Report on a visit to Ghana to carry out a needs assessment/project identification mission in collaboration with the Ministry of Energy (NRI report no. R1830(S))

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Overseas assignment report

Report on a visit to Ghana to carry out a needs assessment/project identification mission in collaboration with the Ministry of Energy

by A P Robinson and H C Coote

Sawdust residues from sawmills and wood processing centres offer an excellent opportunity for utilization as a fuel

Natural Resources Institute

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ABBREVIATIONS USED AND EXCHANGE RATES

Abbreviations used

BET	biomass energy technology
BOD	biochemical oxygen demand
BOPP	Benso oil palm plantation
CIDA	Canadian International Development Agency
FFB	fresh fruit bunches
FRI	Food Research Institute
GDP	Gross Domestic Product
GJ	gigajoule
GOPDC	Ghana oil palm development company
GRATIS	Ghana Regional Appropriate Technology Industrial Service
ha	hectare
ITTU	Intermediate Technology Transfer Unit
kg	kilogram
kJ	kilojoule
kWh	kilowatt hour
LPG	liquid petroleum gas
m^3	cubic metre
mcwb	moisture content (wet basis)
MJ	megajoule
NGO	non-government organisation
NRI	Natural Resources Institute
NOPP	National oil palm plantation
SOPP	State oil palm plantation
TOPP	Twifo oil palm plantation
UNDP	United Nations Development Programme
VALCO	Volta Aluminium Company
wt	weight

Exchange rates
(February 1992)

£1 - 700 cedis
$1 - 400 cedis

SUMMARY AND CONCLUSIONS

Summary

1. Evaluation of previous research and development work on biomass energy technologies (BETs) has highlighted the problem of the lack of continuum between technology development and transfer. It is clear that research on BETs must take account of dissemination in the project design stages. In considering ways of effective technology transfer, NRI has published a strategy, *Best Bets: A strategy for better utilization of biomass for energy* (NRI, 1991).

2. Ghana was chosen as a site to develop the *Best Bets* strategy, particularly in relation to technologies which make use of particulate residues as an energy source, with a view to applying the knowledge gained to other countries and to other areas of technology transfer.

3. A five-week visit to Ghana, by a technologist and an economist, was undertaken to validate the initial stages of the Best Bets strategy. The team had a mandate to consider three processing sectors:

(a) forestry;
(b) cereals; and
(c) oilseeds and edible nuts.

4. The team was attached to the Ministry of Energy of Ghana. Information was collected from the appropriate organizations at national level on the biomass residue resource base, energy uses and costs, engineering capabilities and the organizational structure within which BETs could be introduced. Potential collaborative organizations were identified. Contacts were also made with aid agencies.

5. Visits were made to specific field locations where biomass residues were concentrated. At each location, industries were approached and an appraisal of the potential for field projects made.

6. The national-level and site-specific information was combined to identify the potential, localities and marketing strategy for introducing BETs. The combined information was presented to a workshop comprising a number of the potential collaborating organizations.

7. Project designs were discussed by the workshop participants and the mechanism by which they might be implemented developed. The projects comprised:

(a) Assistance to the forest products industry to utilize sawdust as a fuel for timber drying.

(b) The establishment of a forest products extension service.

(c) Techno-economic appraisal of palm oil mill effluent gasification to supply energy for community use.

(d) Assessment of biomass energy thermal efficiencies in small-scale, village level industries and identification of fuel savings.

(e) Techno-economic study of stand-alone 250kW electricity generation using biomass energy.

Conclusions

8. It is concluded that:

(a) Good opportunities exist to use the substantial quantities of sawdust generated from the wood processing industries. The residue is considered a waste material and its disposal by dumping and open-mound burning is polluting and poses a serious risk to health and property.

(b) There is a pressing need to increase Ghana's timber drying kilning capacity. Coupled to this is a significant fuelling requirement to operate the kilns: current plans by industry centre around the use of wood waste. The sawmillers and furniture processors interviewed expressed an interest in burning sawdust directly as a supplementary fuel for their boilers. Opportunities also exist for the introduction of medium-size sawdust-fuelled timber drying kilns for small- to medium-scale sawmills and furniture workshops.

(c) In discussions with the forest industry it became apparent that there is a lack of professional advice and training available to the industry on aspects such as kiln drying, timber standards, residue utilization, energy efficiency, equipment availability, and non-timber forest products. Opportunities exist for combining work on dissemination of sawdust-burning technologies with provision of such advice to the industry.

(d) The majority of processing of groundnut, coconut, maize, rice, sorghum and millet is carried out at small farm level. Residues are scattered and leave little opportunity for commercial energy utilization. Farmers are being encouraged to graze the residues back into the soil as a source of organic matter, mulch and fertilizer.

(e) The discharge of effluent from palm oil mill operations is reported to pollute the local water courses. As production of the oil palm plantations rise, the scale of pollution is likely to increase. There is an opportunity to gasify the effluent to produce a fuel to meet some of the energy needs of estate workers and their families who, at present, rely on indigenous timber or kerosene for their energy needs.

(f) Should industrial-scale rice mills become operational once more, the suspension burner technology proposed for the forest industry may be transferred and adapted to burn rice husk.

(g) There are opportunities for improving the efficiencies with which traditional fuels are used. The majority of Ghana's agricultural produce is processed by small-scale units which provides much employment in rural areas, particularly for women. Inefficient energy use and increasing prices of fuel are likely to render many of these activities less economic. Efforts to assist small-scale industries with better fuel efficiencies will make them more resistant to increasing scarcities of woodfuel and reduce the need for woodfuel extraction.

(h) Some of the more remote rural areas of Ghana will not have access to the national electrical grid for some 30 years. There is scope for investigating the use of stand-alone electricity generation sets fuelled by biomass-energy to meet short- to medium-term electricity needs.

(i) Good management and engineering capabilities exist in Ghana to support the types of projects outlined in this report. Ministries, research institutes and private industry have expressed their interest in participating in the areas of work put forward.

(j) The expertise and facility base exists within the Ministries, NGOs and institutions to carry out the programmes of work. The Natural Resources Institute is well placed to act as a collaborative organization and provide technical assistance and assist with institutional strengthening in the envisaged work programmes.

(k) The *Best Bets* approach followed during the assignment is workable and has potential application in other countries and to other areas of technology transfer.

TERMS OF REFERENCE AND OBJECTIVES

9. The terms of reference were as follows:

(a) Carry out an assessment of the national situation.

(b) Make an appraisal of the potential for field projects based on visits to specific representative localities.

(c) Carry out project design in collaboration with in-country organizations identified during field assessment for submission to multilateral aid agencies.

(d) Form a development model for the assessment of needs for energy technologies and project design approach that may be applied in other countries.

(e) Analyse the above approach to form a model that may be applied to other areas of technology transfer.

10. The visit objectives were as follows:

(a) Field validation of the first two stages (assessment of needs for energy technologies and project design) of the Best Bests strategy for technology transfer for the better utilization of biomass for energy - with a focus on residues from the processing of forest products, cereals, oilseeds and edible nuts.

(b) Provide a development model for future work in other countries.

(c) Carry out an analysis of the approach and its applicability to other areas of technology transfer.

(d) Arising from the development model, formulate a detailed work plan with project proposals specific to Ghana.

See Appendix 1 for full terms of reference.

INTRODUCTION

11. As the economies and the populations of the developing countries grow so does their use of energy and it is recognized that much of this increased demand will have to be met from renewable energy sources of which biomass residues form a large part (World Commission on Environment and Development, 1987).

12. The utilization of these resources can be maximized through the development, adaptation and dissemination of appropriate biomass energy technologies (BETs) and through advisory services on fuel efficiency. Whilst great efforts have been put into BET research and development, issues of technology transfer have received less attention. The result is that many BETs have remained at the development, field test or demonstration stage and not progressed into the market and reached the industries they were designed to assist.

13. In considering ways of effective technology transfer, NRI has published a document *Best Bets: A strategy for better utilization of biomass for energy* (Natural Resources Institute, 1991) which outlines a strategy in which the range of BETs can be better promulgated and properly matched to country needs. Central to the approach is the recognition that successful introduction of BETs is entirely contingent upon the existence of a clear need for the service they provide.

14. This approach follows a project cycle comprising:

(a) project identification and needs assessment;
(b) project design;
(c) project implementation; and
(d) project review and evaluation.

Within the project cycle elements there is a focus on methods of technology transfer.

15. From a desk study, Ghana was seen to offer attractive opportunities for biomass residue utilization as an energy resource and a visit was undertaken to validate and develop the first two stages of the cycle - project identification and needs assessment; and project design.

16. The team consisted of a technologist, Alan Robinson and a socio-economist, Claire Coote who visited Ghana for 5 weeks. The team had a mandate to consider residues from the processing of three types of products:

(a) forestry;
(b) cereals; and
(c) oilseeds and edible nuts.

They were attached to the Ministry of Energy, which devise and implement the country's energy policy. Close collaboration with them was maintained during all stages of the mission.

17. Accompanied by a representative of the Ministry of Energy, the team visited relevant ministries and departments, NGOs, industries and other organizations at national level to collect information on the biomass residue resource base, energy uses in rural industries, energy costs, engineering capabilities and the organizational structure within which BETs could be introduced. At this stage potential collaborative organizations were identified. Visits were also made to aid agencies who may consider supporting the projects identified during the visit. Views of the agencies, their mandates and priority areas of assistance were considered in the project design.

18. Visits were then made to specific field locations where the three types of residues under consideration are concentrated. At each field location, processing industries were approached and an appraisal of the potential for field projects was made. The balancing of needs and opportunities was central to the appraisal methodology.

19. The national-level and site-specific information was combined to identify the potential for introducing BETs, the localities in which they should be introduced in the first instance and the marketing strategy which should be adopted. The combined information was presented to a workshop comprising a number of the identified potential collaborating organizations and observers from the Ministry of Energy. Using this information specific project designs were discussed by the workshop participants and the mechanism by which they might be implemented developed.

20. The projects comprising:

(a) Assistance to the forest products industry to utilize sawdust as a fuel for timber drying.

(b) The establishment of a forest products extension service.

(c) Techno-economic appraisal of palm oil mill effluent gasification to supply energy for community use.

(d) Assessment of biomass energy thermal efficiencies in small-scale, village level industries and identification of fuel savings.

(e) Techno-economic study of stand-alone 250kW electricity generation using biomass energy.

are presented in this report (see appendix 8) for more detailed analysis by the Ministry of Energy and possible submission to funding agencies for consideration of support.

21. A model for biomass technology transfer in other countries and the approach for other areas of technology transfer are presented in separate reports.

GHANA'S ENERGY SITUATION

General

22. Woodfuel and charcoal meet some 80% of Ghana's energy needs; imported petroleum accounts for approximately 13% and hydro-power 7% (Ministry of Energy, 1991).

23. Various estimates of woodfuel consumption have been reported; a recent UNDP/World Bank estimate is 10.4 million tonnes per annum (UNDP, 1991). Whilst the household sector is by far the greatest user, the industrial sector consumes significant quantities. Current rates of country biomass growth are put at around the consumption rate, however woodfuel extraction is on a selective species basis and concentrated in a few regions; the result is that serious deforestation is occurring in these areas. Although it can be assumed that charcoal and woodfuel will continue to provide the bulk of the country's energy needs for the foreseeable future, the long-term prospect for their sustained supply is threatened (Ministry of Fuel and Power, 1990).

24. In some areas certain biomass residues are utilized as a fuel, in particular: rice straw; maize stalks and cobs; millet stalks; coconut husk, shell and fronds; and oil palm kernel shell. It was reported that dung was being used in northern areas where other fuels are difficult/expensive to obtain (Powell, 1992).

25. Transportation is the largest user of petroleum products. With electricity, over half the total sales in 1989 were taken up by one consumer, the Volta Aluminium Company (VALCO); exports to Togo, Benin and Côte d'Ivoire accounted for 10% (Ministry of Fuel and Power, 1990)

26. The demand for energy is expected to increase as the economy grows. Whilst 50% of Ghana's potential hydropower remains untapped, it is understood that it will not be expanded to any great extent because of the high capital investment cost involved. Under the National Electrification Plan it is projected that future expansion of electricity supplies - from the current installed capacity of 1 090 MW to 1 690 MW by the year 2010 - will be met from gas turbine or oil-fired steam plant.

Reliability of woodfuel and charcoal supply

27. The rate at which charcoal-making and woodfuel extraction are carried out are not sustainable and these activities are creating environmental and ecological problems (Ministry of Energy, 1991).

28. The availability of forestry residues from logging operations on non-reserve forest is likely to continue. Current Forestry Department policy does not allow the utilization of logging residues from reserve forests. There is one school of thought that the residues are an important nutrient source to the forests and should therefore remain.

29. Woodfuel by-products from the sawmilling industry are likely to decrease as the milling operations become more efficient. The amount of woodfuel released onto the market from these operations will further decline as sawmills use more fuel for their expanding timber drying operations. The generation of sawdust and woodshavings will increase as more secondary and tertiary processing is carried out in anticipation of the banning from 1994 of exports of green lumber and air-dried timber.

