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SUBSTANTIVE PREPARATIONS FOR THE CONFERENCE

Report of the Technical Panel on Fuelwood and Charcoal on its second session

CONTENTS

INTRODUCTION

1. The General Assembly of the United Nations in calling the Conference on New and Renewable Sources of Energy established fuelwood and charcoal as one of the areas to be examined. A Technical Panel on Fuelwood and Charcoal, composed of nine experts (listed in annex 1 below) met twice during 1980 in Rome (21-25 January and 8-12 December). The Food and Agriculture Organization of the United Nations (FAO) was host to the meetings and provided the technical secretariat. The present report contains an indication of the problems and constraints which affect the present and potential uses of fuelwood and charcoal, and it presents the Panel's recommendations for improving the situation.

2. At its first meeting, the Panel reviewed available information on the present role and future potential of fuelwood and charcoal and the weaknesses in the data. In order to have a solid, up-to-date basis for its conclusions and recommendations, the Panel identified a number of areas which required further investigation. A number of technical reports were specially prepared at the request of the Panel or as a contribution to its work; they are listed in annex 2. The summary and conclusions of each study carried out for the Panel are attached in annex 3.

3. The report is divided into three chapters. Chapter I is a condensed report of the work of the Panel: it states the nature of the problem, identifies the components of programmes of action in relation to constraints, and spells out the recommendations of the Panel. Chapter II gives an overview of the world fuelwood and charcoal situation, and chapter III examines the potential for improved production and use of fuelwood.

I. FUELWOOD: ENERGY FOR SURVIVAL AND DEVELOPMENT: A STRATEGY

4. Fuelwood and other organic fuels are the major sources of energy for survival for the world's poor. To live, people must eat. To be edible, most food must be cooked. The Panel emphasized that, for cooking purposes, close to half of mankind depended on fuelwood or its derivative, charcoal, or - in their absence - on agricultural residues and animal dung.

5. The study carried out by FAO for the Panel shows a situation of frightening proportions. Already more than 100 million people live in situations where they are unable to obtain sufficient fuelwood to provide even minimum energy needs. Roughly a further 1,000 million are affected by lesser but identifiable shortages. If present trends continue, those numbers will have increased several fold by the year 2000, when over 2,500 million rural people will need to be provided with other cooking fuels to replace fuelwood. As is shown in table 2, all four regions of the developing world are affected.

6. Shortages of fuel in some areas are such that people are no longer able to secure sufficient cooked food to avoid hunger and malnutrition. In cold climates the mortality of old people and small children, who are less resistant, increases if houses cannot be adequately heated. In addition, as supplies diminish, apparently many, if not most, of the people dependent on wood fuels are now suffering some physical or economic burden in order to obtain fuel.

7. Cutting of trees and woody vegetation to meet the growing demand for wood fuels has accelerated the process of excessive deforestation, which seriously threatens the environmental stability of large areas. The destruction of fragile arid land ecosystems such as that of the Sahel, and the erosion, flooding and siltation that has accompanied the removal of tree cover, as in the Himalayas, threaten the agricultural potential and the production of food on an alarming scale. The need to meet the domestic energy requirements of those now dependent on wood fuels is thus not just an energy issue. It is essential if mankind is to maintain the stability of the environmental framework on which we depend for life itself.

8. The challenge must be met mainly through improving the supply, distribution and use of fuelwood and other organic fuels. The Panel has concluded, both from its own studies and those of the other Panels, that there is no alternative source of energy that could provide a viable substitute for fuelwood on a scale which could permit a major reduction in dependence on it, by the world's poor within the next quarter century. Their poverty, and the remoteness of many of them, will inescapably remove other energy sources from their range of possibilities.

9. Fortunately, solutions to the problems of improving the supply, distribution and use of fuelwood and other organic fuels do exist, within the realm of possibility. Trees have unique advantages as a low cost, decentralized system for capturing and storing solar energy. Wood can be harvested and used as a source of energy without complex, expensive equipment, and at little cost other than that of the labour of gathering and preparing it. The main inputs required for its production are land and labour.

10. The task of realizing the potential of wood will not be easy. There are many constraints to its implementation, and the magnitudes involved are by now formidable. But unlike other energy forms, it requires the development of no new technology. It is essentially a task of diffusing and applying known and tried knowledge, and of mobilizing the resources to do so on a massive scale. Improved production and use of fuelwood and other organic fuels can and must be developed locally through local resources and solutions. The participation and co-responsibility of local populations is essential: their resources and skills must be fully mobilized.

11. In essence, what is required is political will, at all levels. Consequently, the Panel recommended that the Conference on New and Renewable Sources of Energy, as its most important objective, make known the dimensions and nature of the energy needs that must be met by fuelwood and charcoal, and that Governments and the international community determine to implement the actions required in order to meet those needs.

12. The Panel stressed that it was not possible to formulate a single detailed plan of action which would meet the multiplicity and the diversity of fuelwood situations. It analysed the possible lines of action and identified the important components in programmes of action which might be relevant to the needs and features of any particular local situation.

