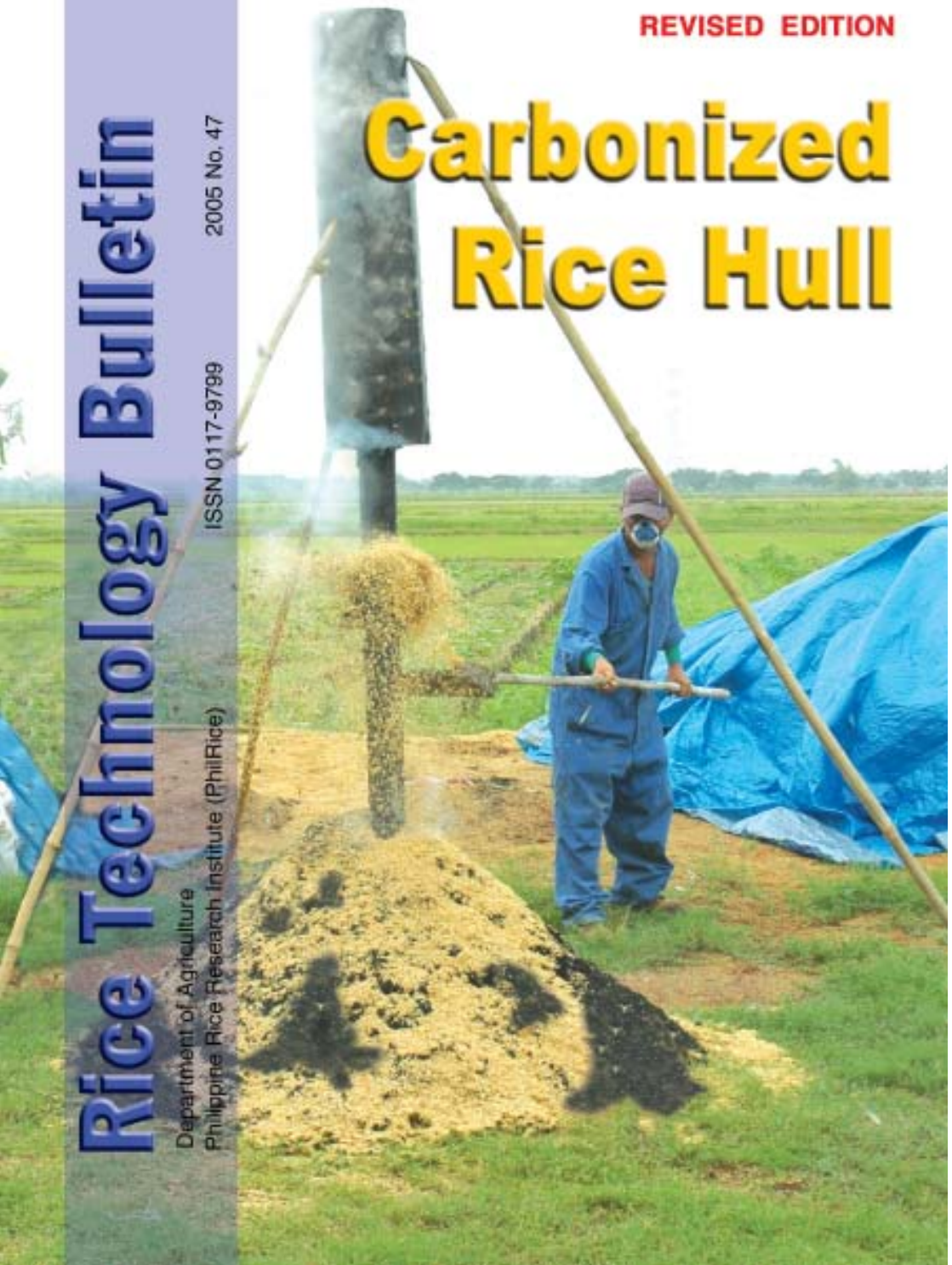
REVISED EDITION

Carbonized Rice Hull



Rice Technology Bulletin

2005 No. 47

ISSN 0117-9799

Department of Agriculture
Philippine Rice Research Institute (PhilRice)

