Philippine Rice R&D Highlights 2013

FARMING WITHOUT FOSSIL FUEL

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FARMING WITHOUT FOSSIL ENERGY

Program Leader: Engr. EC Gagelonia

Executive Summary

Modern commercial farming practices, such as the use of gasoline-powered farm equipment, consume a lot of fossil fuel. Natural gas is a key ingredient in synthetic fertilizer that replenishes the nutrients in the soil while commonly used chemical pest killers are petroleum-based. Thus, as rising petroleum prices continue to increase the cost of producing rice, farmers need to use less fossil fuel without significantly reducing crop yields and profits.

In the coming years, fossil fuel will be depleted, and at this point mankind will have to produce its food without the help of fossil fuels and without destroying the soil. However, for an agricultural system to be fossil fuel-free, the application of inputs will have to be minimized; in other words, agriculture will need to be localized (www.grist/article/how-will-we-feed-ourselves/).

The Farming without Fossil Energy Program aims to substantially or entirely remove fossil fuels in rice and rice-based farming by developing alternative energy sources and inputs to come up with sustainable and cost-effective rice and rice-based farming systems. It will explore the various alternative and renewable energy resources such as biomass waste, wind, sun, water and plants in order to develop processes and technologies to help reduce dependence, if not totally remove, on fossil fuels in rice and rice-based farming operations. In addition, the program will study how energy resource use in rice production can be more efficient by identifying available technologies that are resource-use-efficient.

The project on information, knowledge generation on energy profile in rice and rice-based farming system is necessary for the development of renewable and alternative technologies from rice and non-rice biomass. The development of renewable, alternative, diversified and decentralized energy resource systems for and from rice-based agriculture will provide sustainable energy and fuel for farming activities as well as for electricity generation. The adaptation of low external energy input technologies in rice-based farming will contribute in reducing dependence from fossil enegy use in the rice-based farming system.

A 100 KW downdraft rice husk gasification system was developed for electric power generation for water pumping application. Based on initial tests conducted, producer gas was successfully produced during operation. Several tests were conducted to check suitability of main components. Modification on the carbonized rice husk discharge component of the

reactor was made for better performance. Similarly, a laboratory model of gasifier using rice straw as fuel was developed to determine the suitability of rice straw in gasification. Proximate analysis of the rice straw using NSIC Rc 222 was determined and results showed that it is comparable with rice hull. Thus, rice straw can be used as fuel for gasification but due to its high moisture content, a process must be done to make it usable as fuel. On the other hand, a prototype of instant steam generator was fabricated for application to drive reciprocating piston-type engines. Overall results showed the potential of the steam-on-demand concept to be used with the steam engine in farm-level power generation. Refinement in the design is still needed to further reduce the time of generating the steam relative to the start of pumping as well as stabilize the generated pressure while in operation.

A decentralized energy production system has been conceptualized in PhilRice wherein local rice farming communities can produce hydrous bioethanol from nipa sap. The hydrous bioethanol produced can be used in spark-ignition engines as fuel for small-farm machinery and pump boat. A crude bioethanol distiller with a capacity of 180L and a conical grate furnace as its heat source were developed. Results showed that the crude bioethanol distiller has an alcohol recovery of 67% as compared to the 35% alcohol recovery of the local distillers in Infanta, Quezon. Also, a laboratory reflux distilling column was developed. Results showed that 95% hydrous ethanol was produced by two-stage distillation from 10% initial alcohol content. In addition, a fuel feeding device that can be attached to a spark-ignition engine between the carburetor and the intake manifold was developed, thus bypassing the carburetor. Two engines, a 3.5hp Robin and a 6.5hp Kenbo engine, were retrofitted with the fuel feeding device and attached to a water pump and PhilRice micromill, respectively. Tests conducted, showed that the engine was able to attain its rated power with hydrous ethanol fuel but the fuel economy of hydrous ethanol is twice than that of gasoline.

Adaptation of the PhilRice developed technologies for low external energy input will contribute in reducing dependence from fossil energy use in the rice-based farming system. Among the PhilRice developed technologies that can be adapted in the rice-based farming system to increased farm productivity are the continuous flow rice husk gasifier for mechanical drying application, production and utilization of biodiesel from waste cooking oil, adaptation of the rice husk gasification for heat and power generation for community rice milling and the rice hull gasifier engine-pump system for optimum application in rainfed lowland farms.

I. Information, Knowledge Generation on Energy Profile in Rice and Rice-Based Farming System

Project Leader: EC Gagelonia

The primary goal of the Philippine rice industry is to become self-sufficient in rice as the staple food of the ever-increasing population of the country. For almost three decades, the Philippines has been a net importer of rice from neighboring Asian countries.

At present, we have very minimal references on energy usage and energy source in rice and rice-based farming. By having an inventory of these data, the energy usage for each activity or operations can be assessed and the contribution or share to the total energy requirement can be determined. Also, the energy efficiency of the different farm machines can be assessed with the availability of these data.

Incidentally, the petroleum-based products which are necessary and required in the use and operation of machines and agricultural equipment are increasing in prices. Likewise, the alternative use of renewable energy resources are not yet fully developed and are not available in the market. Thus, it is important to look into the energy sources and efficient use of energy in agricultural farming operations and systems.

Energy audit of intensified rice production systems

EG Bautista and CC Launio

The project was aimed to assess the energy involved in rice production systems in the Philippines. Using the life cycle assessment, the whole energy requirement of intensified rice production system was thoroughly evaluated. Data was gathered through personal interview of farmers regarding activities related to intensified rice farming.

