Charcoal and its Socio-Economic Importance in Asia: Prospects for Promotion[1]

Tara N. Bhattarai
Wood Energy Resources Specialist, RWEDP

1. Why charcoal?

User Convenience: Charcoal can be an excellent domestic fuel. Charcoal can be made from virtually any organic material, like wood, straw, coconut shells, rice husks, bones. Among wood, usually the hardwood species are preferred for charcoal making (e.g. *Acacia*, Mangroves, Oak, *Prosopis*). In Sri Lanka, coconut shells are used at substantial scale. Charcoal is cleaner, easier and less smoky and smelly than other biomass fuels. It can be used in smaller quantities with cheap burning devices for domestic application. Except in some countries, industrial application of charcoal in Asia is limited. But a large number of traditional rural industries and commercial establishments use it as energy source.

Weight reduction for long distance transportation: One of the reasons to convert wood into charcoal is to reduce its weight with respect to its energy content and to increase its economic transportation distance. Charcoal has a heating value twice as much as fuelwood on an equal weight basis. The natural water content in green wood is always high; even hardwood species contain as much as 50-60% water. When trees are cut, the water content in wood starts decreasing rapidly and reduces to 30-40% within a short time even in damp climates. And 3-6 months after the harvest it may go down to only 10-20%, on an air-dried basis. The net calorific value of oven-dried wood is commonly considered as 18.8 MJ/kg (megajoule per kilogram), but it is only 15-16 MJ/kg on air-dried basis (Foley, 1986). RWEDP (1997a) suggests only 13.6 MJ/kg for air-dried wood. RWEDP also cautions that calorific value of wood may vary by a factor 3 depending upon its moisture content.

Higher energy content: The calorific value of charcoal primarily depends on its quality, depending on the amount of water, volatiles and ash content. Its gross heating value is estimated to be within the range of 28-30 MJ/kg. Freshly made charcoal has a zero water content, but it may rapidly gain moisture from the air during storage. Charcoal commonly used for domestic purposes may have a net calorific value of 28 MJ/kg (Foley, 1986). That means, its net energy value is roughly twice as much as for air-dried fuelwood. This big difference makes charcoal cheaper to transport over a longer distance compared to fuelwood.

It is true that by converting fuelwood into charcoal one could benefits from reducing the transportation cost per MJ. On the other hand, by converting wood into charcoal one also looses a substantial amount of energy. If the recovery (or yield) of charcoal is 20% of the initial weight of the air-dried wood, the conversion ratio is 5:1. This ratio may vary between a high 6:1 to a low 4:1, depending upon the method used. The traditional practice of charcoal making in open pits may yield a lower amount of charcoal compared to improved charcoal kilns.

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2. Charcoal production and use may not always be economical

Energy loss during conversion: The average conversion ratio of 5:1 means that 5 kg of air-dried fuelwood is burnt to produce one kg of charcoal. Five kg of air-dried wood is equivalent to 75 MJ (assuming an energy content of 15 MJ/kg), so when this produces 1 kg or 28 MJ in the form of charcoal, there will be a net energy loss of 47 MJ (or about 62%).

Part of the energy loss during the charcoal making process is compensated during end use, because charcoal stoves have higher efficiencies than fuelwood stoves (average efficiency of 30% for charcoal stoves against only 10-15% of untended open fire or tripod).

Product characteristics: Charcoal is a high-volume-low-value-product. This means, it needs large space for transportation relative to its value per unit of weight, a measure used in trade. Therefore, long distance transportation may not be economical without special containers or conversion into charcoal briquettes by further compression. But briquetting requires additional investment in equipment and machinery. In practice, charcoal dust is being densified to ease its handling, transportation and marketing. Some countries have recently started to produce high quality charcoal briquettes exclusively for export (e.g. Indonesia). As regular transport vehicles (e.g. trucks, railway wagons) are designed mostly to transport high-value-low-volume products, their use for long distance transportation of charcoal does not seem practical and usually becomes expensive.