Rice Technology Bulletin Series

No. 1 Released Rice Varieties (1968 - 1994)
No. 2 Pagpaparami at Pagpupuro ng Binhi sa Sariling Bukid
No. 3 Paggawa ng Maligaya Rice Hull Stove
No. 4 PhilRice Micromill
No. 5 PhilRice Flourmill
No. 6 PhilRice Drumseeder
No. 7 PhilRice Rototiller
No. 8 Rice Food Products
No. 9 PhilRice-UAF Batch Dryer
No. 10 Integrated Management of the Malayan Black Bug
No. 11 SG800 Rice Stripper-Harvester
No. 12 Dry-Seeded Rice-Based Cropping Technologies
No. 13 Maligaya Rice Hull Stove
No. 14 10 Steps in Compost Production
No. 15 Rice Tungro Virus Disease
No. 16 The Philippine Rice Seed Industry and the National Rice Seed Production Network
No. 17 10 Hakbang sa Paggawa ng Kompost
No. 18 10 nga Addang ti Panagaramid iti Kompost
No. 19 Characteristics of Popular Philippine Rice Varieties
No. 20 Rice Stem Borers in the Philippines
No. 21 Rice Food Products (revised edition)
No. 22 Leaf Color Chart (English)
No. 23 Leaf Color Chart (Ilocano)
No. 24 Leaf Color Chart (Filipino)
No. 25 Equipment for Rice Production and Processing
No. 26 Use of 40kg Certified Seeds per Hectare
No. 27 Rice Wine
No. 28 Management of Field Rats
No. 29 Controlled Irrigation: A water-saving technique for transplanted rice
No. 30 Minus-one Element Technique: Nutrient deficiency test made easy
No. 31 Management of the Rice Black Bug
No. 32 Management of Zinc-Deficient Soils
No. 33 Management Options for the Golden Apple Snail
No. 34 Use of Evaporation Suppressant
No. 35 Pagpaparami ng Purong Binhi ng Palay
No. 36 Management of Sulfur-Deficient Lowland Rice Soils
No. 37 Management of Planthoppers and Leafhoppers
No. 38 Management Options for Ricefield Weeds
No. 39 Use of Indigo as Green Manure
No. 40 Management of Salt-Affected Soils for Rice Production
No. 41 Wet-Seeded Rice Production
No. 42 Matatag Lines: Farmers Partners in Rice Tungro Disease Management
No. 43 Hybrid Rice Seed Production
No. 44 Metarhizium: Microbial Control Agent for Rice Black Bug
No. 45 Integrated Nutrient Management for Rice Production
No. 46 Management of Armyworms and Cutworms

FOREWORD

Rice hull is considered the most 'unwanted' rice by-product by majority of the rice millers and some farmers throughout the regions. Rice hull disposal has become a problem especially to millers who dump and burn these along roadsides, much as the smoke pesters the motorists, commuters, and the community dwellers.

Now, rice hull can be carbonized to become an extra source of income. Our biomass experts here at PhilRice perfected the process and were able to develop a low-cost equipment for rice hull carbonization. They now train interested individuals and farmer-groups in making quality carbonized rice hull (CRH) not just for local use, but also for export. The first recorded export of CRH to Japan was made by Organic Farmers Unit Association, Inc. (OFUAI) of Balbalungao, Lupao, Nueva Ecija. This venture gave them a gross income of PhP45,000 in a month! This was made possible through the technical expertise of PhilRice, the assistance of our NGO-partner, the Philippine Rural Reconstruction Movement (PRRM), and a private company, AIM Trading Corporation, as the main exporter of quality CRH.

Farmers- turned-entrepreneurs in rice-based production ecosystems especially in San Pablo City, Laguna and in Talavera, Lupao, and San Jose City, Nueva Ecija are also producing CRH. To date, five peoples' organizations (POs) under the PRRM-Kalikasan began exporting CRH to Japan. Also, an Automated Carbonization System (ACS) developed from Japan has been adopted by Oliver Enterprises owned by Nestor Vendivil of Bakal II, Talavera, Nueva Ecija, with the technical support of PhilRice's Waste Management Committee.

We encourage more farmers and other enterprising groups to try this very promising venture. Thus, we came up with this bulletin that presents the outstanding features of the CRH including the procedure and economic analysis of CRH production. The procedure on how to make a simple open-type carbonizer out of locally available materials at minimum cost is also appended for easy reference. With this technology bulletin, we hope to add more value on rice, and consequently, help rice-based communities to become more productive.