Reliability of petroleum products' supply

30. Until current exploration activities lead to commercial production of indigenous crude oil, the country's opportunities to plan for significant growth in the consumption of petroleum products will be severely constrained by its ability to generate the necessary foreign exchange to procure its crude oil needs (Ministry of Energy, 1991).

Reliability of electricity supply

31. Whilst the national grid is expanding, concern has been expressed over the reliability of supply. One large agricultural processing company said that due to power fluctuations 62 electric motors had been burnt out during the past two years. This, combined with power cuts which lost them 10% production time, has persuaded them to invest in a steam turbine electricity generation system at a capital cost of US$ 1.5 million.

32. The drought in 1983-84, which seriously curtailed electricity supplies, highlighted the country's almost exclusive dependence on hydropower (Ministry of Energy, 1991).

Reliability of agricultural residues' supply

33. Concern over the degradation of soils arising from poor agricultural practices has prompted the Ministry of Agriculture to encourage farmers to plough back biomass residues such as crop stalks into the land as a supply of organic matter. Rice straw and rice husk/bran are considered an important source of animal feed (Agricultural Department, 1992) so there is no prospect of their use for energy. No use is made of pure rice husk produced by large-scale mills.

Prices

34. Costs, as at February 1992, for various fuels were obtained and are given, in detail, in Appendix 8. Exact prices for woodfuel and charcoal were difficult to ascertain mainly because of regional variations and their sale by unspecified volumes. Petroleum and electricity prices are set by the Government and are the same throughout the country. Prices are given below:

(a) The average cost of domestic and industrial electricity units are 7.7 and 7.0 cedis per kWh respectively. These prices do not reflect the full cost of distribution nor the long run marginal cost of production and both the electricity generating and distribution companies are in financial difficulty. A tariff study is under consideration by the Government to increase prices. One report (Acres International Ltd, 1991b) suggests that prices would need to be increased four-fold for the financial price to equate with the economic price. Electricity prices in neighbouring countries, to which Ghana exports electricity, were reported (Hagan, 1992) to be four to five times those charged in Ghana. Present price levels in Ghana give little financial incentive to use electricity more efficiently. Electricity generation using a diesel generator works out in the region of 67 cedis per kWh (Twifo Oil Palm Plantations, 1991)

(b) Kerosene is sold at 705 cedis per gallon from garages. Kerosene is often resold in beer bottles. The price quoted in official statistics (Statistical Service, 1991) is 140 cedis per 625ml beer bottle, which equates to 1 018 cedis per gallon. Both prices are shown in the analysis below.

(c) LPG is sold at 100 cedis per kg.

(d) Diesel fuel costs 166 cedis per litre.

(e) Petrol fuel costs 200 cedis per litre.

(f) Woodfuel is sold in various volume measures, different sizes of truck, trailers, piles, headloads and so forth. Figures derived from estimated trailer volumes of sawmill slabs and edgings destined for charcoal manufacture equate to 10 000 cedis per 1.5 tonnes (green/air dry), around 7 cedis per kg. On the market in Tamale it was seen for sale in February at around 10 cedis per kilogram (air dry) in lots of 10 kg. Statistical Service survey figures for Tamale (Statistical Service, 1992) give an average figure for 1991 of 300 cedis per 9 kg (air dry) bundle, equating to an average annual price of 33 cedis per kilogram though prices do vary according to the season. It must be emphasised that these figures are based on very limited data and broad estimations. A detailed investigation of woodfuel prices would be a prerequisite for any economic or financial analysis.

(g) Charcoal ranges from 1 400 to 3 000 cedis per maxi bag. Bag weight varies according to type of charcoal (sawmill off-cuts and savannah wood) and typically falls into two average weights 32 and 45 kg. Equivalent prices when buying by the maxi bag are in the order of 30 cedis (Tamale) to 70 cedis (Accra/Tema) per kilogram. However, charcoal is often sold in smaller quantities and prices for these amounts can be 20 to 80% higher. Again, as for woodfuel, a thorough investigation of prices would need to be carried out prior to any detailed analysis in order to obtain a more accurate picture of energy costs.

Table 1. *Prices (in cedis per kWh thermal) for different fuels, taking into account their different net heating values*

Woodfuel (18 000kJ/kg)	1.4 to 2.0
Charcoal maxi bag (32 000kJ/kg)	3.3 to 7.9
Charcoal small amounts (32 000kJ/kg)	4.0 to 14.2
Kerosene (43 500kJ/kg)	16.7 to 24.1
LPG (45 000kJ/kg)	8.0
Diesel (42 800kJ/kg)	17.0
For reference:	
Electricity (domestic tariff*)	7.7
Electricity (industrial tariff*)	7.0
Electricity (diesel generated)	67.0
* average tariff	

Source: Appendix 3

35. These figures do not take into account the relative efficiencies of the fuels or end-use devices. For example it has been shown that LPG is a cheaper cooking fuel than charcoal (UNDP, 1991). (This was prior to the introduction of the Ahibenso Improved Charcoal Stove which, on quick analysis, works out cheaper than using LPG).

Current energy work programme

36. The Ministry of Energy have a very active work programme in areas of: development of renewable energy; promotion of liquid petroleum gas (LPG); electricity (including the National Electrification Plan); and petroleum. Some 45 distinct projects grouped under the above programmes were planned for 1991 (Ministry of Energy, 1991). A summary of these is given in Appendix 4. Particular efforts are being made at expanding the distribution and use of electricity and promoting the use of LPG - a by-product from the refining of imported petroleum - as a substitute for woodfuel. These efforts are attractive as they are supported by reliable performance data, proven commercially available equipment and overall carry a low development risk.

37. The Ministry of Energy is also involved in a number of projects covering improved woodfuel and charcoal stoves. Such projects offer potentially large woodfuel savings but some difficulties have been experienced with dissemination, reluctance by people to change cooking practices and the higher initial capital cost - despite quoted possible payback period of around one month. The Ministry of Energy is addressing these difficulties through a national promotion and educational exercise and through efforts to reduce the cost of the stove.

38. Work to improve efficiencies of charcoal production have largely been suspended following a study reporting that traditional techniques are more efficient than originally thought and there is therefore less scope for improvement.

39. A number of biogas projects using animal and human waste have been carried out - the major one being the Appolonia village gasification scheme. Socio-economic aspects of these ventures are under examination.

GOVERNMENT POLICIES ON ENERGY AND THE ENVIRONMENT

40. Various policies have been formulated regarding the support of sustainable biomass energy and the main objectives are summarized in Appendix 10.

CEREALS

Description of industry

41. In Ghana the agricultural sector is made up of 4 sub-sectors namely: crops (76% of agriculture GDP at constant 1987 prices), livestock (5%), fisheries (7%) and forestry (12%). Available statistics on food production for 1989 indicate maize production was around 650 000 tonnes, rice around 40 000 tonnes and millet and sorghum 384 000 tonnes.

42. Further statistics covering land use; land area by region; principal agriculture produce; area planted and production of selected food crops; and their contribution to the Agriculture GDP can be found in Appendix 5.

43. Maize and rice production is concentrated in Eastern, Ashanti, Brong-Ahafo and Northern regions, whilst millet and sorghum production is concentrated in the Northern, Upper East and Upper West regions.

44. The majority of farming is carried out on a small-holder basis using traditional production and processing methods. This effectively increases production costs and reduces the crops' competitiveness with imported produce. Calculations of the domestic resource cost for rice and maize indicate that imported rice and maize are cheaper than that domestically produced (Dapaah, 1991). To assist agricultural development, a technology and human resource development programme is underway (World Bank, 1991a).

45. Six industrial-scale (1- to 2-tonne per hour) rice mills exist but only two (Kpong region) were reported to be operational. The others, in the Northern Region, were out of action for various reasons including lack of spare parts and not being financially competitive - due to the poor quality milling equipment and consequential high milling wastage. There did not appear to be any immediate plans to rehabilitate the mills.

46. Cereals storage is an area of concern, particularly for maize. The bulk of maize is produced in areas of high humidity which make sun-drying difficult and time consuming. The first maize crop may be harvested during the rainy season and drying operations can be also hampered by rains.

47. In contrast, traditional varieties of sorghum, millet and rice are harvested in the dry season. The effects of the dry weather before and after harvesting normally mean that farmers rarely need to resort to further drying by natural or artificial means. However, the effect of natural drying can be so severe that the rice has a large proportion of broken grains which affect its value.

48. In spite of the problems with natural drying of maize, some 90% of all maize crop is dried by this method. For the remaining 10% (Dapaah, 1991) batch, stage and continuous drying are employed by a number of companies, both private and public concerns. The dryers are normally gas or diesel fired and operate on a direct drying method (ie the combustion gases are mixed with the drying air) thus avoiding the need for heat exchangers.

49. Various recommendations and justifications have been made for the introduction and promotion of solar drying of maize. This is seen as an alternative and more cost-effective method and future development efforts are likely to be concentrated in this area. NRI has considerable experience in solar drying.

50. The industries allied to cereal production and processing use woodfuel and other biomass fuels. The amounts of fuel consumed are not known but are thought to be considerable. For example, one such user - bakeries - are known to consume large quantities of woodfuel. The techniques are often traditional and there may be possibilities for improvements in fuel efficiency and energy conservation. This would reduce operational costs, help conserve woodfuel and other biomass energy, and - through improved thermal control - may increase product quality and reduce losses. A study of the industries and identification of thermal savings would be required as a first stage.

Description of residues

51. The main residues from the cereals sector are:
(a) maize: stalk, cob;
(b) millet: stalk;
(c) sorghum: stalk;
(d) rice: straw, husk, husk/bran.

Availability of residues

52. The amount of residue production is substantial. Based on cereal production figures for 1990 and typical crop residue ratios the following estimates are given:

Table 2. *Crop and crop residue production*

Crop	Production (tonnes)	Crop:residue ratio	Residue yield (tonnes)
Maize	553 000	1 : 2.5	1 382 500
Sorghum	136 000	1 : 2.0	272 000
Millet	75 000	1 : 2.0	150 000
Paddy	81 000	1 : 1.75	141 750

Source: Ministry of Agriculture, 1991; NRI, 1991

Opportunities for utilization

53. As explained above, most of the production is by small-holder farmers using traditional techniques. For this reason the residues are scattered with no central collection point. This, coupled with the Department of Agriculture's policy of encouraging farmers to use the residues as a source of organic material for the land, leaves little scope for industrial-scale energy utilization. Where scope for utilization exists, the opportunity cost of these resources i.e. any value in their alternative use, must be taken into account in calculating the costs and benefits of a new use.

54. If the existing rice mills, currently out of action, were rehabilitated or new mills installed it is considered there would be an excellent case for incorporating efficient rice husk burner technologies into such plants. A 2-tonne per hour mill would produce approximately 400 kg of husk per hour with a thermal potential of approximately 1.6 MW. Such burner systems using husk as a fuel would provide a source of controlled heat for associated processes such as parboiling and drying. Parboiling operations may be an important future consideration in view of the high incidence of brokens incurred in milling the dry paddy. All paddy produced in the northern areas is parboiled by village processors using wood as a fuel.

55. Technical and commercial opportunities exist for the utilization of the ash residue from the burning of husk. Its use as a reinforcing agent/filler in rubber may be of particular interest to Ghana's expanding rubber industry.

56. A significant proportion of the cereal stalks and maize cobs are already used as a domestic fuel. In view of the diminishing supply of woodfuel their importance as a domestic fuel in the cereal-growing areas will probably increase.

Workshop proposals

57. These are outlined in Appendix 8 and every attempt has been made to reflect the collective views expressed to the

team by the ministries, industry, associations, institutions and other organizations. They are summarized as follows:

(a) Rice husk suspension burner.

The introduction of the brick-built suspension burner, to utilize sawdust waste, would serve the rice industry should the industrial-scale mills be rehabilitated or new ones introduced. The burner technology, originally developed for rice mills using husk as the fuel, should easily be transferable with adaptation.

(b) Reduction in use of woodfuel and other fuels.

An assessment of biomass energy thermal efficiencies in small-scale village-level industries (eg pito brewing, bread baking and parboiling of paddy) would be carried out with identification of thermal savings (proposal also included under Oilseeds and Edible Nuts Programme).

Costs and benefits

58. Investment in a rice husk suspension burner would enable sufficient heat to be produced from rice husk combustion to hot water soak and parboil 2 tonnes of paddy per hour. If wood were used as a fuel this operation would require approximately 1 tonne per day. At a cost of 7 500 cedis (£11) per tonne the annual expenditure on wood that could be saved would be in the region of 2.1 million cedis (£3 000) for an initial capital outlay of 3.5 million cedis (£5 000), representing a payback period of less than two years.

59. Small-scale industries consume considerable quantities of woodfuel. Because prices of wood have not reflected their true cost, wood has not been such an expensive item that users have needed to use it efficiently. However, as supplies begin to dwindle and prices rise, energy costs are becoming a larger component of production costs. The industries, under pressure from relatively cheap imported produce, are being seriously affected but have no access to technologies or advice which would assist them in reducing their fuel consumption. The study would identify areas of woodfuel consumption, scope for improved operating practices and consequently enable them to compete better on price and quality with imported produce. As well as benefits to the users of woodfuel, a programme to reduce consumption would have national benefits. A study of socio-economic implications would be placed high on the project agenda.

