the Design Equations that are employed in designing Boost Converter in Continuous Conduction Mode

1. Duty cycle (D)

Formula for the voltage conversion ratio is as below.
Vo / Vs = 1 / (1-D)
D = (Vo – Vin) / Vo (1)
Where D= Duty Cycle
Vs=Source Voltage
Vo=Output Voltage

2. Current Ripple (ΔIL)

Load current Io = Output power / Output voltage
Δ Io = 10 % of load current(IL)(2)
Relation between input and output currents is as below.
Iin =2IL
Δ IL = 20 % of IL (3)

3. Inductor value

$$L = \frac{V_S * D}{Fs * \Delta Io} \quad (4)$$

4. Capacitance value

$$C = \frac{Io * D}{Fs * \Delta V} \quad (5)$$

Batteries in PV Systems

PV stand alone or hybrid power generation systems has to store the electrical energy in batteries during sunshine hours for providing continuous power to the load under varying environmental conditions. The PV system performance depends on the battery design and operating conditions and maintenance of the battery. Batteries of PV systems are subjected to frequent charging and discharging process. Lead acid battery with deep discharge is commonly used for PV applications. One of the best ways to put a solar PV system with battery backup to good use is to charge up the batteries during peak photovoltaic times and then use the stored electricity when the sun is down.

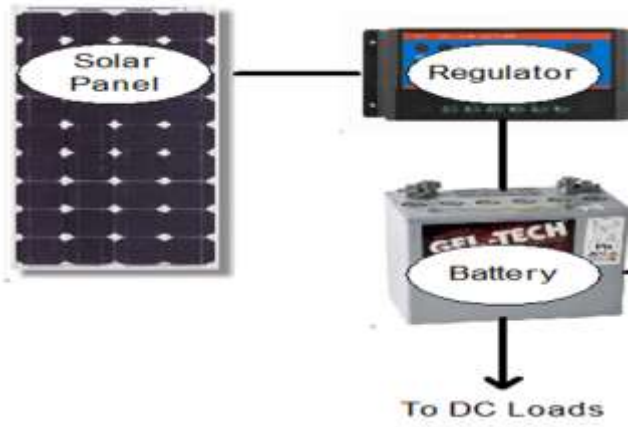

Fig.7 General Block Diagram of Solar PV Systemconnected to Battery

Fig.7 explains the energy storage procedure of battery in Solar PV system with Input Power from solar panel connected to the battery by means of charge regulator. The Output Power from Battery after storage is send to DC Loads. Adding battery storage will help you store your excess generation (that would normally be exported) for use later when your consumption is higher than your generation. As electricity prices rise this sort of battery storage system will become more and more cost effective.

Solar Charge Controller

Solar Charge controller is a device, which controls the battery charging from solar cell and also controls the battery drain by load. The simple Solar Charge controller checks the battery whether it requires charging and if yes it checks the availability of solar power and starts charging the battery. Whenever controller found that the battery has reached the full charging voltage levels, it then stops the charging from solar cell. On the other hand, when it found no solar power available then it assumes that it is night time and switch on the load. It keeps on the load until the battery reached to its minimum voltage levels to prevent the battery dip-discharge.Simultaneously Charge controller also gives the indications like battery dip-discharge, load on, charging on etc.

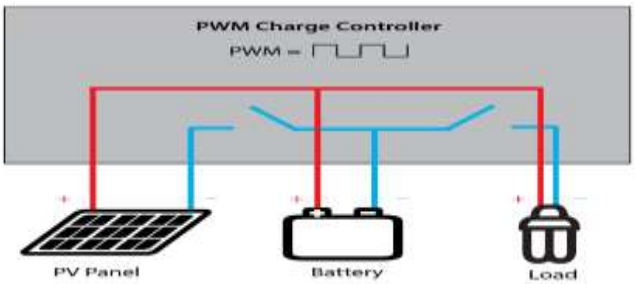

Fig.8 Block Diagram of PWM Solar Charge Controller

The above Fig.8 shows the block diagrammatic representation of PWM Controller connected to PV Panel , Battery and Load. Some modern solar charge controllers use Pulse Width Modulation (PWM) to slowly lower the amount of power applied to the batteries as the batteries get closer and closer to fully charged. This type of controller allows the batteries to be more fully charged with less stress on the battery, extending battery life. It can also keep batteries in a fully charged state (called "float") indefinitely. PWM is more complex, but does not have any mechanical connections to break.