The question arises then, whether it is worth to take the trouble of making charcoal and promote its use? This will not be easy to answer. The situation may vary from one place to another within in a country, not to mention the variations that are found between countries. Feasibility of charcoal production, trade and utilization very much depends upon the local systems of biomass energy acquisition and use. In certain areas fuelwood and charcoal have since long been accepted as a marketable product. Hence, a system of woodfuel production, flow and utilization is in place, often functioning as informal sector activities. In those cases the prospect of further commercialized charcoal production may be high, depending upon availability of the wood required for charcoal making.

3. Who uses? Who produces and where?

Energy consumption in member countries: Energy consumption by fuel type in RWEDP member countries is shown in Table 1. In many member countries the share of biomass fuels in total energy consumption is substantial, if not the most important. Biomass energy refers to all types of biomass fuels including woodfuel (fuelwood and charcoal) and other non-woody biomass (crop and animal residues).

Several types of sources can play a significant role in supplying woodfuel. These are: wood recovered after commercial timber harvest in natural forests and tree plantations; wood collected from public or community forests and scrub lands; wood recovered during replacement of the over-matured trees in non-industrial plantations in the private sector; and residues and by-products generated by different wood-based industries. All or most of these supply sources can contribute to commercial charcoal-making. Among the RWEDP member countries, the share of non-forest areas in total fuelwood supply was reported to be the highest in Pakistan (90%). In six other countries (i.e. Bangladesh, India, Sri Lanka, Philippines, Thailand and Vietnam) it is reported to be between 50-87%, and in Nepal it was only 34%. Information on other countries is still not available (RWEDP, 1996).

Table 1: Energy consumption in RWEDP member countries

COUNTRY	Total Energy (PJ)*	Conventional Energy (PJ & share)*	Biomass Fuel (PJ)*	Woodfuel (PJ)*	Charcoal (% of WF)**
Bangladesh	714	210 (29%)	504	141	NA
Bhutan	14	2 (14%)	12	12	3
Cambodia	96	14 (15%)	81	79	NA
China	31,256	23,866 (76%)	7,390	3,290	NA
India	8,751	5,822 (67%)	2,929	2,603	NA
Indonesia	2,796	1,978 (71%)	818	818	6
Lao PDR	47	5 (11%)	42	42	NA
Malaysia	994	898 (90%)	96	93	35
Maldives	2	1 (50%)	1	1	NA
Myanmar	348	77 (22%)	271	271	7
Nepal	279	23 (8%)	256	192	NA
Pakistan	1,984	1,066 (54%)	918	521	NA
Philippines	965	507 (53%)	458	298	20
Sri Lanka	174	79 (45%)	95	85	NA
Thailand	1,837	1,352 (74%)	485	353	53
Vietnam	1,076	260 (24%)	816	423	4
RWEDP Total	51,331	36,159 (70%)	15,172	9,223	3

* 1993-94 data available from different sources
** Available data from the National Energy Balance of member countries
Source: derived from RWEDP, 1997c.

Charcoal users: Charcoal is an important fuel in many RWEDP member countries, mainly for two purposes:

(a) cooking of food for home consumption in urban areas, and partly for commercial purposes (e.g. restaurants and eateries),
(b) traditional industrial and commercial activities of numerous types (i.e. activities related to food-, agro- and metal-processing; industries based on forest products, minerals or textile products; or industrial/commercial activities of miscellaneous types).

Even in countries with apparently similar circumstances, people's preferences for fuelwood and charcoal seem to vary notably. These factors need consideration before embarking on a program of charcoal development. However, in most cases, there will be opportunities to bring in simple technological innovations for enhancing the efficiency in charcoal making and its end-uses. The traditional technologies that are being used today are still primitive and deserve locally suitable innovation through research and development.

Charcoal producers: Traditionally, charcoal is a product of natural forests, produced mostly by the poor and landless people in rural areas who live in the vicinity of public or community forests. These people find seasonal employment in agricultural fields as paid labor or otherwise during the planting and harvesting seasons, but they must look for alternative off-farm employment during the non-farming seasons. Collection of fuelwood and production and trade of charcoal often serves as an additional income earning opportunity. It helps people to convert the off-season surplus labor into a cash earning opportunity. Therefore, most of the charcoal that is brought to local markets by traditional producers, usually in small amounts as back-load or head-load, is a product of the surrounding public or community forests. This pattern is quite common in many countries in Asia. The practice is prevalent in areas where the local demand for charcoal is limited and the market is small, e.g. only for specific uses (e.g. smithies, ironing).

