THE ENERGY BALANCE OF SHORT-ROTATION COPPICE FORESTS: A PARTIAL ASSESSMENT FOR GEORGIA

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Biological energy sources should be evaluated in terms of energy inputs needed to achieve various levels of biomass yields and energy outputs. Site preparation, seed or seedling production, and the establishment, cultivation, harvest, transport and conversion of the crop all necessitate energy expenditures. These inputs can include energy needed to manufacture the machinery and that needed to run it in the various production and utilization processes, produce fertilizers, and feed the labor force. They may also include environmental energy inputs like solar radiation, rain and wind energies. Outputs can be measured at several stages, such as before or after harvest, transportation, pretreatment (e.g. chipping, pelletizing, drying), or final conversion. Comprehensive energy balances for agricultural crops such as corn (Pimentel et al., 1973) and sugar cane (Hopkinson and Day, 1980) have been calculated, but relatively little is known about such balances for forest crops.

All types of biomass share certain advantages and disadvantages as energy sources. Among the most important positive, long-term aspects are that they are renewable indefinitely, cause no net change in atmospheric carbon dioxide levels and contain relatively few pollutants. Biomass is versatile in that it can be converted into a variety of liquid or gaseous fuels or directly into heat. Disadvantages of biomass include the removal of nutrients and organic matter from soils and high harvest and transport costs because the resource is generally scattered, bulky and high in moisture.

Forest tree species offer several advantages as energy crops in comparison with agricultural crops or other herbaceous plants. The perennial nature of trees offers flexibility in harvest timing and the accumulation of large amounts of biomass in the field. Trees make low nutritional demands on soils and protect them from erosion with an organic litter layer. Broadleaved species sprout from the stump or root system, obviating the need for additional site preparation or planting once they are established and thereby reducing energy inputs needed for the second or subsequent rotations. Woody materials also are less subject to deterioration in post-harvest storage than are the more succulent, herbaceous ones.

There are many different types of forest materials which can and do currently serve as alternate energy sources. They range from logging and mill residues to thinnings and stands which currently lack a market. The specific biomass production system for which I wish to develop energy input / output ratios are short-rotation coppice forests in Georgia. These consist of plantations of broadleaved tree species which are planted much like an agricultural row crop. Seedlings in our current research outplantings are spaced in rows 2.4m apart and 1.2m apart within the rows. These seedlings are allowed to grow, generally with cultural help like fertilization and weed control, until they have fully captured the site. Then they are harvested mechanically and the rootstocks, which remained in the ground after the harvest, will sprout and automatically establish the next stand. These sprouts will grow more rapidly than a new planting would because they are supported by an established rootsystem, designed for a larger plant, which has access to soil water and nutrients. Such rootstocks also act as carbohydrate reservoirs so that the new stem and leaf tissues for the reemerging stand can be developed rapidly. Generally the new stand will fully occupy the site within the first or second growing season after harvest.

For this preliminary assessment it will be necessary to combine energy inputs for a plantation established in 1978 (Steinbeck, 1979) with the energy outputs determined for a spacing, yield and rotation length experiment which was installed in 1967 (Steinbeck and May, 1971). Both plantings, however, are in similar, rolling terrain in the Piedmont province of Georgia and in the main also on the same soil series.

Literature Cited

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