A. Programmes of Action

13. The Panel identified six major programmes of action. They - and the constraints to which they are subject - are described in some detail in chapter III below. All the programmes are based on technologies and techniques which are available and known: the major constraints to massive programmes are institutional, economic and social.

Intensifying the productivity of existing fuelwood resources

14. Substantial additional fuelwood supplies can be made available through intensive management of the available biomass in forests, woodlands, shrublands, and scattered tree resources in rural areas. Such a programme would require particular efforts in bringing all those resources under management for fuel production and in involving rural people in protecting and maintaining a sustained production. The main constraints are related to insufficient awareness of fuelwood needs and potential supplies, to lack of information on management possibilities of such supplies, to the low priority generally attached to fuelwood in forest policies, to insufficient perception of the need to involve local populations and, consequently, lack of an institutional framework to stimulate their active participation. Solutions to the constraints require a continuing effort in order to strengthen the institutional framework, adapt national policies, allocate necessary resources and stimulate the awareness and involvement of all concerned, particularly the local populations.

Creating new fuelwood resources

15. The establishment of new fuelwood plantations presents not serious technological problems but - rather - institutional, social and econcmic problems, apart from the possible competition for suitable land for other uses. Three different types of plantations can be envisaged: large-scale plantations for concentrated demand; community woodlots and farms; and individual planting. Agro-silvicultural or silvo-pastoral systems can also combine fuel production with other goods and services. The main constraints are the lack of effective support in national policies to tree-growing in rural areas, with insufficient awareness of tree-growing possibilities, the inadequacy of the institutional framework, the cost of such programmes, even if they can mostly be executed by calling upon locally available resources. The solutions would require a substantial strengthening of the institutional framework, particularly of the capability to stimulate and support tree-planting in rural areas, adapting as necessary land tenure and land-use systems, credit and incentive systems, the selection and diffusion of fast-growing multipurpose tree species and the use of non-conventional lands. The supporting infrastructure, nurseries and so on should be decentralized in order to meet local needs and potential. Of special importance should be social forestry programmes in which people actively participate in programmes to their own direct benefit. Substantial efforts are required to create new fuelwood resources which meet the needs of growing populations. The Panel recommended a fivefold increase, on average, in current levels of tree-planting for fuel. Additional fuelwood supplies should be established not only in the form of

fuelwood plantations, from individual to large scale, but also as an integral component in agriculture and rural development programmes.

Organizing the distribution of fuelwood

16. Distribution is one of the keys to ensuring access to continuous supplies of fuelwood from existing and new resources. In that context distinction must be made between urban and rural users. For rural users, distribution is mainly based on individual collection, whereas urban users rely on a distribution system. Major urban centres place heavy pressure on surrounding resources. In those areas the diversion of fuelwood from local use to urban markets affects the rural populations which suffer from the disappearance of trees. At the same time more distant supplies may remain untapped because of the cost of transportation and the lack of infrastructure. The constraints inherent to organizing the distribution more efficiently are the lack of storage facilities to ensure stable supplies, the lack of equipment required for large-scale distribution, the inadequate transport and communication facilities, and the disrupting impact of heavy, concentrated demand on local supplies for rural people. The solutions lie with a better control of distribution and pricing mechanisms, the establishment of storage facilities, and the improvement of transport facilities, especially from more distant sources.

Improving conversion technologies

17. Improvements to conversion technologies are of great importance since they represent a substantial potential for energy conservation by reducing the demand for wood. Such improvements range from the seasoning and pre-processing of fuels to the more efficient production of charcoal. Traditional charcoal-making can be improved through more efficient kiln and production techniques. The constraints to the programme are the relatively high cost of even intermediate technology, the socio-cultural, economic and organizational implications, and the lack of available information on improved technologies. Solutions for improving charcoal-making entail raising the level of technical know-how and equipment, promoting the grouping of producers, and organizing and controlling production and marketing, especially in areas of concentrated demand.

Wood-burning stoves

18. Traditional methods of using wood and charcoal for cooking and heating are generally wasteful of fuel, and the potential for improvement is substantial. The use of stoves and fuel is closely related to the local conditions of fuel availability, to cooking habits, and to traditional materials and skills. Improvements in stoves in order to save fuel are generally possible, but they should be developed locally in relation to specific local needs and possibilities. Stove efficiency can not be isolated from technologies for the harvesting, collection and transport of fuel and the qualities of that fuel. Combined efforts on the various aspects involved can result in a reduction in fuel consumption of some 30 per cent as compared to current levels. The constraints to the diffusion of improved stoves are lack of general solutions and of information on reliable proven designs, lack of extension service to stimulate a change in domestic end use to

more efficient stoves and fuel use, the inadequacy of local skills for making and maintaining improved stoves, and the insufficient awareness of the potential improvement among local populations. The solutions would require the involvement of local people - especially women - in the design, and manufacture of adapted efficient stoves, the training of extension workers for the diffusion of the stove technology and use, a continuing effort to improve stove designs and their adaptations further to local needs, the exchange of experience and dissemination of information on improved technologies, and political and financial support in line with the considerable scale of effort required.