Life cycle assessment is use for quantitative analysis of environmental aspects of a product or services over all its life cycle stages. An LCA is a systematic tool that enables the analysis of environmental loads of a product throughout its entire life cycle and the potential impacts of these loads on the environment, emissions to the air, water, and land (such as CO2, BOD, solid wastes) and resource consumption, constitute "environmental loads". Environmental impacts refer to adverse impacts on areas that should be safeguarded, such as ecosystem, human health, and natural resources. There are four phases in an LCA; goal and scope definition, life cycle inventory analysis (LCI), life cycle impact assessment (LCIA) and life cycle interpretation (which is also called as ISO 14040, 1997). This is needed in order to analyze environmental aspects of a product in a systematic way.

Traditionally, products were designed and developed without considering their adverse impacts on the environment. Factors considered in product design included function, quality, cost, ergonomics and safety, among others. No consideration was given specifically to the environmental aspects of a product throughout its entire life cycle. Conventional end-of-pipe regulation focused only on the emissions from the manufacturing processes of a product. Often times, however, adverse impacts on the environment occurred from the other life cycle stages such as use, disposal, distribution, and raw material acquisition. Without addressing environmental impacts from the entire life cycle of a product, for the product design, one cannot resolve the environmental problems accruing from the production and consumption of the product. This study will be dealt with this energy audit of intensified rice production system.

Highlights:

- A national survey was conducted by Socio Economic Division comprising 2500 farmers in 33 provinces. A 12 pages structured questionnaire was used to know farming activities, input used, costs of production, problems encountered, seeding rate for direct and transplanted rice, labor used and other rice farming related matters. Data gathered are still under analysis. Computing the energy of rice production will be computed after the analysis.

- Two presentations related to LCA were done in Indonesia during the Regional Conference and workshop of LCA AgriFood asia 2013 held in Jakarta on June 24-26, 2013.
  a. Recent Development and Applications: Agri-Food LCA in the Philippines
  In this presentation, I first introduced PhilRice as a rice research institute. Introduction of LCA in the Philippines, methods I used to gather the information on LCA, process boundaries in agriculture, previous works related to LCA and people involved in LCA Philippines, organizations that promotes LCA and the concluding remark.

- Green House Gas emission Assessment of rice production in the Philippines. In this presentation, I presented the introduction showing the status of rice in the Philippines, effect of rice production to methane emission, and the methodology used to compute for GHG emissions and result and discussions.

- A paper entitled "Greenhouse Gas Emission of Rice Production System in the Philippines

Based on Life Cycle Inventory Analysis" authored by Elmer G. BAUTISTA and Masanori SAITO was prepared and ready for submission to international journal. We targeted to submit the paper in June 2014.

II.Development of Alternative, Renewable, Diversified and Decentralized Energy Resource System for and from Rice-Based Agriculture

Project Leader: AT Belonio

Biomass, which can be derived from plant materials like rice and other crops including farm wastes, is a potential source of energy for rice mechanization. This energy source can be considered as carbon-neutral since the CO2 emitted by this material when burned is counterbalanced by consuming an equivalent amount of CO2 during their growth stage. Biomass includes rice plant itself and its by-products such as rice husk, straw, and its surrounding weeds in the farming environment. They are usually considered as nuisance in the community due to the large volume and spaces they occupy in the field and in rice mills which makes it necessary for them to be eradicated to take advantage of other farming and business opportunities. Tapping these wastes for beneficial use can provide the energy and power needed to fuel both stationary and agricultural machines used in the farm.

Currently, biomass can be converted into different forms of fuel either solid, liquid, gas, or their combination. Heat can be derived directly by burning biomass with excess air. It can also be burned with limited amount of air to produce char which can be used as soil amendment materials and the heat generated can be utilized to produce steam to provide mechanical power. When burning biomass with limited amount of air, combustible gases such as carbon monoxide (CO), hydrogen (H2), and methane (CH4) are produced. On the other hand, sugar-rich biomass materials such as those living in rice environment like nipa, coconut, sugar, and many others can be processed through fermentation and distillation to extract the bioethanol content which can be used as replacement or supplementary fuel for spark-ignition engines; whereas, oil-based biomass like coconut, jatropha, and others can be converted into biodiesel through methyl esterification that can be used as replacement for diesel as fuel for compression-ignition engines.

Basically, the fuel that can be derived from biomass can be used as source of heat and power. Once power is available, it can be utilized to drive agricultural machines for mechanized operation and/or to produce electricity for powering farmstead equipment and for lighting purposes.

At present, PhilRice is engaged in the research and development of alternative, renewable, diversified, and decentralized energy sources and fuel from rice and non-rice biomass. It is contemplated that the fuel and energy that can be derived from rice wastes and its by-products can be used to fuel varieties of sizes and kind of internal combustion engines that will power stationary and mobile machines for land preparation, irrigation, harvesting, threshing, drying, transport, and milling. With this idea, farmers can be encouraged to produce fuel from their farm which they can subsequently use for their farming activities and they can even sell some for their livelihood. Once this is realized, a sustainable and cost-effective rice farming can be achieved.

Development of renewable, alternative, diversified and decentralized energy resource system from rice biomass
EG Bautista, JA Ramos, LB Moliñawe, AT Belonio, RF Orge, JEO Abon, PS Ramos and MJC Regalado

An electricity generation technology for a rice-producing community can be a good example of a sustainable energy in the area. Electricity from rice husk gasification technology can be generated using their by-products during rice milling operation. The 100kW electricity is enough to supply electric demand for a submersible pump of 30kW, while excess production may be used for lighting purposes.

Rice straw is the major residue in rice production. After the threshing operation, rice straw remains in the field generally unused and scattered for a period of time and immediately burned before land preparation takes place. It is a good source of energy but there are many factors that will be considered in the process before it can be utilized as fuel.