In some RWEDP member countries where large scale production and commercial trade in charcoal is visible (i.e. Bhutan, India, Indonesia, Philippines, Thailand), the wood used for charcoal making may be supplied from different sources, such as public or privately owned natural forests, forest and tree plantations, trees grown in non-forest lands, non-industrial plantations, and community or village woodlots. In other countries, the existing riverine and coastal forests and the mangroves have been managed and extracted exclusively for the purpose of charcoal and/or small size timber production. Wherever charcoal is a widely accepted fuel for domestic cooking and for industrial uses, its system of production and trade is well established. In these countries, wood required for charcoal making is not supplied for free, but as a commercial activity, partly under the forestry sector. The production and flow of charcoal from its producers to end-users may be a complex system, involving a large number of actors.

Sub-regional variation in charcoal use: There are variations in the patterns of consumption of charcoal among RWEDP member countries. Most urban areas in Southeast Asia use charcoal more than their counterparts in South Asia. In the latter, people seem to prefer fuelwood among different biomass fuels, and the use of charcoal as domestic fuel is very limited. There is no clear reason why some countries prefer to use charcoal for domestic fuel and others do not. In Thailand, also the rural people make extensive use of charcoal for cooking, but in Indonesia and Philippines this occurs mostly in large cities. In India charcoal is often used to provide heat for ironing, and little for domestic cooking. Similar situations are reported for Bangladesh, Nepal, Pakistan and Sri Lanka (Foley, 1986).

Charcoal in Southeast Asia: The use of charcoal for domestic cooking has been part of the traditional way of life in some Southeast Asian countries. In these countries, the local food habits of the people demand and encourage commercial production and trade in charcoal. Commercial production of charcoal is undertaken both in the public as well as private sectors (e.g. government forestry departments, state forestry development corporations, privately owned wood-based industries, and other charcoal related undertakings).

Thailand's nationwide energy survey, which was conducted in the early 1980's, shows about 3 million tons of annual charcoal consumption. Its estimated market value then was Baht 4,500 million. The report categorically states that the use of this high-grade biomass fuel cannot be effectively replaced by other fuels within the near future. As a recommendation to the government, the report suggested a strategy of integrated programs of fuelwood production and improved charcoal making, through massive tree planting and technological innovation in charcoal making in rural areas (NEA, 1984). The recommendation stands valid even to-date. Not much is yet known about the contribution of charcoal making and trade in rural income and employment generation.

In the Philippines, the Rural Energy Needs Survey of 1982-83 shows a 24% share of charcoal in energy consumption by the household sector, whereas the share of fuelwood was 54%, and other traditional fuels only 10% (RWEDP, 1991a). In Cebu City only 5.3% of households use charcoal for cooking, which amounts to about 8,000 tons compared to over 54,000 tons of fuelwood per year. Its most common use is grilling and roasting meat and fish (about 38%). Other uses include ironing (about 31%), baking and rattan furniture making. Commercial household activities account for 22.5% of the residential sector's fuelwood consumption. It is reported that wood-cutters and charcoal makers earn 30-50% of the final selling price of these fuels, landowners 15-20%, vehicle owners 10-25%, and rural and urban traders each 10-20%. The Cebu study clearly shows that by converting fuelwood into charcoal the transport costs can be reduced substantially, from a high 35% for fuelwood to a low 6% for charcoal (RWEDP, 1993c).

Some amount of charcoal is produced and used in Southern Vietnam, mostly for domestic cooking, food vending, tea drying, and in chemical and metal industries (about 80 ton produced in Can Gao District in 1991). But the growing demand for fuelwood and wooden poles in Ho Chi Minh City is contributing to non-availability of fuelwood for charcoal making in recent years (RWEDP, 1993d). Some countries use charcoal for non-energy purposes such as water purification, for soil texture improvement, and in chemical and steel industries.