Read on and learn how to turn a waste into cash.

LEOCADIO S. SEBASTIAN
Executive Director

INTRODUCTION

Rice hull (or husk) is the outermost layer covering the rice grain. It is commonly detached during milling and most oftenly burnt and turned into waste. At PhilRice, researchers have found that these unwanted rice hull can be carbonized for different purposes.

Carbonized rice hull (CRH) is made from incomplete or partial burning of rice hull. It is porous and bulky with uniform intact black particles. It contains phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg), and micronutrients vital to growing crops. Because it is also sterilized, it is free from disease organisms. It has many uses ranging from agricultural to industrial purposes. Aside from this, it has also been discovered for medical and home uses.

Every year, the Philippines is producing about 3.1 million metric tons (M mt) of rice hull from about 14 M mt palay. But most of this is just wasted because many rice-based farmers and entrepreneurs have limited knowledge on how to properly manage it. If farmers and entrepreneurs learn, practice, and perfect the technology of carbonizing rice hull to make quality CRH for export, they can earn as much as PhP5,000 a month by producing 1,000 packs of quality CRH at PhP5 per pack (400-500 grams per pack), or a total of PhP9.6 billion a year!

The process described in this bulletin will help not only in properly managing rice hull but also in preventing environmental and human health hazards, while increasing productivity among users.

PROBLEMS ADDRESSED

- Rice hull disposal
- Environmental hazards
- High farm input costs such as fertilizer and insecticide
- Difficulty in pulling rice seedlings
- Water impurities
- High cost of fuel
- Agricultural land degradation

USES

1. As substrate to organic fertilizer

- When mixed with other organic materials, CRH can be a good source of organic fertilizer (OF).

- At PhilRice, the basic mixture of organic fertilizer consists of animal manure (4 parts), CRH (4 parts), rice bran (1 part), and compost (1 part) to produce a good yield.

2. As soil conditioner / ameliorant

- Incorporating 10-15 bags (10 kg/bag) of organic fertilizer with CRH into 20 plots of seedbed at 1 m x 20 m each plot (400 sq. m) good for a hectare makes pulling of rice seedlings easier.

- CRH helps replenish the nutrients and other microelements in the soil that were lost due to continuous cropping.

- It also improves soil structure by increasing bulk density, water holding capacity, and aeration.

- When mixed with garden soil and compost at 1:1:1 ratio, it is a good potting media. Compost is a mixture of decayed organic materials decomposed by microorganism in a warm, moist, aerobic environment, releasing nutrients into readily available forms for plant use *(see Technology Bulletin No. 49 pp.10-12 on how to make a compost from farm and household wastes)*

3. As water purifier / waste water filter

- Activated carbon from CRH filters the dirty particles in water, making it effective in purifying household/drinking water.

- CRH is effective in treating waste water for recycling.

4. As base material for making microbial inoculants (MIs)

- When 30-50% of CRH is mixed with MIs, it becomes more useful. Naturally, CRH is a habitat for beneficial microorganisms that facilitate composting.

- CRH can be used as inoculant-carrier for *rhizobia,* a nitrogen-fixing bacteria found in the roots of legumes.

5. As pest control agent

- Owing to its natural black color, CRH retains heat from the sun. It also contains silica that irritates the golden *kuhol.* When applied after leveling, snails are forced to come out, making handpicking faster and easier.

6. As charcoal for fuel

- Charcoal briquettes from CRH are good alternative sources of fuel. Compared with plain rice hull that takes relatively more time to produce heat, CRH can easily be ignited to produce heat or convert heat into fuel for cooking.

7. As deodorizer / odor suppressant

- CRH also cleanses and deodorizes bad air smell through its activated carbon that absorbs foul odors in the air. The same principle applies when a charcoal is placed inside a refrigerator.

- CRH is used as mulch bed in animal pen and poultry houses to reduce foul smell from urine and feces.

In large-scale rice hull carbonization, pyroligneous substances (e.g. tar) can be used as an active ingredient in producing pesticides. The smoke from the burning rice hull is also a form of gas that generates electricity. CRH also produces smoke vinegar that has many possible uses. At PhilRice, these new technologies are still under observation and further testing for agricultural and industrial purposes.