PhilRice has developed biomass energy conversion systems such as the rice hull gasifier and the continuous rice hull (CTRH) carbonizer wherein heat is generated during its operation. A lot of uses can be generated from this heat. Recently, a proof of concept had been produced wherein the heat generated from the CTRH carbonizer was used to pump water. The carbonizer-pump system makes use of the heat to generate steam, through a small boiler attached to the carbonizer at PhilRice to evaluate the technical feasibility of the 'instant steam' generation concept as replacement for boiler. The idea is to generate pressurized steam from a regulated amount of water right at the time when it is needed (steam-on-demand). This will eliminate the use of boilers, thus, a lot safer to use if proven feasible. One of its possible applications would be to drive reciprocating piston-type engines which, if found feasible, could potentially bring back the popularity of steam engines.

Rice husk gasification systems for100 kW electric power generation
EG Bautista, JA Ramos, LB Moliñawe, AT Belonio and MJC Regalado

The newly fabricated 100 kW rice husk gasifier prototype is aimed to produce 100 kW electricity from an engine prime mover fueled by combustible gas produced during rice husk gasification. It was made from locally available materials and manufactured at PhilRice-REMD shop. The main components are the 120cm rice husk reactor, scrubber, filters, gas storage and the engine-generator set. It uses the principle of downdraft rice husk gasification in which producer gas flows from the combustion zone. Although several tests were successfully done, some minor refinements are still ongoing.

Changes from actual design and drawings may be found during actual testing because of the undetermined quality of available fabrication materials. The prototype, if finalized, will be used to supply power to the PhilRice Negros water pump for irrigating its r crops and excess production may be tapped for lighting offices and street lights. Actual performance data will also be collected during the utilization period.

Highlights:

- The CRH discharge component at the bottom of reactor was modified into bigger parts and changed angle of paddles to a better discharging performance.

- Several tests to check suitability of main components were successfully conducted.

- Producer gas was successfully produced during operation. The engine was powered by the gasifier which run at 1050 and 2225 rpm using 1st and 2nd gear at transmission, respectively.

Figure 1. The modified CRH discharge of the 100kW gasifier reactor

Figure 2. The 100kW rice husk gasification system

Figure 3. The 100kW gasifier during actual test

Instant steam generation to drive reciprocating piston engine
RF Orge and JEO Abon

With the rising cost of fossil fuel, there is an increasing interest on the use of steam engines in the farm because of its simplicity in design, operation, and maintenance as compared to the other kinds of engines. The use of steam engines, however, requires steam boilers which are risky to operate because of the possibility of explosion if some safety measures are not religiously followed. Thus, this study is being conducted to develop a safe alternative technology for generating steam for small scale biomass energy conversion systems.

Highlights:

- A prototype of an instant steam generator (ISG) was fabricated and tested. It consisted of 9m long x 25mm diameter BI pipe bent to form a coil so that it can be mounted on the cooking attachment of the continuous-type rice hull carbonizer (Fig. 1). Water is pumped into this coil and is expected to be converted into steam as it comes out of its 3mm nozzle. The desired steam pressure to be attained is at least 4 kg cm-2 (60 psi).

- Performance testing of the ISG prototype was conducted by pumping water into it at different flow rates, making use of a laboratory-type piston pump. Flow rates were varied by varying the number of pumping strokes of the laboratory piston pump. The following number of pumping strokes was used: 0.5, 1, and 2 strokes per second. One stroke at atmospheric pressure is approximately 10mL.

- Test results showed that the prototype generated instant steam in all of the pumping strokes used. Pressurized steam was produced within 20 to 50 seconds from the start of pumping and stayed for about three to five minutes after the last pumping stroke. It was quite difficult to get real time pressure readings because of highly fluctuating pressure.

- A video camera was used to take footages of the pressure readings to help in coming up with a pressure profile at each of the pumping strokes. In all of the pumping strokes tested, steam pressures of more than 7kg cm-2 (100 psi) were observed, already beyond the capacity of the pressure gage used.

- Overall results showed the potential of the steam-on-demand concept to be used with the steam engine in farm-level power generation. Refinement in the design is still needed to further reduce the time of generating the steam relative to the start of pumping as well as stabilize the generated pressure while in operation.

Figure 4. The prototype of the instant steam generator.

Figure 5. Taking footages of the pressure gauge readings

Rice straw gasification
PS Ramos and MJC Regalado

In the Philippines, the major battle cry in the energy sector is the ever-increasing cost and too much dependent from fossil fuel imports. Biomass energy resources are derived from animals and plants, which are converted into energy (wise, 1983). Conversely, the call in the environmental side is the generation of the huge amount of biomass from rice such as rice hull and rice straw. Rice straw biomass is considered as waste and burnt in the open field thereby posing hazard to people and environment.

Rice straw is the major residue in rice production. With the modern varieties, straw production is at least equal to the rough rice yield, based on the harvest index (ratio of grain to grain plus straw) of 0.50 (Yoshida, 1981). Rice straw is roughly 16 million metric tons annual production based on the harvest index of 0.50 (Yoshida, 1981). Rice straw is generally unused and usually scattered in the field and burnt after harvest. There are other uses such as feed for animals, vegetable production and organic fertilizers but on a r very minimal percentage only. However, conversion to energy is probably the most viable and attractive option because it has a high energy content like rice hull that 1 ton is equivalent to around 360 ltrs of diesel fuel or 408 ltrs of gasoline (Braunbeck, CM. et al. 1994 and Tiangco, 1990).

Studies of gasification of various biomass fuels were reported in the past. Payne et. al (1985) tested three sizes of wood chips in an updraft gasifier to measure the effect of wood chip size on operation and efficiency of the system. A developmental research on power generation was made by Coovattanachai (1987). Hoki and Sato (1992) reported a study on biomass gasifier to provide electricity for small scale industry. Singh et. al. (1994) developed and tested a downdraft type paddy husk gasifier for on-farm electricity generation. Aldas et. al. (1998) adapted a simple downdraft gasifier developed by Tiongco et. al. at the University of California, Davis, USA for small-scale applications in agriculture and rural industry.

