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SMALL KILN CHARCOAL PRODUCTION POSSIBILITIES IN MINNESOTA

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In connection with a proposed research project concerned with the possibility of small kiln production of charcoal in Minnesota, a study of the existing literature relating to charcoal production in the United States was undertaken. The study revealed that existing information is widely scattered and that it needed to be summarized. This is an abstract of a more complete literature review which may be obtained by writing the School of Forestry.

Most charcoal is made by the distillation industry in ovens and retorts. However, since the 1920's, the number of plants representing this industry has declined from about 100 until there are now five operating units. This decline has come about because of the substitution of cheaper synthetically-made chemicals for those previously made by the distillation process, of which charcoal is a by-product. This decline has resulted in a charcoal shortage in recent years, particularly in wartime.

The total cost relationship in the distillation industry thus provides possibilities for small kiln production of charcoal in Minnesota. Such production would shift income to the State, tend to provide more total income in the economy resulting from more efficient production, and use otherwise wasted Minnesota wood. Kilns afford a low capital investment and relatively low cost production in making charcoal alone.

Of primary concern is the potential market in Minnesota and adjoining states. Annual charcoal consumption in the United States is between 300,000 and 350,000 tons, being about equally divided between industrial and domestic uses. Household heating, outdoor cooking, restaurant use and railroad dining cars comprise the main part of the domestic-use market, while chemical, metallurgical and tobacco curing users form the largest part of the industrial outlet. The literature reveals nothing specifically indicating the available market for Minnesota-produced charcoal. Assuming that Minnesota's annual per capita consumption of charcoal for domestic use is at least equal to the national average of two pounds per person, 3,000 tons of charcoal are consumed annually in the State. However, potential Minnesota producers may not have this entire market available to them. Assuming a low cost, decentralized industry in the State, transportation costs to out-of-state producers should make much of the Minnesota market available to local producers, if charcoal is briquetted or adequately packaged to enable cleaner and easier handling. Consumption by tourists and residents of adjoining states also is to be expected. Only the domestic-use market is considered here because the industrial market for small kiln producers in Minnesota is believed to be of minor importance.

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An annual production of 3,000 tons of charcoal per year in Minnesota where none now exists would mean utilization of an additional 6,000 cords of wood per year of lower grade material. With the greatly increased use of charcoal for outdoor cooking, and with normal product promotion, it is reasonable to expect that the existing market can be increased in the near future.

In the literature concerned with charcoal production using small kilns, it is shown that yield is affected by five primary factors: (a) The temperature of operation is the main determinant of the carbon content of the charcoal. As temperature increases the yield of carbon per cord of wood decreases but the charcoal is more nearly pure carbon. (b) As moisture content of the wood increases beyond 20 to 40 per cent the yield of charcoal per cord rapidly decreases. (c) Woods of higher density provide the highest yield per cord, the yield being roughly proportional to the density of the wood being carbonized. This factor is, of course, related to the species. (d) The type of kiln, and (e) the proportion of bark and the presence of decay. Defects other than decay do not affect yield.

The form and size of material to be carbonized are of primary importance in determining how well a charge carbonizes. Roundwood, within limits, provides the most complete carbonization with a minimum of charcoal "fines" (dust or small particles). For small kilns of one to five cords capacity the maximum diameter limit is considered to be seven to eight inches. Larger pieces fail to carbonize completely. In kilns of five to 12 cords capacity, bolts as large as 16 to 18 inches in diameter can be successfully carbonized if placed high in the charge. Handling material smaller than two inches in diameter is usually unprofitable. Length is less important and may vary with the type and size of kiln, as well as the preference of the operator. Slabwood when stacked to allow proper air circulation or when in mixture with roundwood carbonizes well. However, the use of slabwood results in a greater proportion of "fines" from the included bark. Shavings and sawdust do not carbonize well in small kilns.

Of the small kilns reported, the Connecticut cinder block kiln seems to be the best for commercial operation. Charcoal produced in this kiln has from 80 to 90 per cent carbon which is as high or higher than that produced by most other kilns, ovens, and retorts. The connecticut kiln has been operated experimentally in one and two cord capacity sizes and commercially in six to 14 cord sizes. It is relatively efficient in its use of labor and in the yield of charcoal as well as providing a flexible scale of operation. Battery production using three to five kilns as a unit is probably the most efficient method of charcoal production with these small kilns. Beehive kilns are the oldest of the smaller scale kilns in the United States and are only moderately efficient with respect to labor and yields of charcoal. They range in capacity from 40 to 90 cords and thus lack flexibility in varying the quantity of output. The charcoal produced in these kilns is low in carbon content. The Black Rock Forest steel drum type kiln with half-cord capacity is not as efficient in use of manpower but its yields of charcoal are comparable in quality and quantity to the Connecticut kiln. The Mellman retort, although not a kiln, offers another method of charcoal production without the recovery of chemical by-products. A 10-cord per-day unit will produce about five tons of charcoal per day. It operates on a continuous carbonization basis with wood being fed in the top and charcoal removed from the bottom. It differs from the kiln method in that carbonization is maintained by the recirculation and burning of gases given off during the process. The main disadvantages of this retort are the large capital investment and the less flexible scale of output.

The critical factor in the profitability of charcoal production appears to be the cost of wood delivered to the kiln. Cost syntheses for the Connecticut kiln and the Black Rock Forest steel drum type kiln show that over the same range of cost of wood and prices for charcoal the Connecticut kiln yields higher returns, largely due to its lower labor cost per ton of output.

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