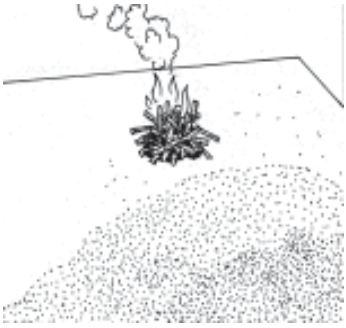
How to make CRH

Materials needed:

- rice hull
- open-type carbonizer
- 200 L oil drums
- long-handled spade/shovel
- match or lighter to start fire
- dried woods/recycled papers
- sprinkler
- G.I. sheet for base
  (optional, if the area is not cemented)

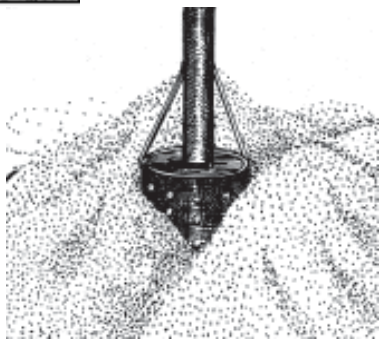
1. Produce fire using pieces of wood, dried leaves, and used papers or newspapers.

Carbonize in a clean, dry, levelled and cemented area, away from residential places, under a tree, and preferably early in the morning or late in the afternoon.



2. Cover the fire with an open-type carbonizer. *(see p 10)*

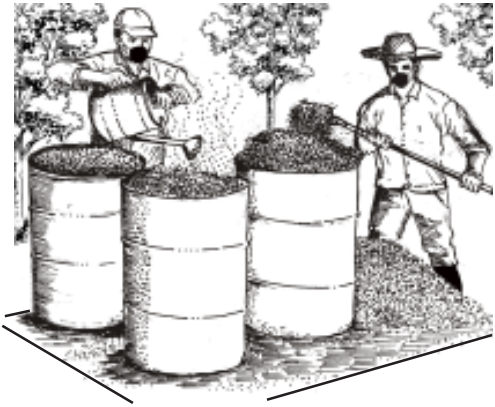
3. Place 12-14 sacks of rice hull around the carbonizer or until it reaches the chimney at 1 meter high. This is to maximize burning time and effort to make more CRH during carbonization than putting a minimum of 3 sacks rice hull around the carbonizer per batch.



When using open-type carbonizer, carbonization can be done under fruit trees to use the smoke for fruit setting and insect pest control . Burning in an open area during windy days prolongs carbonization.

4. After 20-30 minutes or if the rice hull on top of the mound is burning, move the rice hull from bottom to the top of burning mound. Avoid getting too close to the mound while it's hot. Use protective gadgets (*e.g.*, mask and boots).

5. When the mound turns completely black, put the CRH in 200 L oil drums then slightly sprinkle it with water (at most 1 L) using a sprinkler or a knapsack sprayer with fine nozzles to extinguish the smoke and lower the temperature. Do not overburn the rice hull as it will become ash.



6. Allow the freshly-made CRH to cool completely. The following day, bag, seal, and stock it in a safe and dry place.

Export quality CRH has pure, uniform, and intact black particles - no mixture of yellow (unburnt rice hull) and or gray (rice hull ash) .

COST AND RETURNS OF PRODUCING 9 TONS* OF CRH

	PhP
NET INCOME	**31,943.11**
GROSS INCOME	**45,000.00**
PRODUCTION COST	**13,056.89**
Cash costs	
Rice Hull	3,461.54
dried woods	140.00
labor cost	4,500.00
sacks for packaging	4,500.00
Imputed cost	
depreciation cost (carbonizer, drum, sprinkler)	455.35
Benefit-Cost Ratio	*3.45*