Charcoal in South Asia: The situation in South Asia varies in terms of charcoal production and use. In Ahmedabad, India, it is reported that, besides the laundry units which are significant consumers of traded charcoal for ironing of clothes, the middle class people also used some briquettes made of charcoal dust for household cooking (RWEDP, 1993a). Other end-uses of charcoal were, among others, lead extraction and metal processing, coriander seed processing, roadside catering and food vending, and student hostels. Industrial applications of charcoal included manufacturing of incense sticks and extraction of calcium carbonate from limestone. These industries consumed a large amount of high-grade locally traded charcoal. The average volume of charcoal supplied per annum in Ahmedabad City alone is reported to be 23,842 metric tons between 1986-90. This includes the amount supplied from other States. In terms of the economic gain, it is stated that the farmers who produced charcoal got a 14% higher return compared to those who sold fuelwood. Besides, charcoal making was also a relatively easy job compared to converting the thorny *Prosopis* trees into fuelwood. Recently, charcoal consumption by households as well as industries is reported to be declining both due to its rising price and short supply, even if the demand was reportedly still high.

In Bhutan, the ferro-silicion factory used about 4,700 tons of charcoal in 1993. The demand was expected to rise to 60,000 tons level after installation of a new factory under the Bhutan Carbide and Chemical Limited for activated carbon production (RWEDP, 1991b).

4. Factors to consider for promoting charcoal use

In some areas charcoal is not yet being used as a domestic fuel, and the purchasing power of people may be too low to allow for buying traded fuel. People often look for free supply sources to meet their domestic cooking fuel need. In such areas the prospect for charcoal production and trade will be non-existing and should not be promoted.

In other areas a long tradition of charcoal use for domestic fuel exists, and local industrial and commercial activities need charcoal. There, people are aware of the importance of charcoal and its commercial development can be promoted. With a high demand for high-quality charcoal (and maybe even growing with the rise in income of the local people and expansion of traditional industrial commercial activities), these areas deserve special considerations for promoting commercial charcoal production and trade, with additional investment and application of improved technologies.

In areas where the demand for better quality charcoal (with a higher carbon content) is high for industrial uses, the need for technological innovation in charcoal making will be paramount and should be promoted. Similarly, many urban centers and towns demand charcoal for domestic fuel or for industrial and commercial applications (e.g. cooking and food processing). In such areas there is a need for improvement of traditional charcoal production technology, not only for higher recovery in production but also for quality enhancement. In South Asian countries, where the use of charcoal is limited, the immediate priority should be to assure its sustainable supply to meet at least the present level of demand. This can be achieved through more efficient production and utilization by introducing technological innovations, as well as by managing depleted natural forests for fuelwood supply besides other purposes.

The common concept of **'fuel ladder'**[2] applies in many countries in Southeast Asia (e.g. Indonesia, Philippines and Thailand) in terms of charcoal use for domestic fuel. People seem to prefer charcoal among alternative biomass fuels as their socio-economic conditions improve, particularly from the point of view of its easy and clean use. Compared to biomass residues, fuelwood is considered up-ward on the fuel ladder and the next upward step is charcoal, before moving to conventional fuels.

A number of factors play an important role, either directly or indirectly, in determining whether or not to promote the production and use of charcoal in a certain country or area. These may include the following:

(a) What are the biomass fuels most commonly used in the area, and do they include charcoal?

(b) Which of the biomass fuels are self-produced and gathered free of cost and for what specific uses?

(c) What is the amount of locally produced and traded biomass fuels in the local market and what are their supply sources (public, private and/or forest and non-forest sources)?

(d) Do people use charcoal in the area as a domestic fuel, or is the use limited to specific purposes only?

(e) Will people be interested to substitute inferior biomass fuels with a better fuel like charcoal for domestic fuel? If so, at what cost?

(f) What is the average household income, and what alternative fuels (biomass or conventional) do people prefer above a certain income level?

(g) What other important end-uses exist in the area that rely on traded charcoal (modern or traditional industrial and commercial activities, including estimated amount consumed and costs)?

(h) What is the local level of supply-demand of charcoal (including production, availability, shortages, trade, constraints of resources depletion, management status)?

(i) Are there price variations between different end-uses, including the average distance charcoal is transported currently by mechanized vehicles?