There are many sources of energy - solar, wind, water, geothermal and biomass – and among them t biomass is abundant and readily available in some places. Using the technologies for converting biomass into a usable form of energy, the dependence of countries on petroleum products will be reduced or minimized.

This study was conducted at PhilRice, Maligaya, Science City of Muñoz, Nueva Ecija using the laboratory gasifier and rice straw as fuel. This is to test whether the rice straw is suitable to gasification, like the rice hull, or not. The moisture content and the size of the straw are the parameters to analyze the gas produce by gasification.

Highlights:

- The proximate analysis of rice hull is 19.7% ash, 63.7% volatile matter and 16.6% fixed carbon (Pathak et. Al, 1986; Pathak et al. 1988; Witte, 1992). While the rice straw proximate analysis results 11.71% ash, 62.92% volatile combustible matter, 25.37 % fixed carbon for NSIC Rc 222 variety (FRDI, 2013) which is almost the same as the rice hull. Therefore, rice husk and rice straw are considered as lower-rank fuel because of high ash content, which requires an ash removal system to maintain a continuous combustion process.

- Table 1 shows the proximate analysis results for three different varieties (NSIC Rc 222, NSIC Rc160 and PSB Rc72H) with the heating value of cal/g).

- Ultimate analysis of the rice straw and the actual gasification process using rice straw as fuel and the gas analysis using the gas analyzer was recommended for better results of the study.

Table 1. Proximate analysis of rice straw

PROXIMATE ANALYSIS OF RICE STRAW

	NSIC Rc 222	NSIC Rc160	M-1
Volatile Combustible Matter (%)	62.92	57.30	60.07
Ash (%)	11.71	15.86	16.58
Fixed Xarbon (%)	25.37	26.84	23.34
Heating Value (cal/g)	3,081.33	2,927.85	2,881.31

(FRDI, DOST Nov. 2013)

Development of renewable, alternative, diversified and decentralized energy resource system from non-rice biomass

AT Belonio, NCM Tado, AV Morales, KC Villota, PM Reyes and MJC Regalado

The high costs of fossil fuels, coupled with the environmental concerns attributed to its carbon emissions, has triggered massive interest in research involving renewable energy sources as substitute to fuel internal combustion engines that are the workhorses of modern mechanized farming. Hydrous bioethanol, which is composed of 95% bioethanol and 5% water, is one of the renewable energy sources that can be produced from biomass sources to replace gasoline. Food prices began skyrocketing as soon as areas dedicated for food production started to be converted for growing fuel crops such as corn and sugarcane. PhilRice found a good source of ethanol that does not compete as a staple food source and is found in many rice ecosystems along different coastal areas all throughout the country.

This project involves the design and fabrication of a distillation plant for hydrous bioethanol production from nipa sap. As nipa is commonly used as feedstock for "vodka", the project also addressed some improvements on the existing vodka distilling apparatus of the farmers to increase alcohol yield and efficiency. It also involves retrofitting of commercially available gasoline engines to enable them to utilize hydrous ethanol as fuel for different farming operations.

A decentralized energy production system has been conceptualized in PhilRice wherein local rice farming communities can produce hydrous bioethanol. As nipa is commonly situated in coastal areas, the farmers in the community are involved in rice farming, fishing and nipa vodka production. The hydrous bioethanol produced can be used in spark-ignition engines as fuel for their small farm machinery and pump boat.

Highlights:

- Developed an improved crude bioethanol distiller for producing nipa vodka and conducted testing in Brgy. Binooan, Infanta, Quezon. The PhilRice crude bioethanol distiller has a capacity of 180L and has a conical grate furnace as its heat source. It consumes 9-14 kg rice hull per hour and a thermal efficiency of 24-31%. Results from the field testing showed that the PhilRice crude bioethanol distiller has an alcohol recovery of 67% as compared to the 35% alcohol recovery of the local distillers in Infanta, Quezon.

- Developed a laboratory reflux distilling column that utilized steel brush and marbles as packing materials. Results showed that 95% hydrous ethanol was produced by two-stage distillation from 10% initial alcohol content. The steel brush was corroded by ethanol, thus, marbles were chosen as packing material for the distillation plant.

- Developed a fuel feeding device that can be attached to a spark-ignition engine between the carburetor and the intake manifold, thus bypassing the carburetor. Two engines, a 3.5hp Robin and a 6.5hp Kenbo engine, were retrofitted with the fuel-feeding device and attached to a water pump and PhilRice micromill, respectively.

- Conducted demonstrations of the water pump and PhiLRice micromill powered by hydrous ethanol during the 2013 Hybrid Rice Congress, Institute Field Day and in Brgy. Binooan, Infanta, Quezon.

- Miscibility tests showed that 95% hydrous ethanol is completely miscible with unleaded gasoline without encountering phase separation problems. Flammability tests showed that hydrous ethanol will ignite even at 30% purity. This allowed for the testing of the engine at lower hydrous ethanol concentrations. Water pumping tests were conducted using different levels of hydrous ethanol and showed that the engine was able to run even at 80% hydrous ethanol fuel.

- Brake dynamometer testing was conducted on a 6.5hp Kenbo spark-ignition engine using 95% hydrous ethanol and gasoline fuels. Results showed that the engine was able to attain its rated power with hydrous ethanol fuel but the fuel economy of hydrous ethanol is twice than that of gasoline.