** based on OFUAI's experience within 28-working days*

PhilRice Open-type Carbonizer

Where to buy	:	Patricia F. Sagun, OFUAI President Balbalungao, Lupao, Nueva Ecija
	:	Fidel Alfonso 194 San Pascual, Talavera, Nueva Ecija
	:	Danver Tinsmith T. Calo St., Butuan City
	:	Democrito P. Plaza RTR Romualdez, Agusan del Norte
Intended Beneficiaries	:	Farmers and entrepreneurs in the rice-based production ecosystem
Outstanding features	:	Inexpensive and easy to fabricate, lightweight and portable, easy to operate, efficient, and economical
Material used	:	#22 GI sheet for the chimney Used oil drum for the ignition chamber
Unit Cost	:	PhP400-500 per unit (without smokestack) as of 2005
Principle of operation	:	Carbonization is partial combustion of biomass. Ignite few combustible materials (e.g., paper, chaffs) and cover with the ignition chamber. Slowly scatter the rice hull outside the chamber and make mound. Draft force that pulls the smoke through the chimney would continually draw air to carbonize the rice husk. Lengthening the chimney will hasten the carbonization process while enlarging the mound will prolong the process.

Performance Test Results:

Volume of rice hull	:	1,585 L
Duration of Cabonization	:	4-5 h
Volume of CRH produced	:	982 L
Thermal conversion efficiency	:	62 %
Capacity	:	317 L/hr
Carbonization temperature	:	520-560^{O}C
Quality of CRH	:	98% black-colored
Smoke reduced	:	80%

How to make an open-type carbonizer

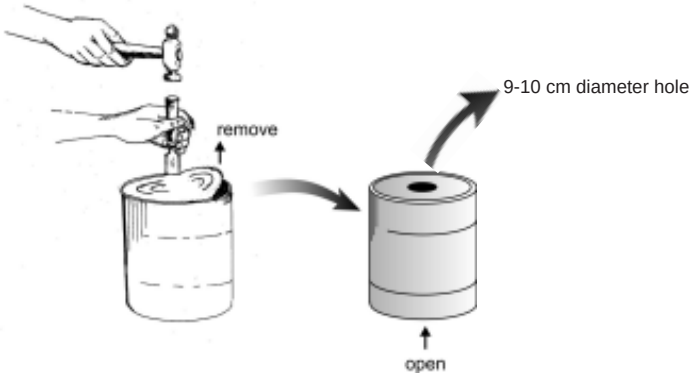
Materials needed:

- *20 L Used oil can*
- *Soldering iron, welding machine or oxy-acetelyne welding*
- *Screws*
- *Metal puncher and cutter*
- *GI sheet #22, 4 x 1 ft.*

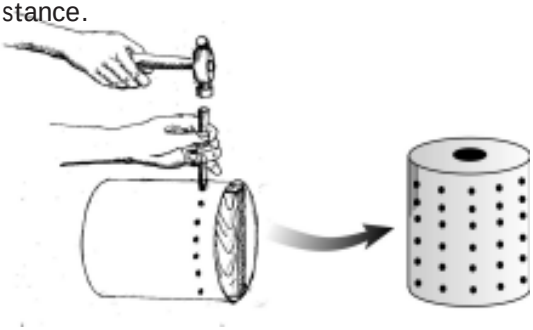
1. FOR THE CHAMBER:

a. Get any 20 L used oil can, about 40 cm height.

b. Remove the top cover and make a hole at the bottom of the can about 9-10 cm diameter for the chimney.



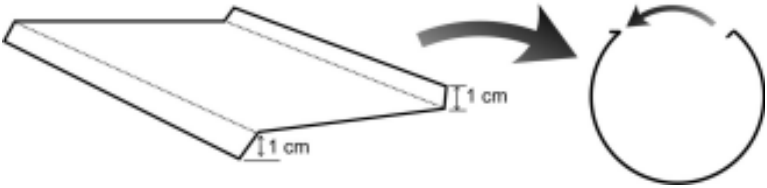
c. Use a metal puncher to make 30-40 holes at 2-cm diameter aligned at 10 x 10 cm distance.



