

**A CRITICAL EVALUATION OF THE PROMISE OF BIOTECHNOLOGY
TO IMPROVE THE PRODUCTION OF RENEWABLE-ENERGY MATERIALS AND FOOD**

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Biotechnology represents the most recent applications of fundamental research in the life sciences. Its products and potential products do not usually come from the applied fields of research, such as agriculture and medicine, but rather from basic studies in reproductive physiology, immunology, molecular biology, microbial genetics, and plant physiology.

On the basis of these origins, biotechnology has several, somewhat separate, areas of product development. From immunology has come monoclonal-antibody applications of numerous types, both diagnostic and therapeutic. From molecular genetics has come gene-splicing methodology with its applications already yielding marketed products such as human insulin and promising other bacterial systems to produce important medicinal substances. And from reproductive physiology has come embryo implantation that has already allowed rapid improvements in cattle herds.

I want to focus on a further area more directly related to renewable energy technology: developments that come from basic studies in plant physiology. Much has been written about sweeping changes that will come from biotechnological research in this field. Advances such as making non-leguminous plants fix their own nitrogen and of hybridising two very different plants to form exotic, totally new, highly productive species are being given much attention. However, most of these advances - exciting though they may be - are too far off and uncertain to help us deal with the very critical problems to be faced in the next decade or two. Micropropagation is likely to yield developments in the next 10 years and is technically available to exploit in large-scale applications.

The micropropagation of plants, also called plant tissue culture, is well developed and more advances are coming rapidly. It is now possible to produce several million plants per year in a small facility that can be operated commercially at a profit and that requires only a few skilled employees. A few such facilities in Africa could produce superior plants in large numbers at low prices and could therefore greatly accelerate development. Large fast-growing plants, nitrogen-fixing species of trees, oil palms, and other plants could be propagated for renewable-energy production. Numerous other species are available for food production and other economic developments. This suggestion is not new; it has been proposed before, for example, by Lugo (1985).

For numerous species, special culture conditions have been developed and commercial production has been achieved. By selection and tissue culture of the best individual plants in a variable population, plant species known to grow well in Africa could be introduced in new localities quickly, cheaply and effectively.

On just a few acres of ground, a tissue culture facility can produce four million plants per year. Selected cuttings are first established in primary, sterile cultures in test tubes or small bottles and allowed to grow under the influence of hormones in the culture medium to maximise branching. About 20 branches are produced in a culture vessel and each branch is cut free and re-cultured in another tube to produce 20 more plants, all of which are sterile and have identical genetic and growth characteristics. Plants at this stage do not have

and do not need roots. One room for sterile inoculation of the culture tubes would serve a whole facility. Tubes are then placed in growth rooms, three of which are sufficient. Each growth room should measure about three by six metres. In most cases, these tiny plants can be immediately placed in soil where they will form roots in a few weeks if kept very moist and grow to sizes that can be planted in low-cost greenhouses or in the field if the weather is good.

A facility of this nature is operated by a for-profit corporation, named Phyton Technologies in Tennessee. It employs five skilled managers, but otherwise uses an unskilled, low-cost workforce of about 50. Other than for standard sterilisers and sterile inoculating hoods, no expensive equipment is used.

Prices are very low for such plants, and the quality is high because they have been started without any pathogenic fungi or bacteria present to slow their growth. But more importantly, the quality of product is uniform, since the original stock selected for culture was the very best plants and only continuing growth of somatic cells has been allowed.

The specific activity for Africa would be a superior tree programme. The US Forest Service has operated such a programme for many years and has resulted in large forest stands of uniform and high quality trees. A programme in Africa would have the advantage over such an older programme, in that it could progress more quickly by using the methods of micropopagation. It is possible to project that within five to 10 years large plantings of trees for fuelwood, fibre, and wind breaks could be well established and, in a few cases, be nearing harvest.

The second consideration is not a technical matter. Frequently renewable resources are not developed because people do not see profitable enough economic incentives. A recent biomass-energy publication in the United States (National Wood Energy Association 1985) states that with 9% of the energy used in the US coming from renewable energy sources this represents a higher input of energy than is produced from nuclear sources. The report is designed to have political influence. It cites government tax and budget policy decisions that are disadvantageous to this area. While such a campaign does not directly affect African nations, it is important since it shows first, that there is a voice speaking in the US for small renewable-energy businesses and second, that that voice is being used for political influence on US public and corporate policies.

Thus I urge you to champion, in your own countries, the causes of renewable-energy businesses. The propagation of trees by the methods described above can be one such business enterprise. The establishment of small businesses is itself a worthy cause. In the US, for example, large businesses are not in general contributing new jobs. These come from new companies in the US and that is undoubtedly true in African countries too.

In summary, biotechnology has great potential to contribute to development in Africa in the foreseeable future. Many different species can be propagated with applications for renewable-energy and food production. It will be important to gain governmental and public support for biotechnological research and product development. This should emphasise, in particular, the establishment of new business enterprises.

REFERENCES

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