OIL SEEDS AND EDIBLE NUTS

Oil palm - description of the industry

60. Oil palm production is concentrated in the Western, Central and Eastern Regions of the country. There are five large-scale estates (BOPP, TOPP, GOPDC, NOPP and SOPP), six

medium-scale mills, some 50-60 small-scale village processing units and household production for own consumption and sale.

61. Large mills process upwards of 250 tonnes fresh fruit bunches (FFB) per day, produced on their own plantations and by outgrowers, and sell most of their output to industrial processors for cooking oil and soap production. They account for 40-45% of production. Medium-scale mills process 15 tonnes per day and village processing units 1-2 tonnes of fresh fruit bunches, purchased from surrounding farms, per day. Much of the oil produced by the medium- and small-scale mills is sold to local markets for direct consumption with very small quantities sold to industrial processors.

62. The wholesale price of palm oil is set by the five large plantations in conjunction with the major consumers which has led to inefficiencies in processing and poor productivity. Smallholder growers have failed to benefit from their greater productivity because they produce an unrefined oil which is sold mainly for local consumption rather than as an industrial input.

Table 3. *Oil palm production (tonnes of FFB)*

Organization	1989	%	1990	%
TOPP	53 055	13.4	57 770	13.5
BOPP	47 987	12.1	40 488	9.4
GOPDC	38 036	9.5	43 220	10.1
NOPP	13 870	3.5	15 400	3.6
SOPP, Okumaning	12 733	3.2	18 302	4.3
Others				
Other private holdings	231 545	58.3	254 700	59.4
TOTAL	**397 227**	**100**	**428 880**	**100**

Source: Ministry of Agriculture, 1991

Oil palm - description and availability of residues

63. A large-scale mill's production of residues (Twifo oil palm plantation, 1991) is in the order of:

Empty fruit bunches	20% of FFB
Fibre	17% of FFB
Shell	7% of FFB
Palm oil mill effluent	0.6 tonne per tonne FFB

64. One tonne of palm oil mill effluent (POME) is capable of producing 28 cubic metres of biogas when digested. Biogas has a calorific value of approximately 20 MJ per cubic metre (Acres International Ltd, 1991a).

Oil palm - opportunities for utilization

65. On the estates empty fruit bunches are either applied directly as mulch or are incinerated to produce potash which is spread on the land. Fibre and shell are used as a fuel for

boiler operation to raise steam for processing and, on two estates, for co-generation of electricity.

66. Although excess fibre and shell are produced during the peak season, the mills do not generally have problems of excess fibre over the year as a whole, unlike in Malaysia where crop yields are up to two-thirds higher.

67. In small-scale processing, empty fruit bunches and fibre are used as a fuel to raise heat for boiling the fruit; but woodfuel is often used as a supplementary and sometimes as the exclusive fuel. The amounts of fuel consumed are not known but could be considerable. Woodfuel is also used by associated industries such as in small-scale soapmaking. The techniques used are often traditional and there may be possibilities for improvements in fuel efficiency and energy conservation. This would reduce operational costs, help conserve woodfuel and other biomass energy, and - through improved thermal control - may increase product quality. A study of the industries and identification of thermal savings would be required as a first stage.

68. Palm nuts are frequently sold for cracking elsewhere in a separate process and the shell used as a heat source for palm kernel oil production. Some shell is sold to blacksmiths who carbonize it for their own use.

69. Palm kernel shell has been identified as a potential source of charcoal for a specific type of activated carbon (Forest Products Research Institute, 1991) but it was considered that the relatively small quantities produced, their high moisture content resulting from the hydrocyclone method of separation used in the mills and the thinner shell of the hybrid Tenera variety would not form an ideal feedstock for carbonizing.

70. The main non-utilized energy source are the methane gases produced during the digestion, in open ponds, of palm oil mill effluent (POME) to reduce its biochemical oxygen demand (BOD) content. Semi-treated effluent is then released into the nearby water courses. The effluent is known to pollute the water course and at one oil palm mill visited it was reported that complaints had been received from local people over poor water quality and fish dying in the river. Palm oil mill effluent has been identified as a potential but limited source of biogas (Acres International Ltd, 1991a) however there are no plans to exploit this.

Coconuts - description of the industry

71. The main concentration of production is in three locations - south-east Ghana (border area of the Volta Region); Cape Coast area of the Central Region and the south-west coastlands of the Western Region (Axim to the western border) (Forest Products Research Institute, 1991). Coconuts are grown on some 45 000 hectares by an estimated 17 700 farmers. Most are grown on smallholdings though there are seven plantations growing between 110 and 220 hectares.

Coconut farmers in the coastal areas are reported to have been abandoning their plantations and growing vegetables and other food crops after the destruction of coconut palms due to Cape St. Paul Wilt.

72. A Department of Agriculture study found that over 70% of the nuts are used for direct processing of oil; 12% are made into copra with the rest consumed as fresh nuts or used for nursery stock.

73. There are several large-scale oil mills in the country but none are operational. All the oil processing is carried out in 6 medium-sized processing units (15 tonnes/day) and some 120 cottage industry mills processing between 2 000 and 7 000 nuts a day.

Coconuts - description of the residues

74. Residues from copra and oil production are the shells and husks. In copra making and fresh oil processing the whole coconuts are split and the flesh cut out; the shells are not separated from the husks.

Coconuts - utilization of the residues

75. The shells with husks are used for copra drying. Shells and husks are used to raise heat for direct oil processing and as a supplementary domestic and bakery fuel. A study in 1990 (Forest Products Research Institute, 1991) found that in the south-west, shells had little or no value whereas in the Volta region - where there are woodfuel scarcities - shells were sold for as much as 6.25 cedis each and there was some trade in shell and husk across the border with Togo. The study estimated that some 20 000 tonnes of shell were not utilized from the direct production of oil. It had been suggested that these might be available as a feedstock for carbonization which could then be exported for activated carbon production but it was shown that they were too widely dispersed to be collected and carbonized economically.

76. There were formally two coir mills, at Tikobo and at Axim, which produced mattress fibre but these are no longer operating.

Groundnuts - description of the industry

77. The production of groundnuts is concentrated in Northern (46 000ha in 1991); Upper West (20 700ha) and Upper East Regions (33 000ha). The 1991 crop was estimated at 67 000 tonnes. Nuts are processed into oil by pounding and the resultant meal used for cooking and snack production. There is no large-scale milling of groundnuts - the country's only commercial mill has not been in operation for the past five years.

Groundnuts - description of the residues

78. These are some 17 000 tonnes (20% of nut production) of groundnut shells and groundnut vines.

Groundnuts - opportunities for utilization of the residues

79. Farmers are being encouraged to use groundnut vines as a mulch. Groundnuts are shelled by the farmers and the nuts sold to village processors. Given the very small holding sizes and the dispersed nature of nut shelling it is unlikely groundnut shells would be available in sufficiently concentrated quantities to be used as an energy source to supply process heat.

Workshop proposals

80. These are presented in Appendix 8 and every attempt has been made to reflect the collective views expressed to the team by the ministries, industries, associations, institutions and other organizations. They are summarized as follows:

(a) Techno-economic appraisal of palm oil mill effluent gasification to supply energy for community use.

Under controlled conditions the effluent can be used for biogas production and as a soil conditioner. The biogas can be burned to serve various energy needs. Such biogas energy schemes are common in Malaysia where the introduction of strict environmental laws have persuaded the oil palm industry to reduce pollution and utilize potential energy sources. The Malaysian oil palm industry has reported good results from the biogas production schemes and their introduction is being promoted.

This proposal would involve a techno-economic study of the introduction of the technology at a selected oil palm mill. The energy would likely be used to supply the needs of local workers and their families, consisting of some 2 000 to 7 000 people, residing near to the mill.

The families currently use woodfuel and charcoal for cooking and kerosene and electricity for lighting. Options to be considered will be the use of biogas for cooking or for electricity generation using gas internal combustion engines/generators. The major environmental benefits will be reduced water pollution and woodfuel/charcoal usage.

The technology is well developed and proven in Malaysia and it is envisaged that technical expertise for the study would be recruited from there. The economic and financial costs and benefits of cleaning up this pollutant and turning it into a useful product would need careful appraisal. The financial benefits may not be sufficient to encourage the uptake of the technology.

Enforcement of environmental legislation might also be a necessary prerequisite for technology adoption.

(b) Reduction in use of woodfuel and other fuels.

An assessment of biomass energy thermal efficiencies in small-scale village-level industries eg oil processing and soap making would be carried out with identification of thermal savings (also included under Cereals programmes).

Costs and benefits

81. With regard to study (a) the costs of a system to utilize biogas produced from palm oil mill effluent has yet to be ascertained. The mill under consideration generates some 34 700 tonnes of POME a year. The potential gas production from this is in the region of 1 million cubic metres with a energy value of 20 000 GJ. The annual value of the gas produced would approximately equal 1 000 tonnes of wood with a tradable value of around 7 million cedis (£10 000) or 600 000 litres of kerosene with a value, at the official retail price of 156 cedis per litre, of 94 million cedis (£134 000). Conversion of POME to biogas would obviate the need to compensate villages for pollution of their water supply and the possible risk of mill closure.

82. With regard to study (b) small-scale industries consume considerable quantities of woodfuel. Because prices of wood have not reflected their true cost wood has not been such an expensive item that users have needed to use it efficiently. The industries, under pressure from relatively cheap imported produce, are being seriously affected but have no access to technologies or advice which would assist them in reducing their fuel consumption. The study would identify areas of woodfuel consumption, scope for improved operating practices and consequently enable them to compete better on price and quality with imported produce. As well as benefits to the users of woodfuel, a programme to reduce consumption would have national benefits. A study of socio-economic implications would be placed high on the project agenda.

FORESTRY SECTOR

Description of industries

83. The forestry sector accounts for about 6% of the Gross Domestic Product and ranks third after cocoa and minerals in foreign exchange earnings. Timber resource is mainly from the closed forest which forms 34% of Ghana's land area, of which 20.4% are forest reserves, 4.5% unreserved forest and 75.1% consists of cocoa, food farms/bush fallow.

84. The forestry sector is concentrated in the Ashanti, Brong-Ahafo, Western and Central regions with a number of furniture processing industries in Greater Accra. The

greatest concentration of sawmilling operations is in Kumasi and Sekondi/Takoradi.

85. The sector employs a labour force of over 70 000 people whilst providing livelihood to about 2 million people out of a total population of 14 million people (Attah, 1991).

86. Ghana's timber industry can be classified under three categories of operation, namely: primary (logging), secondary (sawmilling, plymilling, veneering) and tertiary (furniture, furniture parts, mouldings, flooring, toys and so forth). The structure of the industry is given in table 4.

87. The industry has made notable progress since the introduction of economic reforms in 1983. However, serious constraints inhibiting further progress does exist in areas of marketing, raw material supply, finance, technology and management (Timber Export Development board, 1991).

Table 4. *Structure of the timber industry*

Activity	**Number**
Logging	200
Sawmilling	100
Plymilling	9
Veneermilling	13
Chipboard manufacture	1
Furniture manufacture	200
of which medium/large	40
Flooring	4
Doors	6
Profile boards	5
Toys	2

NB Companies may be involved in more than one area of activity.
Source: Attah, 1991

88. Wood processing has been identified as one of the activities for which Ghana has the comparative advantage in development and it is reported that there is considerable scope for increasing the value added content of Ghana's exports through a more efficient and complete utilization of the timber resource (Attah, 1991).

Timber drying

89. With the directive banning all exports of green and air dry lumber by the beginning of 1994, it is recognized that the industry must be adequately supported with timber drying facilities. Current kilning capacity falls well short of requirements and it is estimated that an additional 200 000 cubic metres of annual kilning capacity is needed. On an average 3-week drying cycle this will mean installing some 12 000 cubic metres of additional kiln capacity.

90. Prompted by this ban, sawmillers and furniture workshops are making enquiries about timber drying and some plans to install commercial systems or increase existing capacity are already in progress. There is little independent professional advice available to the sawmillers and many equipment procurement decisions involving substantial sums of money rest on advice from timber drying kiln manufacturers and salesmen. There is no Ghanaian-produced kilning equipment. The commercial kilns under consideration are typically solid-wood fired but can accept small quantities of particulate wood. Little or no thought has been given to the energy balance and thus how the additional energy demand will be met. In most cases it is assumed that the sawmills generate sufficient woodfuel off-cuts. Whilst this may be the case, opportunity costs exist for the off-cuts for sale as a domestic fuel and for charcoal making (see paragraphs 97 - 104, Opportunities for utilization). Their increased consumption as a fuel at the sawmills would deprive the local market of this fuel source and reduce the revenue sawmills currently obtain from their sale.

91. The Timber Export Development Board is considering plans for centralized custom drying of timber where sawmillers would send their timber consignments for drying prior to export. Such a proposal, whilst in the right direction, is fraught with difficulties. Because the facility will be a separate enterprise it will not have easy access to woodfuel to supply the drying kiln's energy needs, as in the case of sawmills. Moreover, concern by the sawmillers has been expressed over possible delays in getting timber dried and the financial penalties they would incur on late deliveries. Sawmillers tend to prefer direct control and responsibility over the drying process.

