Charcoal Production in Davao, Mindanao, Philippines:
Introducing Yoshimura and Iwate Kilns

Charcoal is widely used in the Philippines, especially in the Southern region. Most charcoal producers in the Mindanao islands use the traditional ground-pit method of production. This method involves filling a large pit with wood, igniting it, and covering the pit with soil. Two small pipes are inserted to allow smoke to escape.

Many other methods of charcoal production exist which are able to produce higher quality charcoal products than the traditional ground-pit method. Above-ground kilns allow for greater control of the temperature and
The kilns in these areas, Approtech and ARECOP decided to build them in Davao. The constructions of the kilns in Davao served multiple purposes:
1. As a technology transfer within the ARECOP network
2. As preparation for other regional high-quality charcoal production
3. As a production center
4. As a training center for high-quality charcoal production
5. As a facility for further research and development of high-quality charcoal in the Philippines

Approtech and Yayasan Dian Tama provided the necessary space and materials, as well as helping hands during the construction of the two kilns. ARECOP provided a kiln production expert to design the kilns and guide their construction.

The Yoshimura Kiln
The Yoshimura kiln was designed with a chamber measuring 2m in diameter and 1m high. The kiln's capacity was 3.5m³ of wood, with an expected output of 350 kg of charcoal. Four chimneys attached to the kiln allowed for wood vinegar collection.

The fire chamber was designed with a small size to avoid adding too much height to the kiln. Dry wood was used for fuel to maximize the kiln's efficiency during the early stages of firing.

The inner and outer walls of the kiln were constructed using a mold. The space between the walls was filled with a mixture of red clay, sand, coral sand, and crumbled material from previous building structures. Shrinkage caused by the red clay as it dried was amended by refilling the mixture from the top.

The kiln floor was made of concrete. The chimney was constructed of red bricks, with sand and coral applied around the chimney body.

A metal kiln cover was made in a local metal workshop. Convincing the workshop owner to make the kiln cover was rather difficult and required a great deal of discussion. The kiln cover was completed in the last hour of the last day of the training workshop. Luckily, it was well made and fit perfectly with the kiln construction. The cover was then painted to prevent it from rusting.

During operation, the kiln lid must be covered with 15 cm of rice husk ash. The ash functions to insulate the kiln and maintain the high heat.

The Yoshimura kiln can be operated directly after construction...
Vinegar can also be collected from rice husk ash. To minimize the risk of the kiln dome losing shape during the curing process, a 20 cm x 20 cm grid frame was constructed to support the dome, made from 10 mm iron bars.

The Iwate kiln takes more time to operate, but produces higher quality charcoal and wood vinegar than most kiln models.

Other Alternatives: Smoke Charcoal, Vertical Drum Kilns, and Horizontal Kilns

Although the kiln construction was greatly appreciated by the local participants, many were concerned that the quantity of charcoal production may be limited. In response, the production expert provided instructions for several other types of above-ground kilns to help supplement charcoal production:

1. Smoke charcoal technique: Usually used to carbonized fine materials such as rice husks or saw dust. Made from GI pipe or hollow bamboo pipe.
2. Vertical drum kiln: Used to produce charcoal from dry biomass waste.
3. Horizontal drum kiln: Used to produce charcoal from wood. Produces better quality charcoal compared to traditional methods.

Participants learned the basic principles of carbonization using these techniques. All of the above kilns were completed in 10 days and were only possible because of the hard work of the coordinator from Approtech Asia, along with ARECOP staff and local workers.
Since 1965

Rows of neatly stacked wood were seen as we entered the front yard of Paidi’s house. The wood pieces have been chopped into uniform lengths and stacked up to one meter in high.

We proceeded to the back yard, an area of modest size where there were operating pit kilns, releasing thin smokes from cracks on the outer soil surface. Mr. Paidi started selling firewood from more than 40 years ago. At that time, he was still young; he with his assistants purchased trees, cut and chopped them into sizes, which was then sold. Trees were purchased from the surrounding villages. “In the past, there were still a lot of trees. I chopped the wood and sold it as firewood”. He was telling us story from the past.

He still remembered that in 1965,
Mr. Paidi decided to hire a charcoal producer from Temanggung to produce charcoal at this place for a month. The technique used by the Temanggung producer was different from what he had known previously. Initially, a ground was excavated, with the length of the pit based on the length of the wood to be processed, while the depth of the pit is based on the stacking height of the wood. Wood is then stacked inside the pit and firing was conducted from the bottom. When sufficient temperature has been obtained, the top surface of the stack is covered with rice straw and then is covered by a layer of soil. The process is left for 3-4 days and the wood has been converted to charcoal. The completion of the process is indicated by the drop on the level of the top most surface by 15-20 cm and the appearance of thin and small quantity of smoke from the cracks on the surface on the kiln's surface. The kiln can then be dug and the charcoal harvested.