Substitution possibilities

19. Substitution is the obvious alternative in some cases, either as a temporary measure - to alleviate the pressure in order to allow the restoration of supplies - or as a permanent way to replace exhausted supplies. Substitution by fossil fuels is a possibility limited by the cost both to the nation and to the individual user. It has a limited application in urban areas and among higher-income groups. The constraints involve the foreign-currency cost, the vulnerability to world energy situations, the lack of adequate supply and distribution facilities in rural areas, and the economic and social acceptability to the user. The possibilities for substitution by other renewable energy sources such as solar energy appear very limited because of the cost of equipment, the technical knowledge involved and the substantial social and consumption changes required. Substituting fuelwood in agricultural or rural industrial uses will have a more direct and faster impact. Agricultural residues are the substitute to which rural people naturally shift when fuelwood becomes scarce. The diversion of large quantities of vegetable and animal residues to fuel use decreases the availability of organic fertilizers and affects the soil productivity for future crops. However, certain amounts of selected agricultural and processing plant residues, such as ground-nut shells, coffee or rice husks, are available and can be used. Technologies do exist for agglomeration and densification which can improve the energy content to the level of fuelwood and facilitate the handling and transport. In fuelwood shortage situations, substitution should be organized at least as a temporary measure. Agricultural residues should be used selectively and, when possible, their fuel quality should be improved.

B. Recommendations

20. Massive and sustained programmes of action are urgently necessary in order to meet the minimal energy requirements of today and tomorrow. They can only be achieved through concerted political will and demonstrated governmental commitment. The urgency and dimension of the problems clearly indicate that Governments must attach the highest priority to those programmes, and that such a priority should recognize that adequate access to energy, particularly for cooking and heating, is of basic importance to survival and development and that fuelwood and charcoal play an essential role in solving the rural energy problem.

21. The accelerating degradation of the fuelwood situation implies that the earlier action is taken, the more effective it will be and the lower and therefore

the cheaper the total effort that is required. The time factor is critical: action should start immediately, without awaiting studies which could be part of action development. The scale of action is another critical factor, since only massive programmes of action are likely to have a sizeable impact. There is little risk of over-estimating the action needed, and under-estimating is not likely to halt the degradation of fuelwood resource supplies and its consequent impact on rural development potential.

22. Fuelwood and charcoal provide an essential source of energy for rural and village households. Decentralized systems and action rooted in people's participation are fundamental to the success of fuelwood and charcoal programmes. The importance of fuelwood and charcoal to the poor cannot be over-emphasized: benefits must accrue to them. Fuelwood programmes should fit local situations and they should therefore be based on flexible approaches which combine various elements of solutions in meeting local needs and possibilities. They should be closely integrated into rural development efforts and they should involve local populations through active and responsible participation.

23. The Panel analysed the constraints which generally affect the implementation of any sizeable fuelwood programme and, as a result, strongly recommended that the following lines of support to action be urgently pursued by Governments and the international community. They should all form integral parts of a global effort to remove the constraints, and they require the strongest concerted political commitment of all concerned.

Political infrastructure

24. Governments should develop a national policy and initiate national programmes which clearly demonstrate the high level of political priority and commitment attached to fuelwood and charcoal in meeting basic energy needs. Such a policy should raise the general awareness and commitment of all concerned - both institutions and people. It should encourage people to grow wood for fuel as an integral part of rural development efforts.

25. Governments should start, without delay, major action-oriented fuelwood programmes. The urgency and magnitude of the tasks require that such programmes should not be conditional on preparatory surveys and studies, which can be completed as part of programme development. Such programmes should reflect in each of the major aspects involved the importance and priority attached to fuelwood: institutions; manpower; finance; research and development. They should be built up as an integral part of rural development and national energy programmes and policy.

26. Governments should substantially intensify the efforts and resources devoted to fuelwood and charcoal on a scale which corresponds to the dimension and urgency of the problem. In particular, the institutions responsible for organizing and supporting the integration of fuelwood and charcoal into rural development, such as forest services, should be strengthened as well as those institutions which are already involved in, or could potentially contribute to, enhancing people's participation in those programmes.

27. Governments should ensure that national forest policy priorities include the production of fuelwood as a major objective, equal in importance to water and soil conservation or timber production. It should be part of integrated forest management systems.

28. Governments should review existing legislation with respect to land tenure, land use and forestry practice and licensing regulations which affect the access to fuelwood resources, and revise them as necessary.

29. Increased international assistance is urgently needed. Existing international organizations concerned with fuelwood and charcoal should reinforce their assistance capability in line with the scale of action required by the dimension and urgency of the problem. The Panel stressed the importance of making maximum use of the capability for assistance that has already been established in some international organizations.

30. International organizations should devote particular attention to strongly supporting efforts in developing countries for institution-building and strengthening as a basic requirement for massive action programmes.

31. International organizations should assist Governments in analysing national fuelwood situations, identifying and monitoring the evolution and implications of current or potential critical situations, and integrating fuelwood in the design of improved national energy sector planning and action programmes.

32. International organizations should promote an international declaration which recognizes energy for cooking and heating as a fundamental human need and stresses the basic role of fuelwood and charcoal in meeting that basic need in the developing world.