Figure 6. Field-testing of crude bioethanol distiller at Infanta, Quezon

Figure 7. Fuel-feeding device attached to spark-ignition engine

Figure 8. Water pumping using hydrous bioethanol as fuel

Figure 9. Brake dynamometer of 6.5 kenbo spark-ignition engine at PhilScat

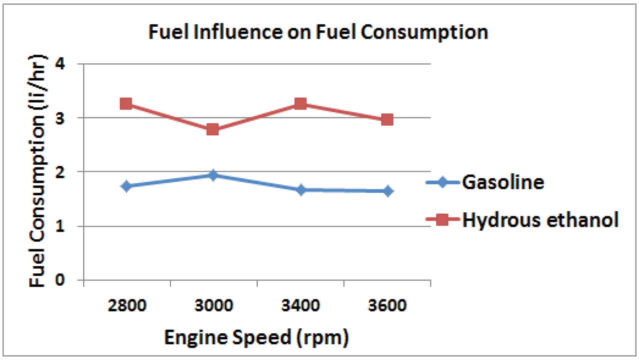

Figure 10. Fuel consumption of engine using hydrous ethanol and gasoline as fuel

III. Adaptation of Low External Energy Input in Rice-Based Farming

Project Leader: JA Ramos

Farm productivity and profitability are the two most important barometers to measure the success or failure of rice production. But high productivity does not necessarily mean profitability. At times, induction of additional inputs provide for higher incremental increase of outputs thereby lessening profitability.

Adoption of modern technologies such as use of high yielding varieties and mechanization, among others, increases productivity but may lead to an equivalent increase in the energy input in production. This has been confirmed accurate by a study showing that the total energy input of mechanized system of rice production in irrigated and non-irrigated fields is 13,920 and 11,969 MJ/kg, respectively. Hence, semi-mechanized system consumes lower at 11,501 and 10,160 MJ/kg (Bautista 2010). Farming system such as this is the usual or the conventional farming system which is energy-intensive and consumes about 837 Mcal of energy to produce a ton of paddy rice, three times higher than the energy input by organic farming system (Mendoza 2002). Nevertheless, most farmers are practicing this method of farming because they seek for high yields during harvesting period and sometimes they do not consider how much they spent to get that yield.

Among the PhilRice developed technologies that can be adapted in the rice-based farming system to increased farm productivity are the continuous flow rice husk gasifier for mechanical drying application, production and utilization of biodiesel from waste cooking oil, adaptation of the rice husk gasification for heat and power generation for community rice milling and the rice hull gasifier engine-pump system for optimum application in rainfed lowland farms.

Adaptation of continuous flow rice husk gasifier as heat source for mechanical drying of palay

JA Ramos, AT Belonio and MJC Regalado

A working prototype of the continuous flow rice hull gasifier was further developed with few refinements based on previous tests that were made. Only minor changes were done on the gasifier to attain desirable performance as to providing heat supply for the dryer. It was then tested with the batch recirculating dryer in paddy drying operation. In 2013, actual drying operations were performed totaling to 8 batches. Five batches of mixed varieties of paddy were dried using the gasifier-dryer system while three batches of M1 rice variety were also dried using the system.

Highlights:

- From the drying of 3 batches of M1 rice variety, the gasifier consumed an average of 41 kilogram of rice husk in an hour of operation. The plenum temperature reached as high as 106°C but it is easily brought down and maintained at about 70°C during the drying process. The gasifier has a computed specific gasification rate of about 140 kg/hr-m2. A summary of test results is shown in Table 2.

- Paddy samples obtained from the drying of M1 rice variety was analyzed in the laboratory for its grain quality together with two other M1 samples that were dried using sunlight and ambient air. A summary of results is shown in Table 3. The mean percentage of brown rice recovery of M1 rice had no significant difference with the use of three drying methods. The percentage of brown rice recovery obtained with the samples dried using the recirculating dryer-cum-gasifier system was 75.95%. The mean percentage of milled rice recovery of M1 rice was also not affected by the three drying methods. The percentage of milled rice recovery obtained with the samples dried using the recirculating dryer-cum-gasifier system was 67.01%. The mean percentage of head rice recovery of M1 rice was also not significantly affected by drying methods. Percentage of head rice recovery is higher at 47.92% with the use of recirculating dryer-cum-gasifier system over the sun dried samples measured at 43.41%. Low head rice recovery obtained using the methods may indicate poor quality of rice samples.

- The profile of temperature, as shown in Figure 11, reveals that the temperature reading at the plenum reached as high as 101°C at the start of gas firing. The drying temperature maintained was about 70°C, with the primary blower set at its lowest air intake. A sudden drop of temperature of drying air indicates the interruption of fire at the burner which has usually occurred during the discharging of char. The temperature inside the reactor varies in range, from 669 to 770°C, after the fire zone has stabilized. The average temperature in the reactor was 774°C. The sudden drop of temperature in the reactor indicates movement of fire zone which has occurred during discharging of char. The flame temperature was measured in the range of from 280°C to 370°C.

Table 2. Results of paddy drying test of the gasifier as heat source in batch recirculating dryer

Parameter	Trial 1	Trial 2	Trial 3	Average
Wt. of paddy, kg	5,856	5,760	6,045	5,887
Initial MC, %	19	19	22	20
Final MC, %	13	12	12	12.3
Firing time, h	0.6	0.75	0.7	0.68
Drying time, h	3.9	4.5	6.8	5.1
Drying temperature, °C	65-73	65-74	67-71	70
Maximum temperature, °C	106	102	95	101
Rice husk consumed, kg	170	178	275	207.7

Table 3. Summary of milling analysis of M1 rice as affected by different drying methods

Drying method	**Brown rice recovery , %**	**Milled rice recovery, %**	**Head rice recovery, %**
Mechanical drying	75.95 a	67.01 a	47.92 a
Air dry	74.40 a	66.71 a	50.12 a
Sun dry	73.83 a	66.83 a	43.41 a