92. The lack of professional advice on timber drying was just part of an overall lack of advisory services to the forest industry. A letter (reproduced in Appendix 6) published in one of the daily papers typifies the industry's plight. Discussions with the forest industry, the Timber Export and Development Board, the Forest Products Inspection Bureau, and the Forest Research Institute of Ghana pointed to the need for an extension service to form the link between research and industry. Areas of interest expressed by the above included timber processing, timber grading, timber drying, utilization of residues, fuel efficiency, equipment availability and non-timber forest products.

93. Training in timber drying techniques was placed high on the forest industries' agenda. Lack of proper training - particularly at furniture workshops - was a problem highlighted by the industry.

Description of residues

94. The main residues from the forestry sector are:

(a) logging residues - butt, top logs, branchwood, and non-sawlog material;

(b) sawmill residues - off-cuts, slabbings and edgings and sawdust;

(c) waste from veneer operations - veneer off-cuts, peeler cores; and

(d) furniture and other wood processing waste - off-cuts, sawdust and woodshavings.

Availability of residues

95. The quantity of residues produced are substantial, as table 5 shows.

Table 5. *Residue production per tonne of timber*

Activity	Form of timber	Weight kg	Residue (Wt kg)
-	Tree in forest	1000	-
Logging	Log for processing	500	Butts etc (500)
Sawmilling	Sawn timber	225	Slabs (155) Off-cuts (50) Sawdust (70)
Wood Processing*	Furniture and other products	160	Sawdust Off-cuts (65)

Source: UNDP, 1988; * Authors' estimate

96. It is difficult to give accurate estimates for residue production. A joint UNDP/World Bank mission (UNDP, 1988) estimated total residue production for the sawmilling and veneering/plywood industry for 1986 which is given in table 6.

Table 6. *Timber processing wastes (cubic metres of solid wood equivalent, 36% moisture content (wb), 786 kg/m3 density)*

Slabs/ edgings	Off-cuts	Sawdust	Veneer waste	Cores
213 000	67 000	93 000	35 000	27 000

Source: UNDP, 1988

Opportunities for utilization

97. The sawdust residues from sawmills and wood processing centres offer the best opportunity for utilization. These residues are generally seen as a waste material since they have virtually no opportunity cost and pose a disposal problem. At present the forest industries, in particular sawmills, have to commit significant resources in human and transport terms - one large sawmill has two tractors and trailers dedicated to moving sawdust every day - to take the material away for dumping in surrounding areas, often for burning with associated hazards to health and property.

98. The total quantity of sawdust produced annually is seen above to be in the order of 93 000 cubic metres of solid wood equivalent - approximately 73 000 tonnes, at 36% moisture content (wb). Not all of this however will offer opportunities for utilization. Whilst the moisture content of sawdust straight from the wood has been estimated at 36% (UNDP, 1988) it will vary - for example, water is used as a sawblade lubricant during sawmilling operations.

99. Attempts have been made at some sawmills to feed small amounts as a fuel supplement to their boilers, but success is limited because of the unsuitability of the furnaces to burn particulate waste.

100. There have been two serious attempts at briquetting sawdust but both efforts have failed. One for financial reasons, thought to be the high cost of transporting the briquettes to the user. The other for technical reasons, the company has no sawdust pre-dryer, an essential part of the briquetting process. Whilst an interest in briquetting was expressed by the sawmillers, the capital and production costs involved and experiences of briquetting ventures in Ghana and elsewhere in developing countries has shown it not to be an attractive commercial proposition.

101. Small quantities of sawdust are used as litter for poultry and for the sawdust-clamp charcoal kilns.

102. The logging residues on non-forest reserves are generally utilized as a fuel (including charcoal manufacture), for local furniture manufacture and handicrafts. On forest reserves the logging residues remain on the forest floor. There is great reluctance on the part of the Forestry Department - which manages the forest reserves - and the Forestry Commission to allow charcoal making operation into these areas for fear of forest fires. This stand is supported by the reported outbreaks of fires from charcoal making operations on non-forest reserves. The current levels of forest/bush fires outbreaks and the resultant destruction of forests, property and loss of life is a cause for great concern.

103. Off-cuts from sawmilling operations are utilized as a fuel for on-site raising of steam for associated processes, for sale for woodfuel and charcoal production, and for sale to

local furniture manufacturers. The sale of off-cuts is an important source of revenue to the sawmills and a valuable source of fuel and furniture material for the local community. The off-cuts should be viewed more as a by-product from the industry, which have an opportunity cost, rather than a waste. The team noted that the extensive charcoal making operations carried out in Kumasi were highly polluting through the emission of obnoxious carbonization gases and ash particles.

104. Veneer wastes are normally used as a fuel for on-site use.

Proposals presented at the workshop

105. These are outlined in Appendix 8 and every attempt has been made to reflect the collective views expressed to the team by the ministries, industry, associations, institutions and other organizations. The proposals concentrate on the utilization of sawdust, the area where greatest opportunities are considered to exist. In summary they are as follows:

(a) Assistance to the forest products industry to utilize sawdust as a fuel for timber drying. The project will consist of the following elements:

(i) demonstration and promotion of sawdust-fuelled medium-size timber drying kilns for use at sawmills;

(ii) demonstration and promotion of sawdust- and wood shavings-fuelled small/medium-size timber drying kilns and solar kilns for use at furniture workshops; and

(iii) demonstration and promotion of a sawdust burner (up to 1MW thermal) to connect to existing furnace/boiler systems for use at sawmills.

(b) The establishment of a Forest Products Extension Service.

Costs and benefits

106. Only a broad indicative appraisal of the introduction of sawdust burner/timber drying kilns can be made at this stage. There is a potential 47 000 tonnes of sawdust (ovendry equivalent) per annum to be utilized as a fuel with a gross calorific value of 890 000 GJ. The oil equivalent is in the order of 21 000 tonnes.

107. Assuming that only half was available for utilization, then some 30 of the larger sawdust burners would be required. The capital cost of these would be in the order of 105 million cedis (£150 000). Over the burners' predicted 6 year life the quantity of wood replaced would be in the order of 141 000 tonnes. This could be sold for woodfuel for 1.06 million cedis at current prices. On an individual burner basis this represents a payback period of 7 months, from the generation of an additional 5.8 million cedis in annual fire wood sales. This does not include the savings in disposal costs currently

incurred in carting away the sawdust of, say 2.8 million cedis per year.

108. Other benefits include:

(a) local employment for manufacture, supply and maintenance of burner/timber drying kiln systems;

(b) availability of a medium size-sawdust burner/timber drying system produced wholly or in part in Ghana;

(c) evaluation and availability of locally produced or imported solar kilns for the smaller user;

(d) value-added to timber for export markets;

(e) access to cheaper kiln-dried timber for local processing;

(f) possible reduction in electricity and fossil fuel consumption used in many conventional kilns;

(g) training in timber drying techniques; and

(h) reduction in urban pollution from dumping and open burning of sawdust.

109. The main objective of the proposed Forest Products Extension Service project is to strengthen the forest products industry and to make it more competitive in the world market.

110. The extension service would address some of the major shortcomings in the forest industry as voiced by the loggers, millers, and processors which may be listed as follows:

(a) selection and procurement of timber processing and treatment equipment;
(b) international marketing strategies;
(c) timber drying techniques;
(d) credit facilities for wood processing;
(e) timber grading standards and quality control; and
(f) training of inspectors, graders, production managers, supervisors and foremen in modern production techniques.

111. It will also benefit rural communities by providing advice to industries based on non-timber forest products.

STAND-ALONE ELECTRICITY GENERATION AT 250 KW OUTPUT

112. Under the national electrification plan it is envisaged that the grid system will reach all populated areas of Ghana within 30 years. The electrification scheme comprises six 5-year phases.

113. Future power and energy requirements will be met by a combination of hydroelectric generation from the existing

Akosombo and Kpong generating stations and additional generating stations - mini-hydro, gas turbine and oil-fired steam plant are serious contenders.

114. One indigenous renewable energy resource which could play an important part in the electrification scheme is biomass. This could be renewable agricultural residues or, more likely, plantation-grown woodfuel. Whilst large scale mega-watt power generation schemes introduce serious logistic problems of biomass supply, there may be scope for small-scale electricity generation in the order of 250 kW output. Such systems could operate away from the grid and supply electricity to isolated areas where plans for grid connection are long-term (20 years or greater).

115. In developed countries there is increasing interest in introducing electricity generation systems at this level, using biomass as a fuel. The technology is at a development stage and prototype equipment exists. The equipment is being introduced into Europe and there may be scope for the application of such technology in Ghana.

116. Prospects for such small-scale biomass fuelled electricity generation warrant further investigation and a techno-economic study proposal of the introduction of the technology has been included. An important factor for investigation is land availability, its cost and alternative uses. At sustained yields of 6 tonnes per hectare some 333 hectares of woodfuel crops would be required to provide the necessary biomass feedstock to generate 250kW of power. Other factors to be considered will cover, *inter alia*, availability of equipment, technical and economic feasibility, social and management implications and environmental impact.

TECHNOLOGY TRANSFER

Experiences of some organizations in Ghana

117. A number of NGOs and Government departments have been actively involved in the transfer of technologies. Details of some of these are given in Appendix 11.

Methods of transfer

118. NRI has considerable experience in biomass energy technologies with the approach outlined in the introduction.

119. The types of technologies that are under consideration for transfer range from those that could be developed for micro-scale energy users to systems already at the pilot stage elsewhere for small- and medium-scale enterprises. The methods of technology transfer will vary according to the needs and interests of the clients. Ability to pay and involvement in design are likely to vary in relative importance but will be of concern, at different levels, to all potential users. The choice of a technology ie its sophistication and scale to be introduced and whether it

should be made of locally available materials also need to be examined. This is generally considered desirable but may depend on the scale of the industry to which a technology is to be introduced and indicates the need for a range of technologies to be made available.

120. NRI's efforts have been directed towards medium-scale industries because this is where large quantities of residues exist and there is a use for the fuel generated. It may be easier to introduce technologies into a commercial environment though considerable thought still needs to be given to the development of a system for dissemination.

121. During the pilot phase in which the technologies will be tested, adapted and demonstrated under commercial conditions, work must also be initiated on a dissemination strategy. This will need to consider the following aspects:

- institutional strengthening
- training
- engineering capabilities and equipment availability
- promotion and marketing
- credit facilities
- socio-economic benefits

These are discussed below.

Institutional strengthening

122. The Ministry of Energy has considerable experience in technology dissemination and promotion particularly at the household level. A review of the Ministry's biomass energy programmes and ideas on strengthening national energy policy and operational management capabilities (Hagan, 1990) recommended that efforts to promote user involvement in technology design and implementation should be intensified and project design should involve a mix of public, private and national and local-level organisations. This would improve flexibility and balance needs of the identifiable groups as well as bringing about optimal use of the resource.

123. To this end it was suggested that the Ministry of Energy increase its involvement in:

(a) integrating energy, equity and development concerns within biomass energy programmes which would involve the development of specialised expertise and institutional capacity for biomass systems;

(b) training and provision of support services for local extension agents; and

(c) compilation and provision of comprehensive data on bio-energy resources, technologies and end-use equipment.

124. These types of activities are similar to those envisaged in the project cycle put forward in NRI's Best Bests Strategy

and would form an important part of any technology transfer project.

Training

125. The strengthening of research and development facilities and advisory services at the collaborating organizations, to support the pilot schemes put forward, would be an integral part of the project proposals.

126. Technology transfer will require considerable inputs to be made in training. Elements of training would encompass:

(a) needs assessment and survey skills;

(b) technology design, testing, commissioning, operation, maintenance and repairs;

(c) energy auditing techniques;

(d) techno-economic feasibility studies;

(e) use of biomass energy laboratory equipment;

(f) marketing/product promotion; and

(g) business management.

127. Other training, specific to certain projects, would also be required.

Engineering capabilities and equipment availability

128. Local capabilities to undertake many of the processes in technology transfer are considered vital for successful long-term viability (Hurst and Barnett, 1990; NRI, 1991). Ghana has a number of engineering firms and ITTUs capable of producing many of the parts of the envisaged technologies.

129. Motors and fans will need to be imported. Second-hand fire bricks are reported to be available from VALCO though not necessarily on a regular basis.

130. Some industries such as the sawmilling industry are accustomed to purchasing large capital items from overseas and may consider it easier/preferable to import materials from abroad than to have to identify local sources. This could be one area where an entrepreneur could put together a package of the necessary items.

131. Biomass energy laboratory equipment would need to be provided by the project.

Promotion and marketing

132. There is widespread agreement that for technologies to be successful they must meet a need, be affordable and be operated and maintained by the users (op.cit.; National

Research Council, 1984) but sufficient attention must also be given to how the technology is to be promoted once it has been adequately field tested and who is to do this. In some cases it will be appropriate for the promotion of the technology to be developed by an entrepreneur as manufacturer or installer of technology while in others, particularly those involving very small-scale operations, it may require more involvement of government institutions and NGOs.

133. In the case of the opportunities for the use of particulate residue combustion technologies there would be plenty of scope for entrepreneurs to be involved in promotion and dissemination.

134. An important part of technology transfer would be to identify such entrepreneurs and to give them training and support to build up their enterprises. Careful consideration must, however, be given to the selection of suitable candidates. This may be an area where assistance should be sought from Chambers of Commerce and NGOs with experience in supporting entrepreneurial development.