(j) What proportion of fuelwood and charcoal is produced locally, and what additional potential exist to enhance their supply, both from within and outside the area?

(k) What is the extent of public and private sector participation in fuelwood and charcoal production and trade?

(l) What is the average transportation distance to bring fuelwood and charcoal to the local market, and what are the costs?

(m) Is the market big enough to attract new investment in charcoal development?

[2] The concept of the 'fuel ladder' implies that with socio-economic development, the fuel used by a household will change. To the fuel users concerned, the top of the ladder looks more attractive, which can mean more convenience, more prestige, greater efficiency, or more of some other preferred quality, as well as a feeling of being more modern (RWEDP, 1997c).

Several more points can be added in the above list. This basic information will be necessary to know the local situations in support of making sound decisions, whether or not to promote the development and use of charcoal in a particular area.

5. Employment

Charcoal production is a labor-intensive process. A large number of people are employed in different phases of charcoal making and distribution: in collection; in sizing the wood; in preparation of kilns for converting wood into charcoal; in loading the wood into the kilns and unloading charcoal after conversion; in unloading, bundling, packaging and transportation; and in marketing and utilization. It is estimated that charcoal production generates between 200-350 person days of employment per Terajoule of energy, as compared to 10 person days per Terajoule for kerosene. This does not include the additional employment generated by the activities that use charcoal, either for fuel or otherwise. The estimated employment generation by fuel type is shown in Table 2.

Table 2: Estimated Employment by Fuel Type

Fuel Type	Amount of Fuel per Terajoule (TJ)	Estimated Employment per TJ Energy Consumed in Person Days[1]
Kerosene	29 Kiloliter	10
LPG[2]	22 Tons	10-20
Coal[3]	43 Tons	20-40
Electricity[4]	228 MWh	80-110
Fuelwood[5]	62 Tons	110-170
Charcoal[5]	33 Tons	200-350

Source: World Bank/ESMAP, 1991 in RWEDP, 1997c

Notes:
1 Where applicable, employment covers growing, extraction, production, transportation, maintenance, distribution and sales, including reading meters. It excludes employment generated outside the country for fuels that are imported in semi-finished or finished state.
2 This assumes that crude oil (for refining), kerosene and LPG are imported.
3 Varying according to capital intensity of the mine, seam thickness, energy value of the coal as well as the distance from demand centers.
4 Varies according to production method ranging from hydro to traditional oil/coal fired units and the efficiency of electricity generation, transmission and distribution.
5 Depending on the productivity of the site, efficiency of producers and distance from the market.

Although the amount and the value of charcoal produced and consumed is not known exactly, RWEDP estimated that the total economic value of woodfuel (including charcoal) in 1990 was close to US$ 29 billion as a total for the RWEDP member countries. It is also believed that woodfuel business is the main source of income for about 10% of rural households and for about 40% of their cash earnings. In times of hardship, or when harvests are insufficient for subsistence, the opportunity to generate income from woodfuel business provides a safety net for poor people, many of whom are women (RWEDP, 1997c).

Area specific cases

In Gujrat State of **India**, charcoal making is an established activity, which is providing employment and income to the poor in the drought-prone areas. It is reported that 34% of the sales price in the local charcoal market was the cost of labor, and 14% contractor, 6% private material, 11% transportation, and 31% return to the cooperatives society of the plantation (RWEDP, 1993a). In RWEDP (1996) it is stated that in the case of fuelwood, the owners of trees and charcoal producers receive around 50% of the final sales price, transporters 10-15%, and traders around 30-40%. The high share for traders may be due to

loss of some charcoal during transport as fines and dust, and partly due to additional cost. In places where charcoal making and trade is an illegal activity (e.g. Nepal), the producer of charcoal seems to have a greater share of the income due to fewer intermediaries involved in the flow process.

For **Pakistan**, it is estimated that close to 100,000 people are involved as wholesalers and retailers in the woodfuel trade, not to mention the many others employed in its production, conversion and transportation. Out of them about 73% are employed permanently, and 27% temporarily. The ratio between woodfuel traders and gatherers is estimated to be 1:5. This means the total number employed comes to about 600,000 people, or some 0.5% of the country's population.