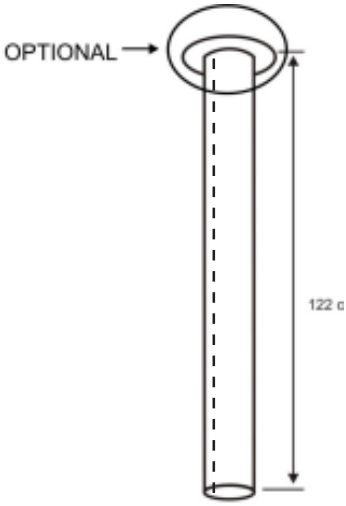
2. FOR THE CHIMNEY:

a. Get a 4 x 8 ft (122 x 244 cm) GI sheet #22 and cut it at 30.5 cm width per chimney. (makes 8 chimneys)

b. Take one cut sheet (30.5 cm width; 122 cm high). Fold 1-cm thick at both length ends of the sheet and clamp them together to make a roll.



c. Attach a 20-cm circumference GI sheet at one tip of the chimney (upper part of the carbonizer) that can be connected to the chimney of the filter to trap the smoke. (optional)



3. a. Weld the chimney to the chamber hole.

b. To make the carbonizer more sturdy and durable (for 2 months of continuous daily use), you can also attach 3-pc of steel (about half inch thick, and 1 ft long), connecting the chimney and the chamber.

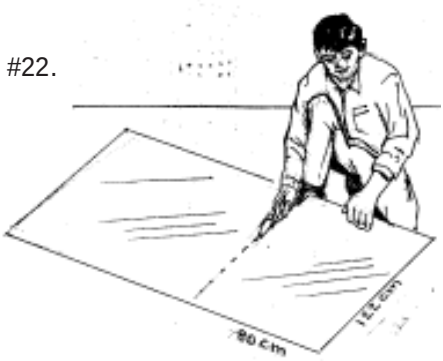
PhilRice Open-type
(without smokestack)

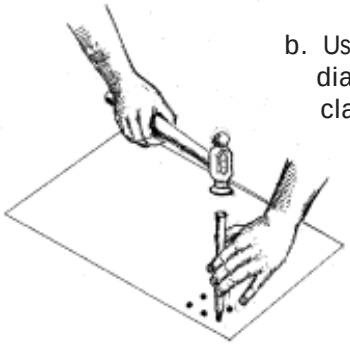
How to make the filter with smokestack (optional)

A filter with smokestack can be attached to the open-type carbonizer to trap and minimize the smoke coming out of burning rice hull that might cause air pollution, especially when carbonization is done within a a residential area. Carbonization is done preferably under fruit-bearing trees because the smoke will be used in the flowering of these trees.

1. **FOR THE FILTER:**

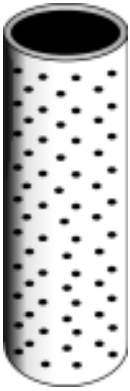
a. Cut a 80 x 122 cm GI sheet #22.





b. Use a metal puncher to make a 40 holes at 2-cm diameter aligned at 10 x 10 cm distance. Fold and clamp together using soldering iron.

c. Close one end of the filter by attaching a circular-cut GI sheet with 9-10 cm hole at the center.