Means in row with the same letter are not significantly different at 5%

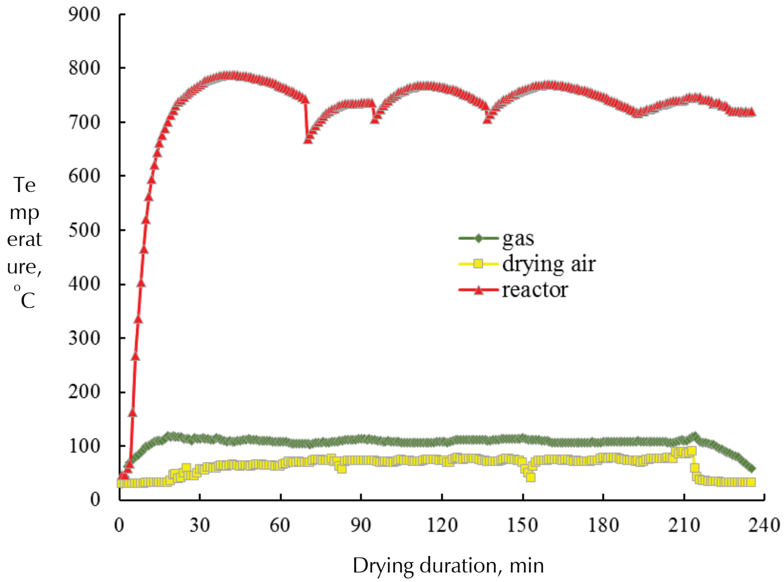

Figure 11. Temperature profile across the gasifier

Production and utilization of biodiesel from waste cooking oil for rice farming operations

PE Mabalot, RF Orge, JEO Abon and F Serrano

The need for sustainable alternative resources of fuel has increased in significance considering the dynamic pricing of petroleum fuels. The cycle of price increase and decrease for petroleum fuels has become a familiar scenario which is considered inevitable in a resource which is believed to be declining in supply. This is coupled with the public's increasing interest on the harmful effects of using non-renewable energy to the environment. Biodiesel then from waste cooking oil will serve not only as a cheaper and environmentally-friendly alternative fuel source but also an optimization of waste materials because the utilization of the material prevents further human consumption of the product which can bring about health risks and an answer to the improper disposal of used cooking oils.

Highlights:

- The methodology used by Dr. Rico Cruz (cruzesterification) was modified to account for the varying quality of oil purchased. It was found out that the recommended 11 grams of potassium hydroxide (KOH) per liter of waste cooking oil is insufficient to convert waste cooking oil to biodiesel when the quality of oil is highly degraded. To account for this varying quality, purchased waste cooking oil was subjected to testing per tin can basis to determine the proper amount of KOH to be used per batch of mixing. It was observed that highly reused cooking oil will require up to 21 grams KOH per liter of waste cooking oil with a conversion rate of 72-75%. Waste cooking oil which was relatively less degraded on the other hand will require 11 to 15 grams KOH per liter of waste cooking oil and will be converted to biodiesel by as much as 92-95%.

- More testing on the different quality of waste cooking oil and a more rigorous characterization both in chemical and physical appearance of the feedstock and biodiesel produced are needed to be accomplished to come up with a simpler processing methodology wherein an initial visual quality assessment on the feedstock and biodiesel can be employed.

- Testing of produced biodiesel at blends of B20 (20% biodiesel), B50 (50% biodiesel), and B100 (100% biodiesel) continue to be viable without encountering engine malfunctions. Biodiesel properties such as viscosity, density, oxidation stability and data on fuel consumption are to be tested in a laboratory.

Modification and adaptation of previously designed rice husk gasification for heat and power generation for community rice milling

EG Bautista, LB Moliñawe and MJC Regalado

Highlights:

- Performance tests show that firing the gasifier took 46 minutes on the average. The voltage ranged from 173-240 volts. Average number of bulbs lighted was 14, which directly show that actual output was 14 kW since each bulb had a 1 kW rating.

- Average consumption of rice husk was found to be 78 kg/ha. The gen-set speed had an average of 1242 rpm. It was also observed that tar collected from the water in the scrubber was about 1.17% of the weight of the water and tar mixture.

- A paper "Evaluation of the up-draft rice husk gasification for power generation" by EG Bautista, M Saito and MJC Regalado, was presented during the 10th International Conference on Eco-Balance at Keio University, Yokohama, Japan on Nov. 22, 2012.

- A presentation of the paper "Evaluation of up-draft rice husk gasification for power generation" was conducted at Tohoku Agricultural Research Center, National Agriculture and Food Research Organization (NARO), Morioka on October 5, 2012. It was attended by around 30 listeners from different agencies in the NARO conference room and was televised.

- A paper was accepted for publication to the Journal of Food and Agriculture environment (JFAE). Confirmation of acceptance will be sent on April 2014. It was reviewed by Dr. Delfin Suministrado of AMTEC, UPLB and Dr. Tomoaki Minowa of AIST, Japan, before being accepted for publication.