Although any microcontroller with sufficient I/O is suitable for the job but for most suitable microcontroller to choose, we have to keep in mind the following things.

- Should have at least two analog I/O for measurement of Solar and Battery Voltage.
- Otherwise we have to add extra AD converter for the job and it will increase the complexity of the circuits and cost.
- Should have at least two digital I/O, capable of switching High Current MOSFET for battery charging and load.
- Should have at least three digital I/O capable of driving direct LEDs, otherwise we have to add extra LED driver for the purpose.
- Should have minimum circuit requirements for its self operation to cut down the cost.
- Keeping in the mind all above things, AVR and Microchip variants of 8-bit controllers can do these jobs very well. So ATMEGA8 (which is AVR variant) microcontroller is used for this project.

Geared DC Motor

Geared DC motors can be defined as an extension of DC motor which already had its Insight details demystified here. A geared DC Motor has a gear assembly attached to the motor. The speed of motor is counted in terms of rotations of the shaft per minute and is termed as RPM .The gear assembly helps in increasing the torque and reducing the speed.Using the correct combination of gears in a gear motor,its speed can be reduced to any desirable figure. This concept where gears reduce the speed of the vehiclebut increase its torque is known as gear reduction.

Fig.9 Geared DC Motor

Chain Conveyor

A chain conveyor operates on the principle of interconnectivity: a chain connects each gear, resulting in a smooth conveying process. The chain conveyor has a series of gears connected into a continuous system by the chain. Typically, each gear has teeth which create a free rotational interface with the chain. The arrangement is set in such a way that each line carries a single pendant. Conventional steel or multi-flex plastic chains are commonly used in connecting the gears.

Once the products you need to transport are safely loaded on the chain conveyor, the system is powered through the manipulation of the ON/OFF button or switch. This causes a clockwise or counter-clockwise rotational movement on the motor system, depending on the desired direction of movement. This leads to a movement of the networked gears and chain to move in the same direction as the motor. As a result, the chain conveyor moves the load through the drive train to the last gear, where off-loading is done. For unidirectional operations, conveyor systems can also be tailor-made to offer movements to either direction. This is achieved through integrating two or more motors on either end of the conveyor system.

Fig.10 Basic Chain Conveyor

Chain conveyor systems are rugged, durable conveyors used to transport products along a production line. They are suited to many items that wouldn't typically convey on a roller conveyor. Therefore, typical uses are to move pallets, racks, industrial containers and any products with a sturdy lower surface.Fig.10 represents the basic chain conveyor setup.

V. HARDWARE SYSTEM

ELECTRICAL HARDWARE SETUP

The components mentioned in Chapter 6 are connected together in Fig 11.12V, 5W Solar Photovoltaic panel extracts the required solar energy required for the entire system. PWM Solar Charge Controller will utilize the maximum power required from solar panel by comparing the input voltage to a set value which is controlled by ATMEGA 8A Microcontroller by providing PWM Signals to the boost converter. The supply voltage for Microcontroller is provided through Power Supply Board