135. In a case study of small-scale industry development in Kumasi (World Bank, 1991b) the existence was noted of a number of new entrepreneurs, often educated in engineering, with access to capital and good contacts with large firms. Some have previously been employed in large firms or come from technical colleges. They were judged to have fairly advanced technical skills and able to see the technical feasibility of increasing the sophistication of local products. Such entrepreneurs had been able to purchase initial capital equipment needed to start at a relatively high level of capacity and expand into niches not taken by large firms and imports. These would be the types of people needed to promote biomass energy technologies.

136. During the demonstration/pilot phase further market research through consultation with prospective users will help refine the technology design into a package which can be disseminated to prospective users. Entrepreneurs would be involved in this activity.

Credit facilities

137. Credit is scarce for all industries though it is more likely to be a problem for the very small-scale enterprises which have great difficulty in amassing capital. The Ghanaian formal financial system, comprising national banks, rural banks and credit unions, is said to provide a poor quality and expensive service in the rural areas and does not have the capacity or interest to serve small-scale entrepreneurs. Bank interest rates are high, in the region of 25-30% per annum.

138. Lack of availability of loans for working capital means that many small-scale enterprises are forced to operate on "hand-to-mouth" basis ie they are obliged to obtain a deposit for an order before they can commence production. Products cannot be made in large quantities and consequent economies of

scale realized. A survey of small enterprises in Ghana carried out for the World Bank in 1990 (World Bank, 1991b) found that enterprise owners cited lack of credit for raw materials as the most serious problem affecting the operation of their businesses.

139. Much of the funding for technology transfer in Ghana comes from international aid agencies. GRATIS, for example, receives most of its funding from the European Community and CIDA with the Government paying 10% of its budget for staff costs. GRATIS runs a machine tools hire purchase scheme through a commercial development bank and is able to subsidize its clients for the first two years of a five-year loan period - the first year a client pays 4% interest to cover bank administration costs, rising to 11% in the second year and to 18% in the third and consecutive years.

140. Funding would be required for the demonstration programmes envisaged for biomass energy technology promotion, dissemination and the training and selection of entrepreneurs. The crucial elements for widespread technology transfer are (a) demonstration of the technology's feasibility and (b) finding the right investor and entrepreneurs to promote the technologies. The latter is an area in which counterpart organizations may have expertise. It is possible that such entrepreneurs will not be able to obtain finance for the ventures envisaged. Quite simply, despite the projects being aimed at areas where there is a clear need and best opportunities, there exists an element of risk which is unquantifiable. In such cases there may be a case for assisting entrepreneurs but over-emphasis on credit may bring forth entrepreneurs of the wrong type.

Socio-economic and environmental benefits

141. From a socio-economic and environmental perspectives these types of projects are extremely attractive for the benefits they could bring to the wider development process. Benefits include:

(a) reduction in use of imported hydrocarbons;

(b) reduced carbon dioxide, sulphur dioxide and nitrous oxide emissions;

(c) creation of employment and opportunities for entrepreneurs;

(d) reduction in imports of equipment;

(e) creation of local manufacturing capabilities and greater value added to local products;

(f) reduced smoke and ash pollution; and

(g) less fire hazard to life and property.

142. Whilst such factors may not persuade individual private investors, they reflect development and environmental goals and should influence the decisions of governments and donor agencies when considering support for such projects.

PROJECT DEVELOPMENT AND MANAGEMENT

Next steps

143. At the workshop the Ministry of Energy outlined the procedure they would follow on receipt of the visit report containing the visit findings and outline proposals, namely:

(a) the Ministry of Energy would carry out a detailed analysis of the reports' findings and proposals;

(b) side-copies of the report would be distributed to potential collaborating organizations and other interested parties (these are shown in Appendix 9) and their comments and views formally sought;

(c) a meeting of interested parties would be held by the Ministry of Energy to jointly discuss: the proposals; division of responsibilities between the various Ministries, Institutes and other organizations; and the next stage;

(d) the final development of the proposal(s), identification of international and local expertise and specific cost inputs; and

(e) subject to internal approval procedures the proposal(s) would be submitted to the selected funding agency(ies) through the Ministry of Finance and Economic Planning.

Ministerial co-operation

144. Co-operation between the relevant ministries is very important for energy technology transfer and the strong inter-relationship between energy and other development activities means that success of projects in other areas is more likely if energy supply is also considered (Hurst & Barnett, 1990). The bringing together of different agencies with their various interests and responsibilities will be vital and thought must be given to suitable mechanisms for implementation.

145. Arrangements will need to be developed to allow joint applications for donor funds and sharing of local costs by the ministries so that support for projects do not fall only on one ministry.

146. Considering the various ministerial policies and responsibilities the Ministry of Energy is the obvious organisation to take a lead role in co-ordinating the biomass energy work. In the project areas where there is a large forest industries component the Ministry of Lands and Natural Resources may wish to assume the role of co-ordinator.

Donor interest

147. Interest has been expressed in the approach to technology transfer following dissemination of the Best Bets strategy to development organizations. During the visit to Ghana discussions were held with representatives of several funding agencies. Overall, the response from them was positive and encouraging. In particular the World Bank, UNDP and the European Community felt that there were areas that they would be interested in considering for their support.

RECOMMENDATIONS

148. That the Ministry of Energy is the lead organization for biomass energy work.

149. Where it is considered by the Ministry of Energy that a project area does not fall sufficiently within its mandate it is recommended that the appropriate ministry consider and develop the proposal.

150. Final project design should be carried out by Ministries and other collaborating organisations and, subject to approval by the lead ministry, the projects are submitted to the funding agency(ies) through the Ministry of Finance and Economic Planning.

151. Following the project submission stage, the projects should proceed at the earliest opportunity to the implementation phase.

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Appendix 1. TERMS OF REFERENCE

1. Assessment of the national situation

- Prior to visit review in-house knowledge and literature.

- Visit appropriate ministries, NGOs, industries and other organizations at national level to collect information on biomass residue resource base (forest products, cereals and oilseeds and edible nuts), energy uses in rural industries, energy costs and the organizational structure within which biomass energy technologies (BET) could be introduced.

2. Appraisal of the potential for field projects based on visits to specific representative localities.

Verify

i) the quantity of forest product, cereal and oilseeds and edible nut residues available for use as fuel;

ii) existing and potential energy processes which could be efficiently met by a BET;

iii) the cost of existing energy systems and fuels and of the BET for that site;

iv) the receptiveness of the potential BET users to the idea of introducing the BET;

v) the technical capabilities of the enterprises which would receive the BET;

vi) the suitability of existing institutions for the dissemination and support of the BET;

vii) the types of technical adaptation needed to successfully introduce the BET into the locality;

viii) necessary steps to overcome deficiencies in the market channels or institutional infrastructure for sustaining the application of the technology;

ix) potential secondary effects arising from the introduction of the BET.

3. Carry out project design in collaboration with in-country organizations identified during field assessment for submission to multilateral aid agencies.

Project design will define:

- a project plan;

- further technical work required to test and pilot the technology and to adapt it to local conditions;

- the preferred structures for commercially manufacturing and marketing the BET;

- arrangements for supply of spare parts and servicing;

- the marketing channels for products (such as charcoal) from BET operations;

- the institutional support structure for technology development, dissemination and training in its use. A decision to work with a given institution will be taken after an appraisal of its suitability for the proposed work taking account of professional credentials, record in developing and introducing technologies, financial and managerial aspects. Institutional strengthening may still be necessary and training and provision of equipment should be included in the project;

- sources of commercial credit, where necessary, for potential purchasers of the plant (only for projects which have reached the pilot stage);

- the budget needed for project implementation;

- costs and benefits to the individual firms and to the country concerned. Preliminary appraisals can be refined as implementation proceeds.

4. Form a development model for the assessment of needs for energy technologies and project design approach that may be applied in other countries.

5. Analyse the above approach to form a model that may be applied to other areas of technology transfer.

Appendix 2. PEOPLE MET

Ministry of Energy
Charles Wereko-Brobby, Energy Policy Adviser
Leo Denkyi, Administrator
Michael Opam, Programme Officer
K.T. Addo. Associate Programme Officer
Charles Anderson, Associate Programme Officer
K. Otu-Danquah, Associate Programme Officer

Volta River Authority
Gilbert Dokyi, Acting Deputy Chief Executive (E&O)
M. Dale McMaster, Head of System Planning (Acres Int Ltd)
Richmond Evans-Appiah, Civil Engineer
A. Lakis Papastavrou, Project Manager, Kpong Farms Ltd

Electricity Company of Ghana
John Hagan, Chief Executive
Fred Asante, Director of Operations

Regional Energy Advisory Board, Tamale
Mr Musa, Chairman

Programme for Rural Action, Tamale
Dr Andreas Massing, GTZ project leader

Ministry of Lands and Natural Resources
George Akaba, Senior Planning Officer

Forestry Department
J. Francois, Chief Conservator of Forests
Kwasi Kesi, Deputy Chief Conservator of Forests
A.S.K. Broachie-Dapaah, Forest Planning Officer, Kumasi
Tim Nolan, Team Leader, Forest Inventory Project

Forestry Commission
Dr Kwabena Tufuor, Director

Forest Research Institute of Ghana (FORIG), Kumasi
Dr A. Ofusu-Asiedu, Director
Sam Nketiah, Research Officer

Timber Export Development Board, Takoradi
Alhassan N. Attah, Statistics Manager

Forest Products Inspection Service, Takoradi
A.L. Bentum, Commercial Services Manager

Timber Association, Kumasi
George Kungatse

Timber Millers Association, Kumasi
B.W.K. Sam, Secretary
E. Ashiaqbor, Accountant

Ministry of Agriculture
Dr S.K. Dapaah, Director of Policy Planning and Monitoring Division

Department of Agriculture, Tamale
Z. Lankono, Regional director of Agriculture

Department of Agriculture, Takoradi
S.M. Yorke, Coconut rehabilitation project

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Dan Amozen, Assistant Area Manager
Paul Hussey, Milling Engineer

Ministry of Industries, Science and Technology
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J Adsasi, Senior Industrial Promotion Officer

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Dr John Dei-Tutu, Deputy Director
Abigail Andah, Principal Research Officer
S.K. Noamesi, Scientific Secretary
B.L.Lartey, Chief Research Officer

Environment Protection Council
Okyena Ampodu-Ageyi, Senior Programme Officer
Edward Telly, EPC Regional Office, Tamale

Ghana Statistical Service
Mr Okeyi

University of Science and Technology, Kumasi
Dr Fred Akufo, Department of Mechanical Engineering
Agbeko Ellis, School of Engineering
Dr Peter Donkor, Technology Consultancy Centre
Essel Ben Hagen, Building Research Institute (charcoal consultant)

Institute of Renewable Natural Resources, Kumasi
Dr J.G.K. Owusu, Director
Dr Frimpong-Mensah, Rural industries
Dr E.A. Abeney, Logging and harvesting

GRATIS, Tema
John W. Powell, EC Technical Director

ITTU, Kumasi
Mr Crossman, Supervisor

Technoserve, Accra
Paul Warmka, Country Director

Empretec Ghana, Accra
Annie Otoo

Agrico Ltd., Accra
Mr Anuka, Technical Manager
H.L. Lawson, Sales Manager

SIS Engineering, Kumasi
Solomon K. Adjorlolo, Managing Director

Western Veneer and Lumber Co. Ltd, Takoradi
Richard J. Butt, Managing Director

John Bitar Ltd., Sekondi
Joseph Helou, Managing Director

A.E. Saoud Ltd., Kumasi
Anthony Saoud, Chief Executive

TAT Ltd., Kumasi
Joe E. Quansah, Production Manager

Logs and Lumber Ltd., Kumasi
Antoine F. Haidamous, Chief Engineer

Ehwia Wood Products Ltd. Kumasi
Ted Atsutsey, Manager

Benso Oil Palm Plantations, Benso
C.J.A. Tyler, Managing Director
Isaac Yendoah, Chief Engineer
Keith Hamblin, Chief Engineer, Unilever UK

Twifo Oil Palm Plantation, Twifo
Steve Larbi, Process Manager
Michael Haddock, Chief Engineer

Furnart Ghana Ltd., Accra
E.G.A. Wellington, General Manager

Fairmitre/K.G.P.Co.Ltd
K.G. Anim, Director

Kumasi Furniture and Joinery Co. Ltd., Kumasi
Mr Asante-Brobby, Accountant
Mr Turkson, Administrative Secretary
Mr Quaini, Production Manager

Charcoal Makers
Sarfo Kantanka, Takoradi
Victoria Ali, Kumasi

British High Commission
Rosemary Stevenson, Aid Secretary
Rexford Quaye, Aid Assistant
Ray Mills, Aid Assistant

World Bank
Mavis A. Yeboah, Energy Adviser
Ken Sigrist, Country Economist

UNDP
Lynn Wallace, Resident Representative
Joseph Byll-Cataria, Deputy Resident Representative

FAO
J.J. Meijer, Programme Officer
J.D. Keita, Regional Forestry Officer

European Community
Guildo Pivetta, Rural Development Adviser
Joachim Zeller, DG8, Brussels

World Bank/ODA Review Mission - Forestry Management Project
Ron Kemp, ODA
Ian Napier, ODA
Piet Werbrouk, World Bank