According to Mr. Paidi's observation, higher quality but lesser quantity charcoal is produced using the technique. The smaller yield was due to the production of higher amount of ash. Using the old technique, 6 big sacks of charcoal can be produced compared to the 5 produced using the newer technique. Since consumers paid the same price for charcoal of different qualities, hence the new technique does not bring about economic improvement. Besides the economic issue, according to Mr. Paidi, the new technique is also more complicated, firing is more difficult, and the need for more frequent control since fire often goes off.

Not thoroughly satisfied with the charcoal production method from Temanggung, Mr. Paidi explored further this brought him to Wonosari, which is still in Yogyakarta province. He again hired a Wonosari's producer to produce charcoal at his place for 1 month. The charcoal production technique from Wonosari was not very different from what he had practiced in the past. Initially, wood pieces, the size of adults' thigh and 1m long were stacked on the ground. At the bottom of the stack, 3 smaller wood pieces were placed 30 cm apart to create openings at the bottom, needed for firing. The first stack consists of the biggest wood pieces, approximately 20 cm diameter; followed by middle sized wood pieces, which are placed above; then, by small wood pieces on top of the stack. The height of the stack is approximately 1.2 meter. Gaps in between wood pieces need...
to be minimized in the stacking. There are altogether 4 openings at the bottom, measuring 25 cm wide and 8 cm high, wherein firing is done.

The wood stack is then blanketed with dry rice straw with a thickness of about 20 cm. The sides are filled with soil, the front and back sides are not covered, since firing is done in those openings. Small wood branches and dry leaves are used to start a fire. When fire has gained sufficient intensity, the holes are then covered with soil and fire is controlled regularly. The same procedure is repeated for the hole located at the back.

Control of the fire is usually done in the evening. The whole process is usually completed in three days. According to Mr. Paidi, the method he learnt from Wonosari was basically the same with what he had practiced initially. However, the producer from Wonosari provided him with important tips on wood stacking, on the control of fire and on smoke observation.

Complaint from customers

The demand for wood charcoal in Yogyakarta has been growing along with the increase of the population in the city. To meet the demand, Mr. Paidi also distributed charcoal from other producers. He stopped distributing charcoal from other producers when he received complaints about the unstable quality of the charcoal he distributed. He realized that he was not able to control the quality of charcoal from other producers. Now that he had stopped distributing charcoal from other producers, he was happy that he no longer received complaints - despite the limited income from the sales of the charcoal he produced.

He realized that to keep his customers, he needs to maintain the quality of charcoal he produced. “A good charcoal is hard, it does not smoke when lighted and it does not finish quickly when burnt”, Mr. Paidi said. “To get good quality charcoal, hard wood must be used”, he added. “I used wood such as rosewood, acacia, tamarind tree and mango tree. He also thought that it is getting more difficult to get wood nowadays. When he restarted the charcoal production in 2001, he only needed to go to the neighboring villages to obtain raw materials, now he must go further. The price has also been increasing. He and his three assistants had to make daily trips in search of wood for charcoal and firewood. While charcoal production was taken care of by his wife and a relative. According to Mr. Paidi, more income could be made from the sales of charcoal.

He further explained, “For the production of charcoal, I only need to pay once for transportation, from the location where wood was purchased to my place. Charcoal buyers will conduct the purchase at my place and transport it themselves. However, I need to transport the firewood twice, from the location where wood was purchased to my place, then from my place to the location of firewood buyers”.

“I’m grateful that I’m still healthy at this old age. If in the future there is no more tree, I have to do something else to earn a living”, Mr. Paidi expressed. His two sons had no interest to continue the charcoal production business and had gone to the urban area to work. When asked how long he will continue to carry out the charcoal and firewood business, he said, “as long as there are still demands for them” he replied with a big smile.
Charcoal and its Uses

The burning of wood by controlling oxygen which slows down the combustion process produces a black substance commonly known as charcoal. Charcoal is a carbon residue which has been used to produce heat energy by humans perhaps since the beginning of civilization. Generally, charcoal is used for industrial production and as a home fuel. Its specific uses may differ from time to time, person to person, place to place or depending on the status of the people using it.

Today, charcoal is one of the cheapest sources of commercial energy in the Philippines and maybe in other countries where trees are abundant. It is now one of the best alternative sources of home fuel considering the present economic crisis. Although many others use charcoal because it is hotter and cleaner, less hazard and produce aroma in food satisfying to the feeling. People who have attained higher financial status use charcoal only for outdoor activities such as backyard grilling (i.e.: barbeque, fish). But more people use it as a main energy source in the household.

In the Davao region, until the late 1990's, the main producers of charcoal were coconut farmers. Their main raw materials for producing charcoal were coconut shells. They supplied fuel both for home and industrial use. Coconut charcoal is one of the best fuels because it can stand longer. With increasing demand for coconut charcoal for industrial use here and abroad, the price already soared high which is no longer cost-effective to use for cooking nowadays.