Finance

33. The Panel stressed that a major financial effort is required in order to sustain the plan of action in each of its major areas. The Panel estimated that the financial effort required in order to realize the potential of fuelwood for meeting basic energy requirements by the year 2000 would amount to an average $1,000 million per year over 20 years in the developing world. 1/ This is based on current 1980 costs of fuelwood programmes. An important contribution to the cost of such programmes could be made by mobilizing locally available resources such as labour, land etc. In most situations there is no risk of over-estimating the magnitude of the necessary efforts, which are likely to require gradual implementation because of existing constraints, mostly institutional and social.

1/ The financial effort has been estimated for the year 2000 on the basis of the cost of establishing the plantations required to meet the fuelwood deficits; actually the cost would also cover the intensified management of existing resources and the efforts to be made in imposing the efficiency in use which would result in lower plantation requirements. The estimate is based on work carried out at FAO and at the World Bank. The cost of building up the necessary institutional framework and organizational infrastructure is not included and could double the total cost of fuelwood programmes during the initial 10-year period.

The average unit cost of fuelwood programmes will be higher in their launching phase owing to the cost of the required strengthening of the institutional framework and of the necessary infrastructure (roads, nurseries; once these have been established the cost should decrease).

34. Governments should clearly support the priority attached to fuelwood; credibility in those programmes will require a sizeable allocation of financial resources to get action on the ground initiated or strengthened. As a start it would require that priority in the use of forestry revenues be attached to fuelwood programmes. When necessary, additional financial resources may have to be mobilized from other sectors of the economy in order to sustain efforts on fuelwood as a source of energy for subsistence.

35. International organizations should substantially increase the amounts of funds available for sustaining massive action-oriented fuelwood programmes in all aspects involved, particularly when foreign exchange is a constraint. The current share of external funding to fuelwood programmes varies from an estimated 40-60 per cent of the total cost. Procedures of external aid negotiation for fuelwood projects should be streamlined in order to allow for a quick response to urgently needed action programmes.

36. International organizations should organize emergency funding mechanisms which meet the particular problem of countries in acute fuelwood shortage situations and which would ensure their access to the required supplies of energy for subsistence at least during their transition to new energy systems or for the time required for restoring fuelwood supplies.

Education and training

37. Governments should substantially intensify the training of the required forestry staff, since staff is already the limiting factor in current forestry programmes in many countries. On the basis of recent regional manpower projections for the forest sector, carried out by FAO, the Panel recommended that training programmes of forestry technicians and of extension staff should be increased by fourfold to sevenfold, according to the present situation in the country and the size of the fuelwood programmes. Training in communications and extension techniques is essential for stimulating social participation.

38. Governments should initiate or intensify popular education and extension programmes in order to raise people's awareness and to stimulate the capability of rural communities to develop, manage and efficiently use their fuelwood resources. Educational institutions should insist on basic training in fuelwood production and use in curricula from primary school onwards.

39. Both Governments and international organizations should make special efforts to involve women in actively participating in fuelwood programmes, particularly in those aspects related to their usual responsibilities of supply and use.

40. International organizations should promote and provide technical and financial

support to national and regional training programmes related to all aspects of fuelwood and charcoal production and use.

Research and development

41. Governments should intensify applied research programmes for the design and development of more efficient systems to grow and use wood for fuel. Programmes should investigate the socio-economic as well as the technical aspects of such systems on the basis of multidisciplinary approaches; they should follow practical orientations and should make use of the lessons of past and current experiences. The ultimate objective should be the identification and experimentation of solutions which meet the specific local conditions and of approaches which enhance the participation of local populations.

42. Governments should devote particular attention to applied research programmes on the selection and improved management of local fuelwood species, on the selection of fuelwood species for dry areas, on the development of information on low-cost tree-planting techniques, on seedling production, on combined agro-silvo-pastoral systems, and on appropriate technologies for harvesting, transportation and conversion of fuelwood.

43. International organizations should stimulate and assist national and regional applied research programmes on fuelwood production and use. Whenever possible, those programmes should be combined in networks for co-ordination of work, technical co-operation between developing countries and exchange of information and experience.

Information flows

44. Governments should further organize the co-ordination of, decentralization of and access to information and experience on current research efforts and programmes; the information should be disseminated under appropriate presentation to the various users.

45. International organizations should continue and intensify efforts to arrange and stimulate the exchange and diffusion of information and experience on all aspects related to fuelwood production and use; they should promote the access of all countries to available information on current developments.

46. International documentation centres should re-examine existing documentation with a view to cataloguing it from the point of view of fuelwood and biomass use for fuel.

47. Technical co-operation among developing countries should be fostered in order to accelerate the transfer of knowledge and experience on fuelwood programmes.

Rural infrastructure

48. Appropriate national institutions, such as forestry institutions, in addition

to fulfilling their direct responsibilities, should strengthen their capability of efficiently servicing, by means of infrastructure and technical support, the efforts being made by rural communities or other agencies involved in growing trees for fuel.

49. Governments should organize and monitor distribution and marketing in order to assure an adequate and stable access to supplies of fuelwood and charcoal to the groups of people most dependent on them. Major urban centres may require particular attention and specific approaches based on their particular needs and possibilities.