Appendix 3. ENERGY PRICES

TABLE OF CURRENT FUEL PRICES - FEBRUARY 1992

FUEL TYPE	UNIT OF FUEL	COST IN CEDIS
CHARCOAL*	45 kilogram bag	
Accra		c2 595
Kumasi		c1 913
Takoradi		c2 328
Tamale		c1 270
PETROLEUM PRODUCTS		
Premium	Litres	c 200
Gas Oil	Litres	c 166
Kerosene	Litres	c 156
LPG	Kilogram	c 100
ELECTRICITY		
Tariff category		
H.V. supplies (above 415 volts)	M.D. (c/kva/mth)	c 660
	Energy (c/kwh)	c 6.50
	Service charge (c/mth)	c1 850
L.V. supplies (below 415 volts)	M.D. (c/kva/mth)	c 730
	Energy (c/kwh)	c 7
	Service charge (c/mth)	c1 850
Non Residential	Energy (c/kwh)	c 20.40
	Service charge (c/mth)	c 140
Residential		
0-50 kwh	Block charge	c 300
51-200 kwh	Energy (c/kwh)	c 4.90
201-600 kwh	Energy (c/kwh)	c 7.70
600+ kwh	Energy (c/kwh)	c 17

* 1991 average monthly price

Source: Petroleum products and electricity prices - Ministry of Energy
Charcoal prices - Ghana Statistical Service

Appendix 4. MINISTRY OF ENERGY WORKPLAN 1991

A. RENEWABLE ENERGY DEVELOPMENT PROGRAMME

PROJECT NO.	PROJECT TITLE
REN 001	Strategies to Improve Charcoal Production in Ghana
REN 002	Improved Charcoal Stove Project
REN 003	Improved Firewood Stoves Project
REN 004	Apollonia Model Biogas Project
REN 005	Monitoring and Evaluation of the Performance of Solar Photovoltaic Systems in Ghana
REN 006	Solar and Wind Resources Assessment
REN 007	Prospects for Solar Water Heating in Ghana
REN 008	Prospects for Substituting Solar Energy for Oil in Large-Scale Commercial Drying of Maize

B. RESOURCES AND ENVIRONMENTAL PLANNING PROGRAMME

REPP 001	Assessment and Use of Bioenergy Residues and Wastes
REPP 002	Rural Energy Planning: Saboba-Chereponi
REPP 003	Energy Use in Agriculture
REPP 004	Promotion of Bioenergy Plantations
REPP 005	Assessment of Environmental Impacts and Indicators of Energy Production and Use in Urban Habitats
REPP 006	Assessment of Impacts and Trade-Offs of Hydro-Dams

C. LPG PROMOTION PROGRAMME

PLG 001	National LPG Promotion Programme

D. PETROLEUM PLANNING AND MONITORING PROGRAMME

PET 001	Inspection and Licensing of Petroleum Operations and Facilities
PET 002	Accounting for the Demand, Supply and Distribution of Petroleum Products in Ghana
PET 003	Expansion of Capacity and Range of Products of the Tema Refinery
PET 004	Bulk Petroleum Products Transportation
PET 005	National Network of Bulk Petroleum Storage Depots
PET 006	Tema Lube Oil Blending Plant
PET 007	Bitumen Production Plant

E. ELECTRICITY PLANNING, DEVELOPMENT AND MONITORING PROGRAMME

ELECT 001	National Electrification Scheme
ELECT 002	Promotion of Indigenous Manufacture of Electrical Hardware
ELECT 003	Demonstration and Evaluation of the Techno-Economic Prospects for Mini Hydro Power Generation in Ghana
ELECT 004	Promoting Modern and More Productive Uses of Electricity
ELECT 005	Power Sector Tariff Study
ELECT 006	Upgrading the Code of Practice in the Electricity Subsector
ELECT 007	Existing Capacity and Future Prospects for Private Power Generation in Ghana
ELECT 008	Rationalisation of Electricity Accounting Procedures

F. ENERGY EFFICIENCY AND CONSERVATION PROGRAMME

	on Energy Conservation Opportunities, Practices and Benefits
EEC 002	Energy Conservation in the Industrial Sector
EEC 003	Energy Conservation Prospects and Future Demands in the Transport Sector
EEC 004	Survey of Patterns of Electricity End-use In the Household, Commercial and Public Sectors

G. POLICY ANALYSIS AND ENERGY INFORMATION PROGRAMME

PPAG 001	Strengthening National Accounting and Information Flows on Energy Resources in Ghana
PPAG 002	Monitoring the Corporate Performance of Energy Sector Institutions
PPAG 003	Coordinating the Public Investment Programme for the Energy Sector Institutions
PPAG 004	Monitoring Petroleum Products Pricing and Revenues
PPAG 005	Production of Annual Energy Statistical Publications
PPAG 006	Impact and Energy Prices on Costs and Standards of Living in Ghana
PPAG 007	Energy Education, Promotion and Public Affairs

H. PROJECT MANAGEMENT, MONITORING AND EVALUATION

PMMD 001	Monitoring Public Agreements in the Energy Sector
PMMD 002	Assessment of Socio-Economic Impacts of Selected Ministry of Energy Projects
PMMD 003	Management of Development Credit Agreements
PMMD 004	Impacts and Lessons from the Management of the Petroleum and Electricity Crises in Ghana

Appendix 5. AGRICULTURE IN GHANA - FACTS AND FIGURES

GEOGRAPHIC AND DEMOGRAPHIC BACKGROUND TO THE COUNTRY

The Country	: Republic of Ghana
Capital	: Accra
Population	: 14.9m. (1990)
Population Growth Rate	: 3% per annum (estimated for 1984 - 1991)
Geographic Location	: Latitude 4,44'S, 11,11'N; Longitude 3,11'W, 1,11'E
Coastline	: 550 km long.
Principal mineral resources	: Gold, Bauxite, Manganese, Diamond

LAND USE (SPECIFIC TO AGRICULTURE)

	Hectares	%
Total Land Area (T.L.A.)	23 853 900	100.0
Agric. Land Area (A.L.A.)	13 628 179	57.1
Area under cultivation (1990)	4 320 000	18.1
Percentage of available farmland cultivated	-	29.0
Total area under irrigation (1990)	7 500	0.0
Area under inland waters	1 100 000	4.6
Other	9 219 641	38.7
Agric. Land availability coefficient (A.L.A. / T.L.A.) = 0.57	-	-

LAND USE (GENERAL)

Land Use	Area ('000 sq km)	% of Total
Savanna woodland	71	30
Bush fallow and other uses	60	25
Unimproved pasture	36	15
Forest reserves	26	11
Tree crops	17	7
Annual crops	12	5
Wildlife reserves	12	5
Unreserved forest	5	2
Total	239	100

Source: Medium Term Agric. Development Programme (MTADP) Document, Min. of Agriculture, Accra.

LAND AREA BY REGION

Region	Area (000 sq km)	% of Total
Northern	70.38	29.5
B/Ahafo	39.56	16.6
Ashanti	24.39	10.2
Western	23.92	10.0
Volta	20.57	8.6
Eastern	19.32	8.1
U/West	18.48	7.8
Central	9.83	4.1
U/east	8.84	3.7
Greater Accra	3.24	1.4
Total	238.53	100.0

% Distribution of Size of Holdings by Region

	Size of Holding (hectares)		
Region	less than 1.2 ha.	1.2 - 2 ha	more than 2 ha
Volta	82	12	6
Eastern	77	15	7
Ashanti	72	22	6
Central	71	18	11
Gt. Accra	69	17	14
B/Ahafo	55	32	13
Western	52	32	16
U/East	48	32	20
Northern	19	43	38
U/West	16	42	42
Mean	60	25	15

AGRICULTURAL OUTPUT

CROP SUB-SECTOR

Principal Agricultural Produce

Tree Crops	:	Cocoa, Oil Palm, Coconut, Coffee
Industrial Crops	:	Cotton, Tobacco, Kenaf
Roots & Tubers	:	Cassava, Cocoyam, Yam
Cereals	:	Maize, Rice, Millet, Sorghum
Fruits and Vegetables	:	Pineapples, citrus, tomatoes and banana and other vegetables
Other	:	Plantain

AREA PLANTED TO SELECTED FOOD CROPS ('000 HA)

Crop	1987	1988	1989	1990
Maize	548	540	567	465
Cassava	390	354	415	323
Guinea corn	272	226	286	215
Millet	235	228	244	124
Yam	204	168	217	119
Cocoyam	196	141	207	142
Plantain	170	119	164	129
Groundnut	151	131	159	127
Rice	72	52	72	49

PRODUCTION OF SELECTED FOODCROPS ('000 MT)

Crop	1987	1988	1989	1990
Cassava	2726	3300	3320	2717
Yam	1185	1200	1280	877
Plantain	1078	1200	1040	799
Cocoyam	1012	1115	1200	815
Maize	598	600	715	553
Sorghum	206	178	215	136
Groundnut	191	230	200	113
Millet	173	192	180	75
Rice (Paddy)	81	105	67	81
Pineapple	8	9	10	10

CONTRIBUTION OF VARIOUS CROPS OF AGRICULTURAL GDP
(1987 CONSTANT PRICES)

Crop	Contribution (%)
Cassava	22
Cocoa	14
Yam	13
Plantain	11
Cocoyam	9
Fish	5
Maize	4
Vegetables	2
Cattle (head)	2
Sorghum/Millet	2
Rice	1
Oil Palm	1
Poultry (birds)	1
Sheep (head)	1
Goats (head)	1
Forestry & Others	11
Total Agric. GDP (1987)	100

Appendix 6. FOREST INDUSTRY INFORMATION

PEOPLE'S DAILY GRAPHIC, Thursday, January 30, 1992. Page 7.

LETTERS

Sustain the timber industry

DEAR Sir, The dailies of November 16, 1991 reported a statement made by the Executive Secretary of the Ghana Export Promotion Council (GEPC), Mr Kwesi Ahwoi, that the government is to ban the exportation of raw lumber and other unprocessed wood products from the beginning of 1994.

This is not the first time he has been reported on this policy statement and many interesting and laudable arguments have been advanced in support of this policy, the most prominent among them being environmental protection, the conservation of our forest and the maximisation of returns from the export of timber products.

As was rightly pointed out in the People's Daily Graphic editorial comment on this policy statement, the companies involved in logging and saw-milling constitute a greater percentage of establishments in the timber industry and they have thousands of people in their employment. One is therefore tempted to ask, what is the GEPC, Timber Export Development Board (TEDB), the Ministry of Lands and Natural Resources and for that matter the government doing to ensure that the value-added processing potentials and capabilities of these companies are tapped to the nation's benefit?

This is in reference to acquisition of necessary machinery and equipment for kiln drying, plymilling, flooring, etc. Again, what marketing strategies have or are being adopted to ensure that our processed timber products would be able to compete favourably on the international market?

In my view, measures must be put in place to help many timber companies engaged in raw lumber production to get financial assistance in the form of foreign loans and credit facilities to bring in machinery and equipment needed for further wood processing. Here the government must guard against the importation by some companies of machinery and equipment that can more aptly be described as 'refuse scraps'.

Also, the Forest Products Inspections Bureau (FPIB) in conjunction with other agencies should draw up training programmes and organise refresher courses for its inspectors and graders, production managers, supervisors and foremen of timber companies to technically equip them with modern production techniques so as to turn out good quality wood products for both the local and export markets.

The Forest Improvement Fund levied on exported wood products by the TEDB must be used solely for the purposes for which it was imposed, particularly, the replanting of timber tree species which are getting exhausted in our forests.

The nation stands to benefit immensely if our logs and raw lumber are further processed before export, but care must be taken to sustain the timber industry and not to kill it by the proposed ban on export of round logs and raw lumber.

Frank Mintah,
Bibiani Logging & Lumber Co.,
Takoradi.

Ghana to stop A.D. sawn exports by 1994

Ghana has announced measures to conserve forest productivity. Instead of adding more species to the list of nineteen already banned from export, there are to be Forest Improvement Levies on six species. For Kussia it will be 50% on FOB, and 40% for Guarea, Afzelia and Ayan, with Canarium and Wawa attracting 10%.

In the first five months of this year Wawa accounted for 65% of log exports by volume (62% by value). The combined contribution of the other five was about 2% by volume. Kussia is mostly cut into special order dimension sizes rather than standard specifications.

Of greater importance to the UK market are signs that Ghana's Timber Committee is to get a better balance between forest concessions and processing by rationalising concession holding and, presumably, reducing the crowded number of operators who still exist, in spite of past efforts to rationalise the industry.

Companies with processing units will be more heavily persuaded to slacken exports of logs.

Wawa logs will be limited to 100 cm diameter and up for extraction. This adds to other species with higher minimum diameters set at 110 cm - Afrormosia, Edinam, Sapele, Odum, Utile and Mahogany. Abura, what little there is, cannot now be felled. Others species are set at 70 cm.

The UK will also note that Forest Improvement Levies are to be put on green/air dried lumber in Utile, Afrormosia, Hyedua, Makore (50% on FOB) and Odum (8.5%). Levies on logs and sawn wood operate from 1st November 1990, and a beady eye is to be kept on interim contracts so that they will not exceed levels considered normal.