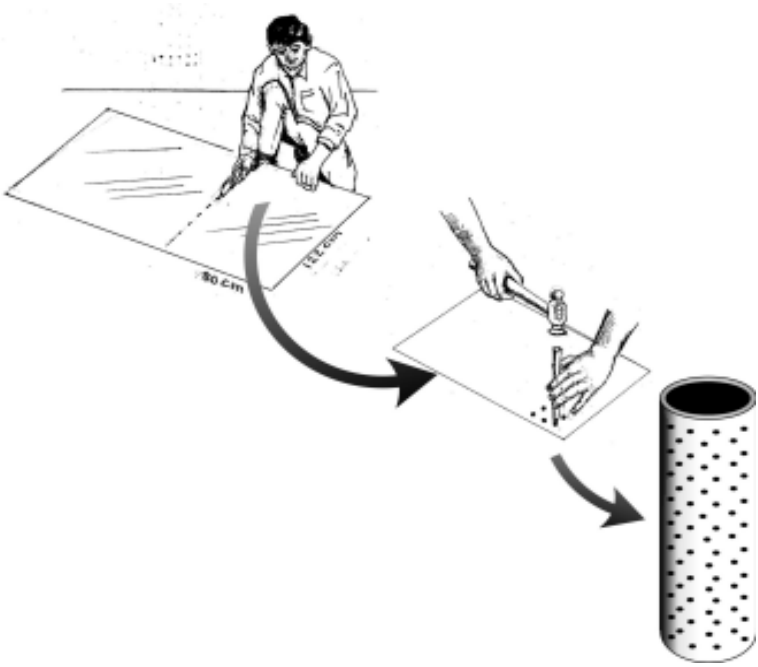
2. **FOR THE FILTER'S CHIMNEY:**

a. b. *follow same procedures a & b of carbonizer's chimney on page 11.*

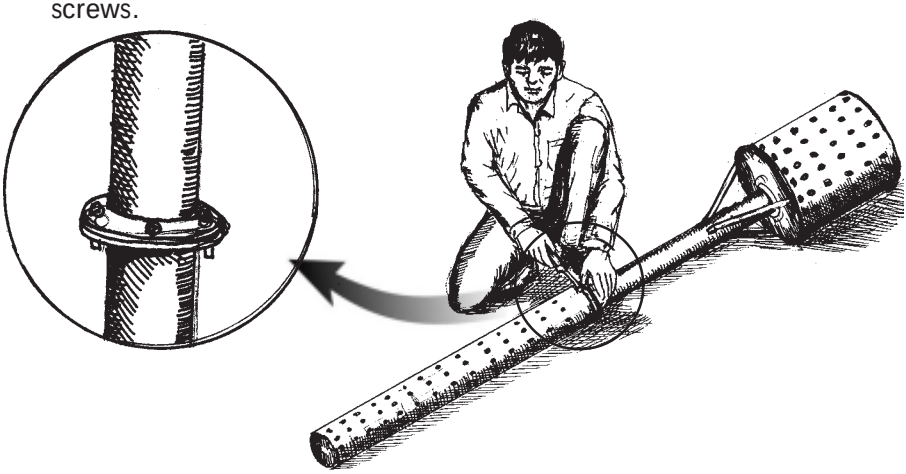
c. Close one end of the chimney by attaching a circular-cut GI sheet.

d. Leave about 15 cm unpunched holes at the upper part of the chimney. Punch about 40 holes within the remaining 107 cm area of the chimney.

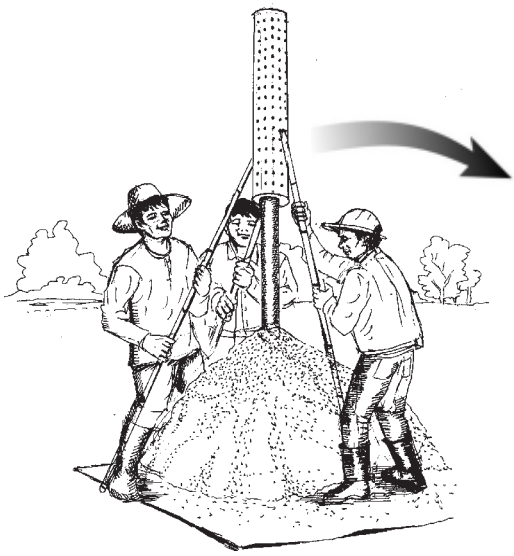
e. Attached a 20-cm circumference GI sheet to the upper portion of the carbonizer's chimney using screws.



3. a. Connect the filter's chimney to the carbonizer's chimney using screws.



b. Put the filter (stocked with sawdust) at the top to trap and minimize the smoke during carbonization. Use 2-3 pcs of bamboo poles inserted either at the adjacent holes or just below the filter to keep it sturdy during actual carbonization in an open area.



Carbonizer with filter (smokestack - optional)

during actual carbonization

REFERENCES

Belonio, A.T. *" Design and Evaluation of a Drum-type Rice Hull Carbonizer and the Manually-Operated Molder for BioCoal Fuel Production and for Agricultural Applications".* http://www.cpu.edu.ph/urc/abstract3.htm. February 2003. 6p.

Ebara. Ebara Rice Husk Utilization, A three-fold leaflet-brochure. "Production of Rice Husk and Electricity". Ebara Corporation, 11-1 Haneda Ashai-cho, Otaku, Tokyo 144 Japan.

International Rice Research Institute. TropRice. *"Rice Byproduct/Rice hull/ husks Uses"*. http://www.knowledgebank.irri.org/troprice/ rice_hull_Uses.htm.Los Baños, Laguna, Philippines. September 2002. pp. 1-3

SLCBC. *"San Leonardo Charcoal Briquetting Corporation".* Geocities. http://www.geocities.com/slcbc_gpe/SLCBC.html. 2002. p. 1

Pablico, S. MA. *"Carbonization turns rice hull into cash".* Agriculture Magazine, February 2003. Vol VII (2) pp. 10-11, 58.