50. Action should be taken by Governments to identify and solve problems related to the lack of appropriate fuelwood and charcoal distribution systems, with the support and assistance of international organizations, as required.

51. In discussing the potential for improved production and use of fuelwood and charcoal, the Panel formulated an additional number of detailed recommendations on specific aspects and constraints: they are contained in chapter III of the present report and should be taken as integral parts of the proposed strategy adopted by the Panel for recommendation to the United Nations Conference on New and Renewable Sources of Energy.

52. Because of the importance of fuelwood as a source of energy for survival and of the urgency and size of efforts required, the Panel recommended that the strategy be widely and quickly disseminated to all concerned organizations, whether national or international, governmental or non-governmental. The Panel expressed the wish that FAO, because of its particular involvement in the fuelwood and charcoal area, in which it has the leading role in the United Nations system, should actively disseminate the results of the Panel's work.

II. OVERVIEW OF THE WORLD FUELWOOD AND CHARCOAL SITUATION

53. Since the discovery of fire, fuelwood has been the primary renewable source of energy for such basic tasks as cooking and heating, and it has played a major role in industrial activities such as iron- and brick-making. Over the past 200 years, since their discovery, fossil fuels, which can be used much more efficiently, have provided an important basis for industrialization and economic growth. In developed countries the widespread use of fossil fuels has displaced that of wood fuels, which now play a marginal role in total energy supplies. But, as shown by a study carried out at the request of the Panel, for some 2,000 million people, mostly in rural areas in developing countries, fuelwood and charcoal, together with agricultural residues, have never ceased to be the predominant fuel, if not the only available one. The over-all energy situation has focused attention on the fuelwood crisis which is developing in large rural areas of the developing countries, not as a consequence of an increasing scarcity of other energy sources but of the dependence of increasing populations on limited supplies of wood used as a traditionally free good. When fuelwood supplies are insufficient, agricultural residues and dung are used as the next freely available fuel; when those traditional fuels are also in short supply, basic energy needs for survival are not met.

54. Fuelwood is usually the preferred fuel of rural people because it has been locally available and because it does not require complex, expensive equipment to procure or to use. Traditionally its production and use are closely integrated into the social tissue of rural communities, and it is well suited to decentralized rural energy systems. Usually socially and environmentally acceptable, fuelwood has clear advantages as a renewable and sustainable energy source. However, overcutting of the fuelwood resource can have severe effects on the natural resources and thus on the important protective role which trees play.

55. The recorded production of fuelwood and charcoal from the forests supplies one fifth of the developing world's energy consumption. In addition, considerable quantities of fuelwood gathered in wildlands or agricultural lands are not precisely known. Of the amount of energy stored in biomass, most is accumulated in woody vegetation suitable for fuelwood and charcoal use. The theoretical potential annual growth of the world forest resource is estimated at 110.10^9 TJ; that potential far exceeds current needs. However, fuelwood situations are predominantly local in character. In recent years it has become evident that in many instances demand for fuelwood exceeds the accessible supply from existing forests and tree resources. As a result, environmental, social and economic damage due to deforestation add to the increasing daily burden of women and children in search of fuel to cook the food and heat the house.

56. Recorded fuelwood and charcoal supplies accounted for 5.4 per cent of the world energy consumption in 1978 - an estimated 15.10^6, TJ which compares to 257.10^6 TJ of commercial energy. Table 1 indicates the share of fuelwood in total recorded energy consumption. In the world as a whole, fuelwood and wood for charcoal represent 59 per cent of the total volume of wood removed from the forest - 1,566 million m^3 out of some 3,050 million m^3 in 1978. Consumption in

Table 1. Fuelwood in world energy consumption in 1978

	Population (millions)	Total fuelwood a/ (millions of m^3)	Consumption per capita (m^3)	Energy b/ equivalent of fuelwood (millions of gigajoules)	Commercial energy c/	Fuelwood (percentage of total) d/ %
World	4 258	1 566	0.37	14 720	256 594	5.4
Developed world	1 147	145	0.13	1 363	205 115	0.7
Market economies	775	54	0.07	508	145 148	0.3
Centrally planned economies	372	91	0.24	855	59 967	1.4
Developing world	3 111	1 421	0.46	13 357	51 479	20.6
Africa	415	353	0.85	3 318	2 415	57.9
of which least developed countries	138	163	1.18	1 532	255	85.7
Asia	2 347	796	0.34	7 478	37 558	16.6
of which least developed countries	130	34	0.26	319	180	63.9
Centrally planned economies	1 010	220	0.22	2 068	24 048	7.9
Latin America	349	272	0.78	2 557	11 306	18.4
of which least developed countries						

a/ Includes wood for charcoal.

b/ IM^3 = 9.4 gigajoules.

c/ IMT coal = 29.3 gigajoules.

d/ Not including other sources of non-commercial energy important in some regions.

/...

developed countries was about 145 million m^3, approximately one tenth of their total roundwood use, while consumption in developing countries was 1,421 million m^3 - that is, 85 per cent of their total roundwood use. Fuelwood is much more important in some regions and countries. In Africa, it contributes 58 per cent of total energy consumption. In some countries, it amounts to over 90 per cent of all energy supplies.