In the **Philippines**, the joint UNDP/World Bank ESMAP study of 1992 estimates that over 830,000 households are involved in woodfuel related business, ranging from gathering to trade (536,000 in gathering, 158,000 in charcoal making and selling, 40,000 as rural traders and another 100,000 as urban traders). It is also reported that about 10% of all rural household earnings and 40% of their cash income is derived from woodfuel related jobs.

Similarly, in **India** 3-4 million people are believed to be involved in woodfuel trade, which makes it the largest source of employment in the energy sector. To remain in the charcoal business there, a trader expects an income of at least IRs. 5,000 per month.

In **Nepal** about 6% of the population in a village near Pokhara were found involved in woodfuel supply to the town nearby, but the study also indicated that the share of charcoal in the total supply was only small (RWEDP, 1991a).

In **Myanmar**, charcoal is brought to Yangon from different places, where it is used extensively. In rural areas its use may be limited (smithery). The total volume of charcoal supplied to Yangon from different places in 1995-96 was about 56,000 tons. It shows a declining trend in supply from the 1994-95 level, which was reported slightly over 77,000 tons. Of course, this figure is based on records maintained by government agencies and does not take into account the amount supplied informally, which may be very significant. A large number of people are employed as traders and middlemen between the producers and end-users who also pocket their share of the return, and seem to be financially better-off than the gatherers (RWEDP, 1997b).

In Majalaya of West Java, **Indonesia**, charcoal is used only for specific purposes (e.g. for smithies, ironing and special food preparation). It is generally bought in the market and used sparingly. It is also reported that people usually make more money by charcoal making than working as agricultural labor, but the risk is also higher. The farthest point charcoal is transported for sale is around 90 km, and its quality is determined primarily by size, texture, weight, and tree species used. How many people are involved in this business is not adequately known. It is reported that charcoal production could also be an illegal operation secretly conducted in public forests, illegally felling trees in government managed or protected forests. Charcoal from these sources is traded in closed markets, often at night, and it would be difficult to track the amount and value (RWEDP, 1991a).

6. Price competition and quality of charcoal

Charcoal consumption and price: Price comparison between different types of fuels in Peshawar, **Pakistan** shows an advantage of natural gas use on MJ basis. The energy value of natural gas with end-use efficiency of 60% is the highest, i.e. 16.5 MJ of useful energy per one Pakistani Rupees (PRs), against 2.6 MJ for fuelwood (at 20% efficiency), and only 1.5 MJ for charcoal (at 25% efficiency). The market price of charcoal was very high in

relation to its calorific value (PRs. 5 per kg, or 30MJ) compared to PRs. 1.4/kg and PRs.1.3/m^3 for fuelwood and natural gas of calorific value of 17.8 MJ/kg and 36.5 MJ/m^3 respectively. Charcoal use in Pakistan is limited to domestic/commercial uses including space heating during the winter months in government offices. The annual consumption is 3,486 tons against 44,600 tons of fuelwood in Peshawar, and there are no other industrial applications. It is reported that around 1,000 charcoal production units exist in Pakistan, mostly located in Punjab and Sindh provinces, which produce about 100,000 tons of charcoal annually (RWEDP, 1993b).

In **Nepal** the demand for charcoal increases during marriage seasons (twice or three times a year) because of demand for new jewelry and metal-wares. The market price of woodfuel is reported to have increased sharply, from about NRs. 6 to NRs. 10 or more. Substantial inflation of the Nepalese currency over the years could be the reason for this sharp rise. Charcoal is required in small quantity for self use only and may be produced domestically as a by-product of fuelwood (RWEDP, 1991a).

The market price of charcoal in Ahmedabad in India varied between IRs. 2,600 to 3,100 per ton in 1991, depending on its quality. For many users quality is not the main concern (e.g. briquette makers, lead extractors, food venders), but the metal processing industries, incense makers, and the carbide industries are sensitive to quality. These industries have their own specified standards for charcoal, and quality determination is based upon the chemical analysis report of the charcoal being offered (RWEDP, 1993c).