Tadeo, B.D., R.C. Corales, R.E. Aldas, H.X. Truong, P.S. Ramos, and N.A. Ablaza. *"Development of eco-profitable agricultural products by system integration of biomass and other household farm wastes in the Philippines".* Philippine Rice Research Institute (PhilRice) Maligaya, Science City of Muñoz, Nueva Ecija, Philippines. http.www.philrice.gov.ph/biomass utilization.html. September 2002. 5p.

Taguinod, AC. PhilRice Newsletter, *"Rice hull: a golden waste".* Maligaya, Science City of Muñoz, Nueva Ecija, Philippines. July-September 2002. Vol. 15 (4). p. 8

Subject Matter Specialists for revised edition
Contancio A. Asis Jr, PhD
Rizal G. Corales
Jocel C. Cordero
Bernardo D. Tadeo, PhD

Managing Editors/Writers
Arturo C. Taguinod
Teresa P. de Leon

Graphics Design and Layout
Eladio M. Avellanoza
Carlo G. Dacumos

Illustrations
Carlito N. Bibal

Photos
Jocel C. Cordero
Arturo C. Taguinod

Editorial Advisers
Leocadio S. Sebastian, PhD
Kathleen D. Solis

For more information, contact:

Rice Engineering and Mechanization Division
Philippine Rice Research Institute
Maligaya, Science City of Muñoz, 3119 Nueva Ecija
Tel. No. (044) 456-0285; -0113; -0651 locals 309 & 311

Published 2005 by the Philippine Rice Research Institute.

PhilRice

PhilRice is a government-owned and controlled corporation attached to the Department of Agriculture. It was created through Executive Order 1061 dated 5 November 1985 (as amended) to help develop high-yielding and cost-reducing technologies so farmers can produce enough rice for all Filipinos.

It accomplishes this mission through research, development and extension (RD&E) through its central and branch stations coordinating with a network that includes 57 agencies and 70 seed centers strategically located nationwide.

PhilRice is an ISO14001-certified agency.

Its interdisciplinary programs are the following: (1) direct-seeded and (2) transplanted irrigated lowland rice; (3) hybrid rice; (4) rice and rice-based products; (5) rice-based farming systems; (6) policy research and advocacy; and (7) technology promotion. With these programs, PhilRice develops and promotes technologies that are ecosystem-based, location- and problem-specific, and profitable to the Filipino farmers.

for more information, text or call (0920)911-1398; write, visit or call:

Department of Agriculture

Philippine Rice Research Institute

ISO 14001 CERTIFIED

PhilRice *Central Experiment Station*
Science City of Muñoz, 3119 Nueva Ecija
Trunklines: 63 (44) 456-0394, -0426, -0649, -0651, -0652
E-mail: prri@philrice.gov.ph
Website: http://www.philrice.gov.ph

PhilRice *Batac*
Batac, 2906 Ilocos Norte
Tel: (77) 792-4714
Tel/Fax: 792-4702; -2544
E-mail: batac@philrice.gov.ph

PhilRice *Isabela*
San Mateo, 3318 Isabela
Tel: (78) 664-2280, -2954
Tel/Fax: 664-2953
E-mail: san_mateo@philrice.gov.ph

PhilRice *Los Baños*
UPLB Campus, College, 4031 Laguna
Tel: (49) 536-3631 to 33
Fax: 536-3515; -0484
E-mail: los_banos@philrice.gov.ph

PhilRice *Negros*
Cansilayan, Murcia, 6129 Negros Occidental
Tel/Fax: (34) 446-3403
E-mail: negros@philrice.gov.ph

PhilRice *Agusan*
Basilisa, RTRomualdez, 8611 Agusan del Norte
Tel: (85) 818-4477; 343-0778
Tel/Fax: 343-0768
E-mail: agusan@philrice.gov.ph

PhilRice *Midsayap*
Bual Norte, Midsayap, 9410 North Cotabato
Tel: (64) 229-8178
Tel/Fax: 229-7242
E-mail: midsayap@philrice.gov.ph