57. Information on the use of agricultural and animal residues for fuel is generally lacking. Only a few countries have carried out detailed analyses of rural energy consumption and of the portion supplied by agricultural residues. Although no general indications can be given, that source of energy is known to be particularly important in certain countries of Asia - notably, India, Bangladesh, Pakistan and Nepal. In India where energy use from agricultural residues and dung is approximately equivalent to that from fuelwood, the traditional fuels combined contribute to nearly half of total energy consumption.

A. The situation in developed countries

58. Energy derived from wood accounts for only 1-2 per cent of total energy consumption in the developed world as a whole. That proportion varies from negligible levels in urbanized, forest-poor countries to up to 5 per cent or more in countries with a large forest resource. It has been estimated that over 8 per cent of Sweden's primary energy consumption is derived from wood (including waste liquors burnt for energy in pulping operations).

59. In 1978, about 36 million m^3 of fuelwood were harvested in Europe (excluding Turkey), about 21 million m^3 in North America and 78 million m^3 in the Union of Soviet Socialist Republics. In addition, it is estimated that in those regions about 35 million m^3 of industrial wood residues were used as fuel and that waste liquors provided about 1 million TJ to the pulp industry.

60. The main users of wood energy in the developed countries are inhabitants of rural areas and the forest industries. The former are often themselves forest owners or have easy access to wood supplies. Wood is usually used for space and water heating, as part of an energy "mix" with, for example, electricity. Forest industries are important producers and users of wood for energy. In North America 80 per cent of wood-derived energy is used in forest industries, while in Europe the percentage is about 44 per cent. The industries essentially burn the residues of their own processes to satisfy at least a part of their energy needs. Several forest industry sectors - notably, saw-milling, plywood manufacture and chemical pulping - are potentially energy self-sufficient or "net exporters" of energy, although the potential is rarely achieved.

61. The end of the "cheap-energy" era has caused attention to be paid once again to the potential of wood as a source of energy. Governments and individuals have become conscious that wood is a renewable, decentralized, domestic energy source. Above all, the rise in prices of other forms of energy has made wood relatively much more attrative from an economic point of view. Demand for fuelwood has increased strongly and prices have risen markedly in the second half of the 1970s. While wishing to safeguard the raw material supply of the forest industries,

several Governments have reassessed the place of wood in their energy supply policies and foresee the possibility of an increased contribution, notably from logging and industrial residues and thinnings.

62. In the medium term the prospects are for an increase in the contribution of wood to energy supplies in the developed countries. The forest resource is, however, limited compared to the huge total demand for energy and wood is, therefore, unlikely to be a major source of energy, with the possible exception of some countries or areas with a particularly favourable ratio of forest resource to energy demand. In the immediate future, the consumption pattern is likely to be similar to that at present: low-grade wood, used unmodified, chipped or possibly compressed, burnt to provide heat or steam for rural inhabitants (in single households or larger units such as schools or hospitals) or the forest industries. In the longer term, energy plantations of fast-growing species and wood-derived liquid or gaseous fuels could also play a role in some countries and are at present the subject of intense research.

B. The situation in developing countries

63. The average fuelwood and charcoal consumption per capita of the developing regions is reported at 0.5 m^3/year (equivalent to 4.3 GJ), with wide variation from country to country or within countries. In the group of least developed countries, fuelwood and charcoal are by far the prevailing source of energy, accounting for four fifths of energy consumption. Dependence on wood fuels is particularly high in some countries of Africa. In countries such as Brazil and Argentina large volumes of fuelwood and charcoal are used in large-scale industries.

64. The figures of fuelwood consumption for many countries are based on estimates. Because most fuelwood is collected and used locally and is not procured through a market system, it is usually not accounted for in official energy statistics. Forestry statistics normally provide information only on supplies officially harvested from forest reserves; they ignore supplies from trees in open country, homestead gardens and so on, and from areas not considered forest. Official statistics on fuelwood and charcoal, therefore, usually offer a partial indication of the importance of fuelwood.

65. Information is particularly lacking on both availability of supplies and consumption of animal and agricultural residues. In most countries livestock or crop production statistics can provide only rough indications for estimating the availability of dung or crop residues.

66. Because fuelwood can seldom bear the cost of transport over long distances, the balance between consumption and supplies is usually determined at the local level. Hence statistics at the national level may obscure the situations of local scarcity, and efforts should be made to identify and monitor sites where imbalances are developing.

C. The situation with regard to rural and urban energy systems

67. Fuelwood, charcoal and other traditional fuels dominate rural energy systems because of their decentralized local availability and because of the possibility of sustaining the supplies. Trees or parts of trees can be harvested for firewood even when they serve other functions such as a source of fodder, food or structural material. When only limited quantities of fuelwood are available, large amounts of agricultural residues or dung are often used. The village energy system works in an integrated fashion which encompasses other activities and resources, and the role of those traditional fuels must be seen as a complex function at the village level with numerous interconnexions with land tenure and use, agricultural practices, resource allocation mechanisms and social structures.