Nothing is specified about the quality of charcoal that is used in Peshawar city, **Pakistan**. RWEDP (1993b) only mentions that there is variation in sales price at every level of charcoal trade. For example, a wholesaler buys charcoal at PRs. 3,600/ton at the production site in Punjab and sells it to local large consumers and retailers at PRs. 4,400/ton (including the transport costs to Peshawar of PRs. 500/ton), which gives a gross profit margin of about 22%. The retailers on the other hand sell the same for PRs. 5/kg (or PRs. 5,000/ton) which gives a mark-up of another 14%, against 11% for fuelwood.

The relationship between woodfuel prices and prices for alternative fuels is not clearly established yet. Prices of woodfuels seem to be rising over time. But when inflation and general price indexes are taken into account, the price is more or less constant. An exception is Myanmar where it rose from US$ 150 to US$ 450 per ton over a 6-year period. No clear information about the reason is available (RWEDP, 1996). By using the current wholesale price index of 1959-60 as a standard, RWEDP (1997d) shows that the wholesale price index of fuelwood has changed manifold by 1994-95. But taking into consideration the changing value of money over time, the wholesale price index of fuelwood deflated by general price index shows a declining trend in price during the first 17 years and an increasing trend in the later 18 years. Information from Myanmar does not indicate anything about the effect of quality on market price of charcoal. However, it does suggest that over the years, the current market price of charcoal has increased substantially, from K 15 to K 150 over the last 5-6 years for a bag of about 40kg in Pyinmana town (RWEDP, 1997b).

In the Philippines, charcoal prices vary considerably according the quality and season of trade. For example, the price of heavy charcoal was 1.9 Peso per kg during the dry season and P 2.1 per kg during the wet season, a 20% difference in price. For the lighter charcoal the price was almost P 2.4 per kg (RWEDP, 1991a).

7. Charcoal production potential for market supply

Uncertain demand: It is rather difficult to predict the demand and supply situation of charcoal in Asian countries in the coming years. The international oil price was once thought to shoot-up sky-high due to short supply (depleting reserves), but this has not happened.

Instead, it has been declining due to increasing supply from newly explored reserves in different parts of the globe. Consequently, it has affected market prices of alternative energy sources as well, including biomass. Considering changes in energy consumption in the region, charcoal is not likely to play a dominant role in the energy market in the coming years. The current trend in energy transformation in urban centers is in favor of conventional fuels. For the household sector these are mostly LPG and natural gas. Other energy sources play a dominant role in the industrial sector and the use of biomass for modern energy applications is still confined to a few countries.

The factors that promote this shift include: increasing supply of conventional fuel substitutes at fairly affordable prices, especially to urban areas; the growth in annual income of middle class people in most developing countries; the accelerated rate of urbanization associated with industrialization and creation of centers of employment; the changing food habits of the population in urban centers; the increasing use of conventional energy-based cooking devices in modern households. Even poor people who may be serving as laborers in urban centers tend to use conventional fuels (mostly kerosene) due to various reasons, e.g. ease of use, cheaper or comparative in price, and cleaner in use than most biomass fuel. These advantages are partly due to government subsidies on commercial fuels to control woodfuel use presumably associated with deforestation and environmental preservation. Therefore, even if the population in urban centers will be growing rapidly in the coming years, the demand for charcoal and other biomass fuels is not likely to increase accordingly due to peoples' changing preferences.

On the other hand most rural people are not expected to change their current fuel use practices as long as the traditional supply sources are easily available and accessible. This could mean that in some cases inferior biomass rather than fuelwood may dominate energy supply. In such a situation, promotion of the use of charcoal seems rather bleak. As stated earlier, many different factors play a role in people's decisions regarding the choice of fuels, and the price of charcoal can be one of the significant factors.

Charcoal use will not completely phase out: No matter how difficult it may be to visualize the future supply and demand scenario of charcoal in the region, experience from the past suggests that the use of biomass fuels will not be declining, and may be increasing in most countries. Its use is not expected to phase out neither in the short-, medium-, or long-term. Even in countries with a fast developing economy, an accelerated growth in conventional energy consumption due to rapid industrialization did not result in a declining consumption of biomass fuels (e.g. Indonesia, Philippines, Thailand). And among the commonly used biomass fuels in these countries, charcoal has a specific place (e.g. for chemical and industrial applications, and preferential cooking), and this use is not going to phase out easily. Some developed countries in Asia buy charcoal and charcoal briquettes for specific end-uses and they buy this from other countries in the region. Considering these specific requirements, it can safely be concluded that there is a continued need for improvement in efficiency of production, unhindered, open and competitive trade, and optimum utilization through technological innovations in the coming years. Wherever these conditions are not in place they should be promoted.