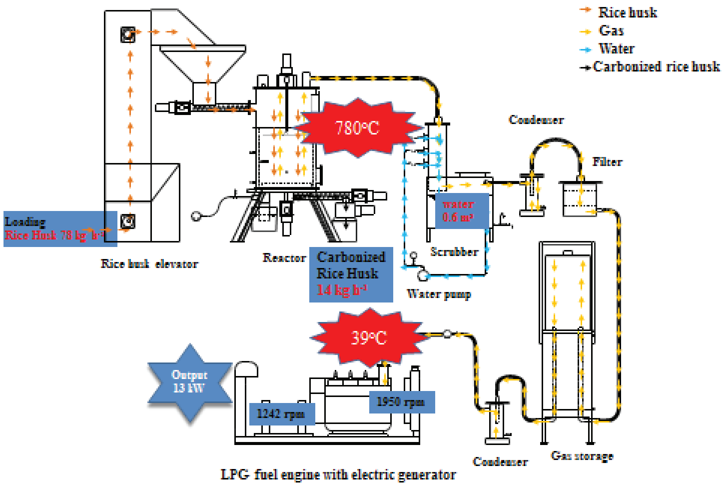

Figure 12. Schematic diagram of the performance test of up-draft gasifier system

Development of ricehull gasifier engine-pump system for optimum application in rainfed lowland farm
AS Juliano

The capacity to irrigate crops of the existing ricehull gasifier engine-pump system designed by PhilRice is not enough and needs to be developed further for the rainfed lowland farm application specifically for small farmers with an average area of one hectare. The system with a four-inch diameter pump size needs to meet the requirement of four (4) hours continuous pumping operation with a water discharge capacity of 10 liter/second (lps). Also, the gasifier system design should be simple and easy to operate to facilitate easier operation (incorporate simple switching device to easily control the mixture of air and producer gas needed to run the engine at optimum performance). Tapping the excess gas of the gasifier system and bringing it back to the reactor/scrubber is important to improve further the performance of the system specifically in increasing the time of operation without additional rice hull biomass. Making the system work at optimum performance to different condition of the ricehull biomass (old and new stock) as source of fuel is also needed.

It is in these contexts that this study was conceptualized. Furthermore, the study will focus on the optimization of water utilization from the rice hull gasifier engine-pump system to be developed for the crops to be considered. The expected results of the study will be the basis for the selection of crops which can achieve their respective significant yields (growth and productivity) corresponding to the fluctuation of water supply from the gasifier system. Eventually, the system should be able to help farmers increase farm productivity.

Highlights:

- Completed the design of new reactor for 2 hours continuous operation. Increasing the diameter of the existing reactor from 30 cm to 50 cm and increasing the height are the major improvements made to attain 2 hours continuous operation. Using this new reactor, a bigger ring/suction blower from 8″ diameter to 12″ diameter was considered to provide enough air pressure needed in the burning of rice hulls and bringing the produced gas efficiently toward the engine. An optimization tests using a bigger suction blower is needed to the system to determine the best speed of the blower that gives enough air pressure with enough producer gas for the engine to run excellently and with minimal excess gas.

- Completed the design of semi-automatic air-gas mixture device. The new design of the device was based on the existing design from the US. A semi-automatic design simplifying the adjustments from two in the existing system (air and gas) to one (gas only) with fix amount of air form the device. Determining the amount of air needed by the engine for optimum performance will be based on the result of the optimization conducted (Table 4).

- Fabricated and tested the reactor for 2 hours operation and the semi-automatic gas-air mixture device using the local materials.

- Conducted optimization tests using the available 16 hp gasoline engine to determine the best setting of the engine with optimum speed performance. As shown in table 1, the 1/3 opening of the gas valve opening and the # 1 setting of the air valve opening gave the best results with less rice hull consumption of 37 kilograms to run the engine for 131 minutes (2.18 hours) with an average shaft speed of 2334.6 rpm.

- Started designing the new reactor for 4 hours continuous operation of the system. From the existing reactor of the system an incorporation of the auger couple with the speed reducer will be considered. The 12″ thickness of the carbonized rice hull in between the reactor and the auger will be included in the design in order facilitate the cooling of the burned rice hull while moving downward to the auger. Determining the proper speed of the auger to meet the requirement of discharging the burned rice hull (CRH) and continuously feeding of rice hull through gravity will be done considering the optimization test of the system with speed reducer.

- Installed the 1.5 pieces of 4″ diameter pipe (STW) at Baloc field in preparation for the experiment. Samples of different layers of the soil during the drilling operation were gathered for analysis. Installation of STW is better to be done during dry season months in order to determine the area with best groundwater aquifer.

Table 4. Initial average result for the engine performance optimization tests using the gasifier system

Producer Gas valve opening	**Ricehull Consumption, kg**			**Shaft Speed, rpm**			**Time of Operation, min**		
	Air valve opening			*Air valve opening*			*Air valve opening*		
	1	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*
1/4 opening	38	38	43	2265.4	2258.6	2358.2	136	103	121
1/3 opening	**37**	41.5	40.5	**2334.6**	2378.2	2436	**131**	110	104