68. Fuelwood and charcoal play an essential role as domestic energy for millions of households in the developing world. In the climatic conditions of most tropical countries, cooking represents the largest use, essential for the subsistence of most people who otherwise have practically no access to other forms of energy. Wood has been the preferred domestic fuel of rural people as a free good not requiring complex, expensive equipment to procure or to use. Domestic energy requirements for cooking and water heating range approximately 6-10 GJ per person per year, or 0.5-1.0 m^3 of wood; they vary considerably with climatic conditions and cooking habits. If space heating is included, total domestic energy requirements vary still more - up to 25-30 GJ per capita per year in cold mountainous climates. Seasonal variations, wood species, moisture content and availability substantially modify actual consumption levels.

69. Domestic energy input requirements are considerably higher in developing countries than in developed countries because of the low conversion efficiency with which traditional fuels are used to produce useful heat. A number of factors, including the utilization of traditional earth stoves or three-stone systems, the nature of the food, traditional cooking habits, and the way fuelwood is collected and used, result in a conversion efficiency which seldom goes beyond 10 per cent. Charcoal stoves have an efficiency almost double that, but still much lower than commercial fuel stoves. Charcoal production itself, however, consumes large quantities of fuelwood. Gross energy budgets tend, therefore, to emphasize traditional fuels because of the low efficiency with which they are used.

70. Various rural industries, such as brick and lime kilns, blacksmith forges, pottery kilns, tea driers and tobacco-curing units, often use fuelwood and charcoal for generating heat. In some countries the use of wood fuels for processing and rural industries amounts to considerable volume and can give rise to large demand concentrations. Current technologies in small rural and village industries result in relatively high fuel consumption rates, which usually can be easily reduced by more efficient processes. The increasing relative scarcity of energy may stimulate interest in using firewood and charcoal and other biomass-based fuels to meet industrial needs, especially in rural areas.

71. Rural fuelwood use is still mainly of a subsistence nature. The supply usually comes from a limited area at short distance from the consumer's dwelling; when the forests are too distant, most of the wood used for fuel comes from trees

outside the forest. Fuelwood rarely enters the commercial market. Because of the localized character of fuelwood collection, demand in areas of high population density results in heavy pressure on fuelwood resources and the remaining tree cover; even fruit trees or trees with an important productive or protective function are cut, and eventually supplies may be brought from distant sources by costly transport, with implications for the cost of wood energy. As supply shortages worsen, people increase their use of free substitutes such as agricultural waste and dung. They are increasingly forced to purchase fuelwood, which then becomes a commercial good.

72. In many countries, urban use of wood fuels is an important and growing share of the total consumption of those fuels: rural people who immigrate to join the urban poor continue to depend on wood for cooking and heating. Fuelwood tends to be replaced by charcoal, a more convenient, energy-efficient fuel but also one which is usually produced through a wasteful process. The concentration of demand in urban areas places heavy pressures on supply in surrounding rural areas, often resulting in complete removal of the woody vegetation. The commercial supply of wood fuels to urban demand diverts the production from local rural use, which may have severe implications on the rural poor, threatening their access to basic energy supplies.

73. Large quantities of fuelwood are needed to produce charcoal, a fuel which is easier to transport, store and distribute. Traditional charcoal-making has a low average energy efficiency up to approximately 20 per cent; the energy content of the charcoal itself varies widely, but on the average, the weight is double that of fuelwood. Charcoal can thus be transported economically over longer distances than fuelwood. Traditional charcoal cooking stoves are usually from two to three times more efficient than wood stoves, and charcoal is usually preferred, especially in urban areas, because it is easy to store and to use.

74. In increasingly large areas, heavy dependence on wood fuels, growing population and increased urbanization result in marked imbalances between the available supply of and requirements for wood fuels, with resultant scarcities. As local sources of fuelwood are being exhausted, people spend more time and money on fuel collection or purchase. They use more agricultural residue and dung as the next immediately available fuel. In some cases minimum energy requirements can not be met even through the use of all available vegetable fuels. Scarcities affect primarily the poor without access to alternative fuels, and when acute, they have dramatic implications, even - when food can not be adequately cooked - on nutrition.

75. Under the increasing pressure of fuelwood cutting, the depletion of tree resources leads to their disappearance. The depletion of the natural vegetation results in increased ecological fragility and in the degradation of the resource base, soil and water, on which agriculture is dependent. In arid, semi-arid or mountainous areas the disappearance of the woody vegetation causes desertification, erosion and siltation. The use of agricultural residue or dung as fuel diverts their nutrient content from returning to the soil and hampers the restoration of its productivity: the loss in fertility can be both very marked and speedy. The pressure of basic energy needs can result in irreversible degradation of the

environment, to the extent that the basis for life and development no longer exists, and people have to move, with socio-economic and even political results which can be dramatic.