Factors affecting production potential: Factors that could affect commercial charcoal production and trade include: scarcity of wood for charcoal making; ambiguity, inadequacy or flaws in government regulations (e.g. existing regulations often look restrictive rather than supportive in the name of forest conservation); lack of understanding of local wood fuel systems, which often tend to adapt themselves to changing situations; informal nature of operations and the market; variations in the systems to match specific site conditions (simple or complex and sophisticated). Individual actors play specific roles only and will not be in a position to influence the system independently.

Supply sustainability and quality: Maintenance of the supply and quality of charcoal in the market is a difficult task. It cannot be regulated by urban traders or consumers, since a large number of charcoal operations are currently unregistered, and are often illegal, relying on illegally collected wood from public forests. The whole operation may take place within the boundary of government managed forests which is illegal according to most existing forestry legislations. This is often viewed as a challenge to forestry agencies.

Integration with forestry development: The new forestry development strategies that are being pursued in the region aim to foster people's participation in forestry development. The programs that are under implementation under the banner of Social/Community Forestry Development have been partially successful to enhance awareness about energy conservation at household level. The programmes have tried to address the issue of fuelwood supply enhancement not only through tree plantation and forest conservation, but also by promoting efficient energy utilization. Development and dissemination of improved cook stoves was primarily for energy conservation and to some extent also for smoke reduction from cooking. Other sectors still seem unaware and this condition must change. Most charcoal makers even today follow the age-old practice of charcoal making in open pits with very little consideration to increase the yield and quality.

Therefore, wherever, whenever and whatever possibilities may exist, the issues related to charcoal development should be addressed by incorporating them into the on-going programs of participatory forestry development, as well as in other private and contract forestry development schemes. Integration of multipurpose trees into the farming system may support extended application of charcoal also in rural areas that could provide the raw material for charcoal making, through generation of wood as a by-product. If such a strategy were pursued in the future, it would certainly contribute to the local socio-economic conditions, not to mention the national economy and the environment.

Policies: All these issues require a thoughtful reform in government policies related to land and tree ownership/tenure, sustainable management and utilization of tree resources, distribution networks for private and public goods and services, rules and regulations governing production, flow and sustainable utilization of environmentally friendly renewable energy resources, incentives and credit facilities to support investment for wood production and utilization, research, development and technical information flow. And wherever possible, modern applications of wood energy should be promoted, by creating a 'level playing field' for competition between alternative energy sources. The key is to create a situation that will allow recovering the economic cost of charcoal making and transportation to the market without loosing its strength in terms of price compared to conventional fuels.

Cost recovery and scale of operation: The economic cost of charcoal production may vary significantly depending on the type of production systems. In a traditional system the producer collects the wood free of cost, and uses his labor to dig the pit to convert the wood into charcoal, and transports the final products to the market for sale. There is no cash investment in this type of operation. The production cost is virtually zero in such cases (except for tools that are purchased for common household use which are also used for wood cutting and pit digging), unless one has to pay a nominal fee to the forestry department as a government royalty for wood and to obtain a permit for making charcoal in the forest. Then this cost is the only cash investment in charcoal making, which rarely is the case. The producer of charcoal under such a system simply works to convert free time into a marketable product, in the absence of other cash earning opportunities. As long as the

market price of charcoal is attractive enough to encourage this type of production, the poor will see it as an attractive option to earn cash.

The commercial producer, on the other hand, has to consider whether he can recover the cost of inputs to the manufacturing process from the returns when the charcoal is sold in the market. This makes the investment more risky and the risk increases as the scale of operation expands. This type of producers will try to maximize the returns from their investment by introducing innovations, both technological as well as managerial. Wherever this type of operation exits, the opportunity for further development will be high and desirable.

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