The UK imports of Iroko/Odum direct from Ghana were only 1,600 m3 out of a total for the species of over 16,000 m3 during January-June 1990. Although some also comes via Ireland, most of Britain's Iroko arrives direct from Cote d'Ivoire (12,000 m3). Volumes of Afrormosia and Hyedua will be very small.

However, from Ghana's point of view Odum is its second most important sawnwood export. In January-June 1990 about 18,000 m3 (22%) was in this species. The other four species accounted for a little over 8%.

The levy on Odum might have been higher but seems to have been modified because of its importance as an export earner. The effect will be reviewed.

The longer term aim is to move on from air dried lumber. These five species can stil be exported without F.I.L. if they are kiln dried, or further machined as mouldings and profiled wood.

Ghana is becoming much keener on building up more kilning capability but a problem seems to be finance. Many companies already have loan repayment difficulties and, incidentally, liquidity problems because a proportion of export earnings is automatically locked away in export retention funds overseas. The concept of some Government kiln centres may have practical problems. Last year a shipping company, OTAL, was planning to offer kilning facilities at Tema harbour, but a switch of use for that port put paid to that idea.

In the longer term, Ghana says that all air dried sawnwood exports, except those for exterior construction work, will cease from 1st January 1994. This gives plenty of time to consider ways for the commercial sector to react. It would put Ghana miles ahead of the rest of West Africa. Whatever grumbles arise as a result of this stated intention, it will focus minds on the practicalities and in this respect must be beneficial.

So far, Ghana's processed wood exports beyond air dried lumber only amount to about 6% of the total. The individual volumes are very small.

GHANA'S PRINCIPAL MARKETS FOR SAWN WOOD

m3	Year 1989	Jan.-May 1990
F.R.Germany	45,033	19,477
U.K.	27,568	16,930
Ireland	19,874	12,834
Spain	14,987	6,838
Italy	8,191	3,368
France	6,800	3,678
Belgium	5,626	4,821
U.S.A.	4,493	2,516
Holland	2,726	3,171
Japan	335	113
S. Arabia	4,013	960
India		1,682
Portugal	210	
Cuba	581	
Cyprus	524	
Lebanon	207	
Denmark	121	
B. Faso	5,747	3,635
Niger	5,109	2,320
Other African	1,377	458
Others	532	224
Total	154,054	83,025

Source: T.E.D.B.

Ghana's efforts to promote more species have not been very noticeable but are expected to increase. Timbers on the list must include Dahoma and possibly Albizzia. Endeavours will be made to sell plantation Teak.

GHANA EXPORTS
FURTHER PROCESSED PRODUCTS
January-May 1990

cubic metres	Machined and Profiled	Furniture Parts	Flooring	Sliced Veneer	Rotary Veneer	Plywood
UK	151	1,217	28	1,160	934	57
FR. Germany	212		38	1,983	425	
Italy	219		515	977		
Spain				248		
Ireland		54				
USSR				100		
Netherlands						27
Belgium	49				15	
Finland	81					
Togo		1				309
Nigeria				35		
Total	712	1,272	581	4,503	1,374	393

Appendix 7. BIOMASS ENERGY WORKSHOP

Date: 11 February 1992
Venue: Accra

LIST OF PARTICIPANTS

Name	Title/rank	Organisation
Leo Denkyi (Chairman)	Administrator	Min of En
Michael Opam	Programme Officer	Min of En
K.T. Addo	APO	Min of En
Charles Anderson*	APO	Min of En
K. Otu-Danquah*	APO	Min of En
Emmanuel Mensah*	Programme Officer	Min of En
Irene Commey*	Energy Education/ Promotion Officer	Min of En
E. Ofori-Nyarko*	APO, Rural Energy	Min of En
Benjamin Agyare*	APO, Resources and Environmental Planning	Min of En
Samuel Adu-Ase*	APO	Min of En
John Asser*	APO, Rural Energy	Min of En
Wisdom Akiataku*	APO	Min of En
J. Essandoah-Yeddu*	APO	Min of En
Gilbert Dokyi	Acting Deputy Chief Executive (E&O)	VRA
John Hagan	Acting Managing Director	ECG
K.K. Eyeson	Director	FRI
J. Dei-Tutu	Deputy Director	FRI
A. Andah	Principal Research Officer	FRI
J.D. Keita	Regional Forestry Officer	FAO
A.K. Mosi	Acting Deputy Director	AHPD
Kwabena Tufuor	Director	FC
Hawa Bint-Yafub	Service Personnel	FC
Augustine Arthur	Assistant Scientific officer	FC
A. Ofosu-Asiedu	Director	FORIG
Sam Nketiah	Research Officer	FORIG

Note:
Min of En = Ministry of Energy
FRI = Food Research Institute
VRA = Volta River Authority
FORIG = Forest Research Institute of Ghana
ECG = Electricity Company of Ghana
FC = Forestry Commission

APO = Associate Programme Officer
* Observers

OBJECTIVES AND AGENDA

Objectives: i) To present findings of Needs Assessment/Project identification mission; ii) To develop areas of interest and working arrangements for possible future collaboration.

Agenda:

1. Registration

2. Welcome

3. Introduction by presenters

4. Technology transfer - a strategy

5. Presentation of findings of Needs Assessment/Project Identification mission

   a) Ghana's biomass residue resource base
      i) Oilseeds and edible nuts
      ii) Cereals
      iii) Forestry

   b) Energy uses in rural industries

   c) Energy costs

   d) Engineering capabilities

   e) Organisational structure onto which BETs could be introduced

   f) Potential collaborative organisations

   g) Contact with funding agencies

   h) Areas of work which offer potential:

   Forestry
   (i) Assistance to the forest products industry to utilize sawdust as a fuel for timber drying. The project will consist of the following elements:

      (a) demonstration and promotion of sawdust-fuelled medium-size timber drying kilns for use at sawmills;

      (b) demonstration and promotion of sawdust- and wood shavings-fuelled small/medium-size timber drying kilns and solar kilns for use at furniture workshops; and

      (c) demonstration and promotion of a sawdust burner (up to 1MW thermal) to connect to existing furnace/boiler systems for use at sawmills.

   ii) Establishment of a Forest Products Extension Service.

Oilseeds
i) Gasification of waste palm oil mill effluent.

General
i) Assessment of thermal efficiencies in village level industry and identification of savings.

ii) Techno-economic study of stand-alone 250 kW electricity generation using biomass energy.

6. Open discussion - interest, views, development of potential work programmes, funding, collaboration between organisations.

7. Summary and next step.

KEYNOTE ADDRESS DELIVERED BY MR LEO DENKYI, ADMINISTRATOR OF THE MINISTRY OF ENERGY

Distinguished Participants,
Ladies and Gentlemen

Our task today is to deliberate thoroughly over issues that have emerged over the past four weeks as a result of research activities undertaken on the biomass resources of this country by a mission from the Natural Resources Institute (NRI) of the Overseas Development administration, United Kingdom in collaboration with the Ministry of Energy, Republic of Ghana.

The NRI mission comprising Mr Alan Robinson, a technologist and Miss Claire Coote, an economist, who are familiar to most of us assembled here, have been in this country with the view of assessing Ghana's biomass resource potential and trying to evolve pragmatic projects in the biomass sector in support of the on-going economic recovery efforts.

Alan and Claire our major resource persons for this gathering will present the highlights of their mission outlining what they have observed on the ground in this country pertaining to the production and use of biomass resources.

Our discussions, which will follow the presentation, will have to focus on the opportunities available for optimising the use of our biomass resources and recommending the most favourable approaches for attaining the desires and wishes of Ghana's macro-economic development process in the energy sector.

Finally, Ladies and Gentlemen, I wish to take this opportunity to welcome you all to this Ministry and also wish to express our profound gratitude to all those who in diverse ways have made this gathering possible particularly the NRI, ODA and Ministry of Energy staff.

I wish you all fruitful discussions.

Thank you.

Appendix 8. OUTLINE PROJECT PROPOSALS

1. Assistance to the forest products industry to utilize sawdust as a fuel for timber drying.

Background

With the proposed ban of exported lumber and air-dried timber products by 1993, there is a pressing need to increase Ghana's timber drying kilning facilities from the current reported installed capacity of 50 000 cubic metres to an estimated 200 000 cubic metres. Coupled to this need will be a significant increase in energy demand to fuel the kilns. Industries which generate large quantities of woodfuel as a by-product will likely use this to fuel their boilers. This will reduce current revenues from the sale of woodfuel and decrease the availability of woodfuel to outside markets. Electricity may be used by smaller-scale industries such as furniture workshops.

Ironically, these same industries generate great quantities of sawdust and wood shavings which are a potential source of energy but in most cases are considered a disposal problem. They often represent a negative value as tractors and trailers are employed at great expense to dump the sawdust in surrounding areas. The practice of dumping and open-mound burning is considered by many as polluting and constitutes a hazard to both health and property.

The proposal seeks to provide Ghana with an in-house manufacturing and maintenance capability for small- to medium-scale timber drying kilns and sawdust/wood shavings furnaces. A number of one-year demonstrations of the kilns and sawdust furnaces will take place simultaneously at selected sawmill and furniture workshop sites during which the systems will be matched and adapted to suit feedstock specifications and local requirements. Entrepreneurs to promote and market the technologies will be selected and trained. During the demonstration phase a strategy will be developed to establish and promote the systems on a commercial basis. The demonstration of commercial solar kilns, which may be of particular interest to smaller furniture manufactures, will run concurrently.

Potential collaborating organizations

Ministry of Energy, Ministry of Lands and Natural Resources, Environmental Protection Council, Forest Products Inspection Bureaux, Timber Export Development Board, Forest Research Institute of Ghana, Forestry Department, Forestry Commission. Natural Resources Institute, UK and other organizations as identified and appropriate.

Duration

3 years

Method

1. Mount team, consisting of local and international expertise, to draw up detailed plans with selected lead organization, industry, associations and Government.
2. Demonstration sites identified, design and scale of technologies chosen.
3. Sawdust furnace and kiln-drying systems demonstrated, adapted and developed, entrepreneurs selected, credit scheme set up, training provided, manufacturing capabilities established, systems promoted and marketed.

Outputs

1. In-house capability for sawdust furnace and timber drying kiln manufacture and marketing.
2. Increased employment in engineering sector.
3. Utilization of sawdust and wood shavings as a fuel.
4. Increased availability of woodfuel for domestic use.
5. Reduced environmental pollution and health and property hazard from dumping and burning of sawdust.
6. Increased kilning capacity.
7. Trained personnel in timber drying.
8. Value added to timber and timber by-products.
9. Strengthening of forest and forest products industry

Inputs

Project cost: circa £1 200K

2. The Establishment Of A Forest Products Extension Service

Background

A major deficiency in Ghana in the Forest Products sector is the lack of extension or technology transfer facilities. Without mechanisms to exchange information appropriate to local conditions, it is difficult to move an industry or business forward. The academic and research organizations that develop data, techniques, and systems to improve wood use and supply need to have an outlet that is more applicable to industry than just publishing data.

Industry and businesses allied to forestry and forest products have a pressing need for sound advice, information, training and assistance in areas of: equipment availability, processing techniques, modern practices, and marketing. Subject areas include: sawmilling; drying; preservation; non-timber forest products; energy; and wood engineering.

The proposal seeks to establish an extension and technology transfer capability specifically geared to industries' needs. Specific areas of assistance will be drawn up in close consultation with related industry, businesses, Government and non-government organizations, and research and development centres.

Potential collaborating organizations

Ministry of Energy, Ministry of Lands and Natural Resources, Environmental Protection Council, Forest Products Inspection Bureaux, Timber Export Development Board, Forest Research Institute of Ghana, Forestry Department, Forestry Commission. Natural Resources Institute, UK and organizations with expertise in forestry and wood processing such as the timber Research and Development Association, UK.

Duration

Initially 3 years

Method

1. Mount team, consisting of local and international expertise, to discuss requirements with selected lead organization, industry and Government.
2. Establish Forest Products Extension Service.
3. Extension service programme underway.
4. Phased support from industry with view to service continuing at end of 3 years.

Outputs

1. Forest Products Extension Service Centre.
2. Trained personnel.
3. Setting up of fund to support Centre.
4. Better utilization of timber, non-timber and by-products.
5. Value added to timber and timber by-products.

6 Strengthening of forest and forest products industry

Inputs

Project cost: Circa £900K

3. Techno-economic appraisal of palm oil mill effluent gasification to supply energy for community use.

Background

In the large-scale processing of fresh fruit bunches to palm oil considerable quantities of effluent are produced. This is digested, in open ponds, to reduce its BOD content. Semi-treated effluent is then released into the nearby water courses. The effluent is known to pollute the water course and at one oil palm mill visited it was reported that complaints had been received from local people over poor water quality and fish dying in the river.

Under controlled conditions the effluent can be treated for use as a soil conditioner and biogas production. The biogas can be combusted to serve various energy needs. Such biogas energy schemes are common practice in Malaysia where the introduction of strict environmental laws have persuaded the oil palm industry to reduce pollution and utilize potential energy sources. The Malaysian oil palm industry have been pleased with the results of the biogas production schemes and their introduction is being promoted.