Abbreviations and acronymns

ABA – Abscicic acid
Ac – anther culture
AC – amylose content
AESA – Agro-ecosystems Analysis
AEW – agricultural extension workers
AG – anaerobic germination
AIS – Agricultural Information System
ANOVA – analysis of variance
AON – advance observation nursery
AT – agricultural technologist
AYT – advanced yield trial
BCA – biological control agent
BLB – bacterial leaf blight
BLS – bacterial leaf streak
BPH – brown planthopper
Bo - boron
BR – brown rice
BSWM – Bureau of Soils and Water Management
Ca - Calcium
CARP – Comprehensive Agrarian Reform Program
cav – cavan, usually 50 kg
CBFM – community-based forestry management
CLSU – Central Luzon State University
cm – centimeter
CMS – cystoplasmic male sterile
CP – protein content
CRH – carbonized rice hull
CTRHC – continuous-type rice hull carbonizer
CT – conventional tillage
Cu – copper
DA – Department of Agriculture
DA-RFU – Department of Agriculture-Regional Field Units
DAE – days after emergence
DAS – days after seeding
DAT – days after transplanting
DBMS – database management system
DDTK – disease diagnostic tool kit
DENR – Department of Environment and Natural Resources
DH L– double haploid lines
DRR – drought recovery rate
DS – dry season
DSA - diversity and stress adaptation
DSR – direct seeded rice
DUST – distinctness, uniformity and stability trial
DWSR – direct wet-seeded rice
EGS – early generation screening
EH – early heading
EMBI – effective microorganism-based inoculant
EPI – early panicle initiation
ET – early tillering
FAO – Food and Agriculture Organization
Fe – Iron
FFA – free fatty acid
FFP – farmer's fertilizer practice
FFS – farmers' field school
FGD – focus group discussion
FI – farmer innovator
FSSP – Food Staples Self-sufficiency Plan
g – gram
GAS – golden apple snail
GC – gel consistency
GIS – geographic information system
GHG – greenhouse gas
GLH – green leafhopper
GPS – global positioning system
GQ – grain quality
GUI – graphical user interface
GWS – genomwide selection
GYT – general yield trial
h – hour
ha – hectare
HIP - high inorganic phosphate
HPL – hybrid parental line
I - intermediate
ICIS – International Crop Information System
ICT – information and communication technology
IMO – indigenous microorganism
IF – inorganic fertilizer
INGER - International Network for Genetic Evaluation of Rice
IP – insect pest
IPDTK – insect pest diagnostic tool kit
IPM – Integrated Pest Management
IRRI – International Rice Research Institute
IVC – in vitro culture
IVM – in vitro mutagenesis
IWM – integrated weed management
JICA – Japan International Cooperation Agency
K – potassium
kg – kilogram
KP – knowledge product
KSL – knowledge sharing and learning
LCC – leaf color chart
LDIS – low-cost drip irrigation system
LeD – leaf drying
LeR – leaf rolling
lpa – low phytic acid
LGU – local government unit

LSTD – location specific technology development
m – meter
MAS – marker-assisted selection
MAT – Multi-Adaption Trial
MC – moisture content
MDDST – modified dry direct seeding technique
MET – multi-environment trial
MFE – male fertile environment
MLM – mixed-effects linear model
Mg – magnesium
Mn – Manganese
MDDST – Modified Dry Direct Seeding Technique
MOET – minus one element technique
MR – moderately resistant
MRT – Mobile Rice TeknoKlinik
MSE – male-sterile environment
MT – minimum tillage
mtha^{-1} - metric ton per hectare
MYT – multi-location yield trials
N – nitrogen
NAFC – National Agricultural and Fishery Council
NBS – narrow brown spot
NCT – National Cooperative Testing
NFA – National Food Authority
NGO – non-government organization
NE – natural enemies
NIL – near isogenic line
NM – Nutrient Manager
NOPT – Nutrient Omission Plot Technique
NR – new reagent
NSIC – National Seed Industry Council
NSQCS – National Seed Quality Control Services
OF – organic fertilizer
OFT – on-farm trial
OM – organic matter
ON – observational nursery
OPAg – Office of Provincial Agriculturist
OpAPA – Open Academy for Philippine Agriculture
P – phosphorus
PA – phytic acid
PCR – Polymerase chain reaction
PDW – plant dry weight
PF – participating farmer
PFS – PalayCheck field school
PhilRice – Philippine Rice Research Institute
PhilSCAT – Philippine-Sino Center for Agricultural Technology
PHilMech – Philippine Center for Postharvest Development and Mechanization
PCA – principal component analysis
PI – panicle initiation
PN – pedigree nursery
PRKB – Pinoy Rice Knowledge Bank
PTD – participatory technology development
PYT – preliminary yield trial
QTL – quantitative trait loci
R - resistant
RBB – rice black bug
RCBD – randomized complete block design
RDI – regulated deficit irrigation
RF – rainfed
RP – resource person
RPM – revolution per minute
RQCS – Rice Quality Classification Software
RS4D – Rice Science for Development
RSO – rice sufficiency officer
RFL – Rainfed lowland
RTV – rice tungro virus
RTWG – Rice Technical Working Group
S – sulfur
SACLOB – Sealed Storage Enclosure for Rice Seeds
SALT – Sloping Agricultural Land Technology
SB – sheath blight
SFR – small farm reservoir
SME – small-medium enterprise
SMS – short message service
SN – source nursery
SSNM – site-specific nutrient management
SSR – simple sequence repeat
STK – soil test kit
STR – sequence tandem repeat
SV – seedling vigor
t – ton
TCN – testcross nursery
TCP – technical cooperation project
TGMS – thermo-sensitive genetic male sterile
TN – testcross nursery
TOT – training of trainers
TPR – transplanted rice
TRV – traditional variety
TSS – total soluble solid
UEM – ultra-early maturing
UPLB – University of the Philippines Los Baños
VSU – Visayas State University
WBPH – white-backed planthopper
WEPP – water erosion prediction project
WHC – water holding capacity
WHO – World Health Organization
WS – wet season
WT – weed tolerance
YA – yield advantage
Zn – zinc
ZT – zero tillage

List of Tables

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Department of Agriculture

PHILRICE

PHILIPPINE RICE RESEARCH INSTITUTE

We are a chartered government corporate entity under the Department of Agriculture. We were created through Executive Order 1061 on 5 November 1985 (as amended) to help develop high-yielding, cost-reducing, and environment-friendly technologoies so farmers can produce enough rice for all Filipinos.

We accomplish this mission through research and development work in our central and seven branch stations, coordinating with a network that comprises 57 agencies and 70 seed centers strategically located nationwide.

To help farmers achieve holistic development, we will pursue the following goals in 2010-2020: attaining and sustaining rice self-suffiency; reducing poverty and malnutrition; and achieving competitiveness through agricultural science and technology.

We have the following certifications: ISO 9001:2008 (Quality Management), ISO 14001:2004 (Environment Management), and OHSAS 18001:2007 (Occupational Health and Safety Assessment Series).

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