At the beginning of the 21st century, other non-coconut farmers are seeing the opportunities and starting to produce charcoal from wood trees.
There are two tree species that carbonize due to their high energy-efficiency: these are locally known as “Giant Ipil-Ipil” and “M. adre de Cacao” trees. These species are both easy to grow, fast growing, fast regenerating and widely available in the Philippines.

There are now several forms of charcoal on the market for home use. At supermarkets, briquettes are available (processed charcoal pre-formed into blocks) and coconut charcoal cleaned from residual dust. At public markets, re-packed natural wood charcoal and coconut charcoal are available in different sized packages. The packages range from enough charcoal for one cooking session to enough for use over three days. Wood charcoal is, however, much cheaper than coconut charcoal. The price of wood charcoal is almost 50% lower than the price of coconut charcoal.

For the Davao Region, the biggest volume of wood charcoal is sold at variety stores and other retailers in the community using recycled rice sacks as one package. The average price of wood charcoal now ranges from $1.60 - $1.70 US per bag with weight ranging from 11-18 kgs per bag. Other big consumers of wood charcoals are those selling roasted chicken that are proliferating almost everywhere these days.

**Practices in Charcoal Making**

Charcoal production practices in Davao Region are basically traditional in nature. Wood is converted to charcoal through the partial combustion process. Under this system, heavy fumes are released to the environment during carbonization. The process is simple but critical. If burning is done by a non-expert, all of the fuel wood might be turned into ashes.

In charcoal making, poor control during the combustion process can result in a low recovery rate and poor quality of the charcoal produced. During the burning period, oxygen must be properly distributed in the chamber but managed in such a way that it is of very minimal supply.

There are various stages before charcoal is produced. The first stage is the heating of the chamber until it can sustain the burning process; the second is the drying of raw wood materials; third is the burning where gases are released as heavy fumes visibly come out of the chamber; fourth charcoal is produced.

Quality charcoal can be produced if the production process is properly prepared and managed. Selection of good fuel wood as raw materials also contributes to good quality. Old cut wood already infested with insects and fungi can no longer produce good quality charcoal.

Charcoal producers in Davao use different methods and techniques. The most common methods are the use of oil drums as furnaces and the earth-pit method. Many of the producers using coconut shells as raw materials use drums to produce charcoal. While those who use wood as raw materials mostly use the earth-pit method. Although, they excavate earth pit of different dimensions and forms. Some use galvanized iron sheets and flattened drums to cover the kiln with soil on the top. While others also use green grasses or banana leaves and pulp to cover the chamber with soil on the top.

Charcoal production in this part of the country is still on a subsistence level. But with the significant number of farmer-producers participating in the industry, it was able to substantially produce volume enough to cushion the impact of skyrocketing prices of charcoal.
The situation also created the charcoal stove makers to produce more and improve their products to suit market needs. The flourishing of different improved stoves sold in the market is a real manifestation that charcoal industry had soared high for the past few years.

Several of these improved stoves now available in the market are designed either as survival mechanism against the currency turmoil or as a cooking gadget with performance efficiency and convenience comparable to electric, LPG and kerosene stoves.

Turning Threats to Opportunities

The use of fuel wood in cooking food has been the lifeblood of the poor. But the practice of converting wood to charcoal or using firewood both produce fumes maybe harmful to the environment and human beings. Perhaps the use of charcoal in cooking food attempts to eliminate harmful effects to the household. However, charcoal production is expected to cut more trees as the most sufficient source of raw materials. Certainly, it will create more pressure to the environment and most particularly to our dwindling forest.

However, these threats posed to the environment are challenges that can be turned into opportunities. Like if the charcoal producers are given enough information, they will be able to appreciate the importance of planting more trees to ensure sustainable charcoal production. Policies also can be designed in such a way that other carbonaceous materials from agricultural wastes can be utilized as raw materials for charcoal production.
This booklet provides concise information on the thermodynamics of cookstoves and tactics for improved stove design. As a practical guide for stove designers, it outlines the work of leading researchers, explains the basic theory behind stove improvement, and offers technical details of the central principles for design.

The final chapter provides designers with an in-field method for measuring the performance of stove prototypes. A water-boiling test provides reliable information about the performance of a stove without requiring a computer or complicated calculations for data analysis.

Fuelwood and charcoal are major sources of energy in developing countries throughout the world. In countries which face an acute energy shortage, efficient methods of fuel production are of vital importance. In order to make the most efficient use of natural resources and ease fuel shortages, wasteful methods of fuelwood and charcoal production must be avoided.

This training manual is a revised and enlarged version of an earlier manual on charcoal preparation. It presents step-by-step directions for preparing fuelwood, along with detailed illustrations.

This comprehensive manual presents techniques for making charcoal using simple technologies. Its main purpose is to inform and orient government agencies and industries in developing countries concerned with improving production and distribution of charcoal.

This manual represents the collective wisdom of charcoal makers from many countries. It is offered with the hope of increasing charcoal production, while also conserving forest resources by curbing wasteful methods of production.