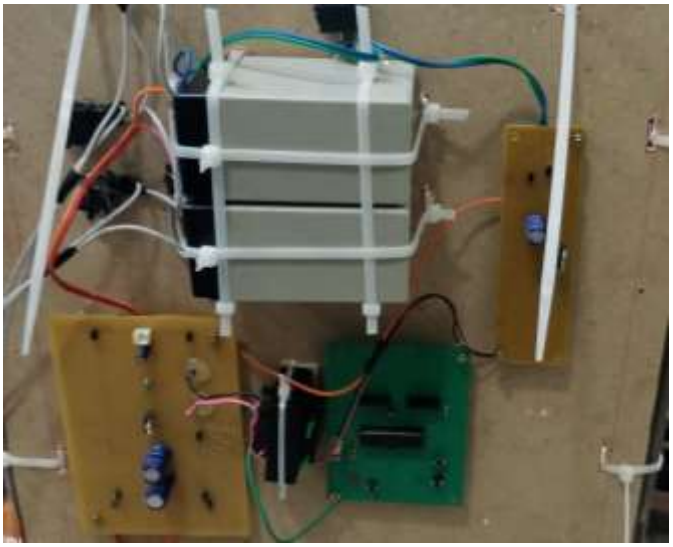

Fig.11. Electrical Hardware Setup of Boost Converter

The input power from solar panel through charge controller is provided to Boost Converter. The function of Boost Converter is to transfer the power by boosting it to required level with minimal losses from 12V to 24V. Once the Power is boosted, it is sent to 24V Batteries thus storing the required power. Input Power is supplied to two 24V DC Switches from battery.

MECHANICALHARDWARE SYSTEM

In Fig.12, When Switch 1 is turned ON, the 24V Geared DC Motor starts to run. This Motor is connected to Turning mechanism which teds the grains present below. When Switch 2 is turned ON, the Geared DC Motor starts to run at maximum of 50 RPM. This in turn runs the Chain Drive which drives the conveyor connected by plates and chain. Each Plate carries the grains present on the floor for drying and carries it to the top of the conveyor, thus filling the box collector present at the back side for grains. The entire system is fitted with four wheels all sides. There is a Metal Handle to

push and move the system at which the Entire Electrical system is fitted.

Fig.12 Mechanical Hardware setup

VI. CONCLUSION

In this project, In order to reduce the Drawbacks of the Traditional Sun Drying, A Mechanical system was Designed and Fabricated with Solar System acting as source of Input Power. Thus this system eases the sun drying by turning the grains for reducing the moisture content and collecting it after its turned.This can be further used for future for extending to larger agricultural applications with automatic control.

VII. ACKNOWLEDGEMENT

Our sincere gratitude and thanks to Dr.N.Senthilnathan, Professor and Head of the Department, Department of EEE for guiding and mentoring us through the different stages of the project. We also thank the management of Kongu Engineering College for supporting the project and appreciating our efforts.

REFERENCES

[1] Edwin DC. Subido, Jr, Danica Mitch M. Pacis, Nilo T. Bugtai ,"Design Implementation of a Tedding Mechanism for Grain Sun Drying",5th DLSU Innovation and Technology Fair 2017,De La Salle University, Manila, Philippines,November 28 & 29, 2017

[2] Sony P. Aquino, Helen F. Gavino, Victorino T. Taylan, and Teresito G. Aguinaldo, "Design, Fabrication and Performance Evaluation of Mobile Engine-Driven Pneumatic Paddy Collector", World Academy of Science, Engineering and Technology,International Journal of Biological, Biomolecular, Agricultural, Food and Biotechnological Engineering Vol:7, No:8, 2013

[3] Sudhakar H S, Indira M S, Gujjala B Balaraju and Siddhartha Bhatt M,"A study of boost converter with solar photovoltaic system for maximum energy efficiency",The Journal of CPRI,Vol. 11, No. 1, March 2015 pp. 133-138.

[4] TesfayeOlanaTerefe,"Design And Development Of Manually Operated Reaper Machine", International Journal of Advanced Research and Publications (IJARP),2017

[5] NasirCoruh ,SatilmisUrgun, TarikErfidan ,SemraOzturk, "A Simple And Efficient Implemantation Of Boost Converter",Issue: 2367, 6th IEEE Conference on Industrial Electronics and Applications ,2011.

[6] Jang Y., Dillman D. L., and Jovanovic´ M. M. " A new soft-switched PFC boost rectifier with integrated flyback converter for stand-by power", vol. 21, no. 1, pp. 66–72.,IEEE Trans. Power Electron,2006

[7] International Research Institute (IRRI), "Paddy drying manual,"Retrieved on November 19, 2011 at http://www.knowledgebank.irri.org/.../Drying. Los Baños, Laguna, Philippines.

[8] International Research Institute (IRRI), "Training manual in grain storage," RetrievedJanuary30,2011athttp://www.knowledgebank.irri.orgericeproduction/PDF_&_Docs/Training_Manual_Grain_Storage.pdf.Los Baños, Laguna, Philippines.