The project seeks to carry out a techno-economic study of the introduction of the technology at a selected oil palm mill. The energy would likely be used to supply the needs of local workers and their families, consisting of some 2 000 to 7 000 people, residing near to the mill. The families currently use woodfuel and charcoal. Options to be considered will be the use of gas for cooking or for electricity generation using gas internal combustion engines/generators. The major environmental benefits will be reduced water pollution and reduced woodfuel/charcoal usage.

The technology is well developed and proven in Malaysia and it is envisaged that technical expertise for the study will be recruited from there.

Potential collaborating organizations

Ministry of Energy, Ministry of Lands and Natural Resources, Ministry of Industries, Science and Technology, Ministry of Agriculture, Environmental Protection Council, Twifo Oil Palm Plantation, Natural Resources Institute (UK), Selected Malaysian Organization/Company.

Duration

Work to be undertaken over a period of approximately 6 months.

Method

1. Mount techno-economic team, consisting of local and International expertise, to carry out study.
2. Study to include technical and economic feasibility, socio-economic implications and environmental impact.

3. Subject to favourable prognosis a demonstration scheme at a selected oil palm mill will be put forward with plans for wider dissemination.

Outputs

1. Techno-economic study of the utilization of palm oil mill effluent for energy production.
2. Scheme for demonstrating project with plan for wider dissemination.
3. Assistance to the oil palm industry.
4. Assistance to local communities in possible energy supply and reduced water pollution.
6. Potential reduction in woodfuel usage through supply of biogas.

Inputs

Project cost: circa £50K

4. Assessment of biomass energy thermal efficiencies in small-scale, village level industries and identification of fuel savings.

Background

A large quantity of woodfuel is used by the small-scale village industries situated throughout the country. Their energy usage forms a significant part of the estimated 1.3 million tonnes per year of non-household woodfuel used.

Typical industries include: brewing; fish drying; bakeries; brick manufacture; oilseed and edible nut processing; and crop drying.

Methods of fuel usage, types of furnace etc are often based on old practices and designs when fuel conservation may not have been such as an important factor as today. Past efforts in Ghana on, for example, improved fish drying systems have clearly shown the scope for woodfuel conservation. However, the scope elsewhere for such woodfuel reductions has not been well studied or documented.

The project seeks to carry out a systematic study of the main rural industrial woodfuel users, audit type and quantities of fuel usage and identify areas where assistance could be given to reduce fuel consumption. Areas of possible assistance include improved furnace design, utilization of waste biomass residues, training in improved operation.

The main benefit to industry arising from the introduction of such conservation measures will be in reducing operating costs. Other benefits will likely include increase in quality through improved process heat control.

Potential collaborating organizations

Ministry of Energy, Ministry of Lands and Natural Resources, Ministry of Industries, Science and Technology, Environmental Protection Council, Food Research Institute, Natural Resources Institute, UK and other organizations as identified and appropriate.

Duration

Work to be undertaken over a period of approximately 1 year

Method

1. Ministry of Energy/NRI to mount techno-economic team to carry out study. Team to consist of local and international expertise.
2. Study to look at main rural industrial users of woodfuel and identify the scope for thermal savings, taking into account technical and economic feasibility, acceptance by operators, socio-economic implications and environmental impact.

3. Subject to a favourable prognosis, the study will recommend various improvement schemes through further research and development, adaptation of existing methods and demonstration programmes with plans for wider dissemination.

Outputs

1. Study document giving assessment of fuel usage in rural industries and identifying scope for thermal savings.
2. Recommendations for introducing woodfuel savings.
3. Scheme for R&D programme, and demonstration projects with plan for wider dissemination.
4. Potential for:

- assistance to rural industries;
- reduced operating costs for rural industries;
- increased quality and quality control;
- reduction in woodfuel usage; and
- efficient use of waste agricultural residues as a fuel.

Inputs

Project cost: circa £120K

5. Techno-economic study of stand-alone 250 kW electricity generation using biomass energy.

Background

Under the national electrification plan it is envisaged that the grid system will reach all populated areas of Ghana within 30 years. The electrification scheme comprises of six 5-year phases.

Future power and energy requirements will be met by a combination of hydroelectric generation from the existing Akosombo and Kpong generating stations and future generating stations - mini-hydro, gas turbine and oil-fired steam plant are serious contenders.

One indigenous renewable energy resource which could play an important part in the electrification scheme is biomass. Whilst large scale mega-watt power generation introduces serious logistic problems of biomass supply, there may be scope for small-scale electricity generation in the order of 250 kW output. Such systems could operate away from the grid and supply electricity to isolated areas where plans for grid connection are long-term (20 years or greater).

In developed countries there is increasing interest in introducing electricity generation systems at this level, using biomass as a fuel. The technology is at an advanced stage of development and prototype equipment exists. The equipment is being introduced into Europe and there is scope for the application of such technology in Ghana.

The project seeks to carry out a techno-economic study of the introduction of the technology. Factors to be considered will include, availability of equipment, technical and economic feasibility including land availability and opportunity cost, social and management implications and environmental impact.

Potential collaborating organizations

Ministry of Energy, Ministry of Lands and Natural Resources, Forest Research Institute of Ghana, Forestry Department, Forestry Commission, Environmental Protection Council, Volta River Authority, Electricity Company of Ghana, Natural Resources Institute, UK and other organizations as identified and appropriate.

Duration

Work to be undertaken over a period of approximately 6 months

Method

1. Mount techno-economic team to carry out study. Team to consist of local and International expertise.
2. Study to include technical and economic feasibility, biomass supply, socio-economic implications and environmental impact.

3. Subject to favourable prognosis a demonstration scheme at a selected site will be put forward with plans for wider dissemination.

Outputs

1. Techno-economic appraisal of small-scale stand-alone electricity generation using biomass as a fuel source.
2. Scheme for demonstration project with plan for wider dissemination.
3. Potential use of a indigenous renewable energy resource.
4. Electrification scheme brought forward in isolated areas, prior to introduction of the grid.

Inputs

Project cost: circa £50K

Appendix 9. POTENTIAL COLLABORATING ORGANIZATIONS

Ministry of Energy
Volta River Authority
Electricity Company of Ghana
Ministry of Lands and Natural Resources
Forestry Department
Forestry Commission
Forest Research Institute of Ghana (FORIG), Kumasi
Timber Export Development Board, Takoradi
Forest Products Inspection Service, Takoradi
Timber Millers Association, Kumasi
Ministry of Agriculture
Ministry of Industries, Science and Technology
Food Research Institute, Accra
Environment Protection Council
Institute of Renewable Natural Resources, Kumasi
Twifo Oil Palm Plantation, Twifo

Appendix 10. ENERGY AND ENVIRONMENTAL POLICIES

Ministry of Energy

The Ministry of Energy' principal aims are to consolidate and accelerate the development and use of the country's indigenous energy sources, especially woodfuels, hydro-power, petroleum and solar energy.

Under their renewable energy programme the broad objectives for the future development of renewable energy resources are, in the short-term:

(a) To improve the efficiency of production, conversion, and use of woodfuels at all the socio-economic sectors.

(b) To promote the development of renewable industries that have strong indigenization prospects over the short- and medium-terms.

In the medium- to long-term, the objectives will be:

(c) To demonstrate and evaluate renewable energy technologies with the potential to meet the needs of prioritized socio-welfare objectives.

(d) To provide support for research, development and demonstration on renewable energy technologies with the greatest potential to increase and diversify the country's future energy supply base.

National electrification scheme

The Government of Ghana has instituted a National Electrification Scheme (NES) to implement its policy to extend electricity to all parts of Ghana within a 30-year period, from 1990 to 2020.

Environment Protection Council

The Environment Protection Council calls for action on woodfuel and states:

(a) Industries that rely or intend to rely on natural woodlands for their woodfuel will be required to demonstrate sustainable regeneration of the woodlands or be required to meet their wood requirements from tree plantations established by the industry or woodlots established in the vicinity by outgrowers with the support of the industry.

Forestry Commission

The Forestry Commission have just released proposals for the revision of the National Forest Policy for Ghana. It includes the following statements:

(a) Industrial plantations will be established by appropriate industries for specific end uses in appropriate places. These will include plantations for brick and tile, iron and steel smelting, tobacco curing, match factories, pulp and paper mills and the mining concerns.

(b) Approval for the establishment of industries that depend on woodfuel will only be granted after adequate proof that the particular factory will not depend solely on the natural forest for fuel.

(c) Emphasis will be placed on the secondary and tertiary processing of forest produce. Viable value-added products will be identified and promoted.

(d) Industries based on non-timber forest produce will be promoted to benefit rural communities.

Directive on timber exports

It is reported (UNDP, 1991; People's Daily Graphic, 1992a; People's Daily Graphic, 1992b; Attah, 1992;) that there is a Timber Export Development Board directive which prohibits the export of green and air-dry lumber after 1993 (see Appendix 6). Only kiln-dried timber and finished wood products will be granted export licences. The supply of timber to the local market will not be affected.

Appendix 11. TECHNOLOGY TRANSFER

One of the most experienced organisations in technology transfer is the Ghana Regional Appropriate Technology Industrial Service Project (GRATIS). GRATIS has been responsible for setting up workshop centres - Intermediate Technology Transfer Units (ITTUs) - in the regional capitals to train small-scale entrepreneurs in equipment use and to assist them in purchasing machine tools. Objectives include the improvement of the local manufacturing capability and to demonstrate the viability of a technology to show their clients that a new process can be profitable. The concept of the ITTU began in 1974 and a pilot technology centre was set up over 10 years ago (Smile, 1986). The project hopes to complete the establishment of the last ITTU in 1993.

Their technology transfer strategy is based on the needs of their clients who are expected to demonstrate commitment in their request for assistance, "put them off but leave the door open" (Powell, 1992). A lot of emphasis is placed on finding entrepreneurs and helping them to develop their own ideas. Programmes to introduce new technologies must also consider the culture and traditions of the target community and specific analyses of problems affecting small-scale and rural industries need to be carried out. Such socio-economic studies are now being carried out by GRATIS' social development section.

The Food Research Institute (FRI) is concerned with the development and uptake of improved small-scale processing equipment and methods. One of its particular areas of experience in technology transfer is with the Chorkor fish smoking kiln, designed to reduce drudgery in fish smoking and improve fuel efficiency. The kiln was developed with the help of users and is largely based on the traditional method. Because of this it is reported to have been readily accepted. Since its introduction it has spread to many fish smoking areas. This has been made possible with financial support from international agencies and the active involvement of Ghana's National Council on Women and Development in extension work. Once the technology has been taken up in one village the adopters go to neighbouring villages to tell others about it. Demonstration has to be part of the dissemination programme and local artisans must be trained in kiln design and construction.

The project began in the early 1970s. However, despite the publicity the Chorker smoker has received and its obvious operational and cost advantages, it is interesting to see that a large number of traditional smokers are still being used.

Technoserve's main focus in technology transfer is in small-scale oil palm processing through 2 pilot schemes to assist village-level processing units which they will extend to 60 plants over the next five years. Their philosophy of technology transfer is that demonstration/pilot projects are important to determine and demonstrate economic and technical viability. Many attempts to introduce improved technologies fail because adopters have unrealistic expectations about what the technologies can do because they have not been properly compared with existing systems. In addition, where people are presented with something they have not had to work for or invest in there is little incentive to maintain or repair it because if it breaks down they will be no worse off than before and repairing it costs money.

Technoserve expects project beneficiaries to contribute financially to feasibility studies and to project infrastructure such as buildings. A loan will be negotiated with the Agricultural Development Bank for equipment purchase and the organization has a management contract with Technoserve to provide training and assistance for 2 years. Technology transfer requires considerable follow-up and market development which necessitates a long-term commitment and sufficient funding. The second phase of this project will last at least five years.

The Ministry of Energy is involved in widescale technology dissemination through two main projects, one to promote the use of LPG as a substitute for woodfuel and charcoal and the other to introduce an improved charcoal stove to reduce charcoal consumption. A combined LPG cylinder and gas cooker has been introduced and by 1991 some 10 000 had been put on the market. A door-to-door service has been introduced to increase accessibility in Accra, Tema and Kumasi. As of end-1990, 35 institutions had had their kitchens converted to use LPG. The 1991 work programme objective was to increase the number of institutions using LPG and to introduce LPG stoves adapted to suit cooking requirements of small-scale food sellers (Ministry of Energy, 1991a). Consumption of LPG can still be significantly increased but project monitoring indicates that there is some consumer resistance to the use of LPG because of fears over safety. Unavailability of full cylinders is reported to be a problem sometimes.

The other main initiative is the dissemination of a locally-designed charcoal stove which produced fuel savings of 35 to 40% during a 9-month trial in Accra. Funds were given to a commercial manufacturer to produce a large number of stoves. By the end of 1990 some 3 000 stoves had been sold in 6 urban centres. The project workplan for 1991 was to disseminate 10 000 stoves and redesign the stove to take all cooking pan sizes (Ministry of Energy, 1991a). Dissemination of the stoves has been by supplying interested ironware traders, who responded to advertisements in the media and who fulfilled certain conditions, to stock and promote the stoves. The traders have a grace period in which to start selling the stoves before they have to pay the Ministry of Energy for them.

The relatively high cost of the improved stove, compared to the traditional model, is considered one of the main reasons mitigating against widespread uptake.