D. Evolving situations

76. In order to provide the Conference with a clear indication of the importance of fuelwood and of the magnitude of the dramatically developing problems of scarcity, the Panel requested a global reconnaissance survey of the fuelwood situation in developing countries. The survey was executed by the Forestry Department of FAO by means of assessments of existing and potential fuelwood consumption and supply, independent of political or geographical boundaries. Regional teams analysed the situation at the country and subregional level in Africa, Asia and Latin America. The survey clearly identifies where fuelwood shortages exist or are emerging under current trends. It indicates the magnitude of the populations involved, the severity of the shortages and the physical potential for maintaining or improving fuelwood supplies. Its main conclusions are summarized below, and table 2 presents the information on the populations involved.

77. In 1980 situations of acute scarcity involved approximately 90 million rural people in developing countries in areas where even over-exploitation of existing woody vegetation together with agricultural residue, where available, was insufficient to supply fuelwood requirements. Minimum energy needs were not met and energy consumption was below minimum levels. Such situations currently prevail in Africa, mainly in the arid and semi-arid areas south of the Sahara, in the east and south-east and in mountainous areas; in Asia, in the Himalayas and the hills of South Asia; and in Latin America, mostly in the Andean Plateau and the arid areas of the Pacific Coast in South America. In addition some 150 million people live in major urban centres situated in rural areas, already in fuelwood deficit. Under prevailing ecological conditions and with expanding demographic growth, any large-scale forestry effort to improve fuelwood supply is likely to be very costly and offer only a partial solution to increasing energy needs. Action to supply substitute fuels must be taken promptly in order to alleviate the pressures on remaining fuelwood resources.

78. In 1980 deficit situations involved 833 million rural people and 166 million urban dwellers in areas where the population is still able to meet its minimum energy needs, but only by harvesting in excess of sustainable fuelwood supply. The resource is, therefore, inadequate to meet present needs. Those in such situations in Africa amount to 146 million people, mainly in savannah areas in the west, central and south-eastern areas. In North Africa and the Middle East 70 million rural people live in situations of fuelwood deficit. In Asia 550 million people in rural areas and small urban centres are affected, mainly in the Indu Gangetic plains of Central Asia and in South-East Asia. In Latin America 82 million rural people live in such deficit situations, mostly in the semi-arid and arid areas. Under current trends those situations will deteriorate to acute scarcity, which will affect the increased populations of the year 2000. The physical potential for improving fuelwood supplies generally exists, especially in more favourable ecological conditions, by means of generalized, intensified management of existing resources and of village and farm plantations. The resources would, however, probably not meet the current needs of growing populations.

Table 2. Populations with fuelwood deficits a/
(Millions of people)

Region	1980						2000			
	Acute scarcity		Deficit		Prospective deficit		Acute scarcity		Deficit	
	Total	Rural	Total	Rural	Total	Rural	Total	Rural	Total	Rural
Africa	55	49	146	131	112	102	88	74	447	390
Near East and North Africa			104	69					268	158
Asia and the Pacific	31	31	645	551	308	271	238	53	1 532	1 441
Latin America	15	9	104	82	158	99	30	13	523	236
Total	101	89	999	833	578	472	356	140	2 770	2 225

a/ Total population and the population with a predominant rural type of energy consumption (total population less urban centres over 100,000 inhabitants); these are the estimated populations living in the areas under the identified fuelwood situations.

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79. Prospective deficit situations are those in which supply at present exceeds demand but - if current trends of depletion of fuelwood resources continue - in which deficits will occur by the year 2000. Under the evolving situations, the additional population under deficit conditions will be 1,000 million people, of which 800 million are rural. Over half of the additional population in those situations will be in Asia; in the whole of Central and South Asia, fuelwood may be expected to play only a marginal role by the year 2000 if current trends continue. Fuelwood supplies might be maintained if the management of existing resources were intensified, closely integrated into agricultural and land-use practices, and complemented by plantations.

80. By 2000, under current trends in a few countries (seven in Asia, six in Africa, nine in continental Latin America) there will still be adequate supplies because of the favourable availability of resources in relation to growing populations. The case of the Republic of Korea deserves particular mention, because it illustrates how a successful programme may reverse trends towards acute fuelwood scarcity. Despite high population density and limited forest area, a plantations programme has resulted in a substantial increase in the availability of fuelwood.

81. The Panel stressed the gravity and magnitude of the emerging fuelwood problem, exposed by the over-all assessment of fuelwood situations in developing countries. Not only are many of those countries heavily dependent on fuelwood, charcoal and other traditional renewable sources of energy, but the dependence is amplified by the evolving energy situation, and the impossibility of rural people and urban poor to shift to alternative sources of energy remains. The fuelwood crisis is developing at an accelerating pace, which will leave few countries unaffected by the end of the century. The extension of current trends indicates that within two decades over 2,300 million rural people in developing countries will need to be provided with massive supplies of alternative fuels. Fuelwood and charcoal deficits could reach 900 million m^3, equivalent to 200 million tons of oil, while fuelwood will play only a marginal role, especially in densely populated areas. The impact of such sitations on lower-income people, especially women and children, on economic and social development prospects, and on the loss on a world-wide scale of productive natural resources is evident. Therefore, the Panel attaches particular importance to the forthcoming Conference as a major opportunity to alert all concerned to the need for urgent and massive action to reverse current trends, ensuring for the people who most depend on it an adequate supply of fuelwood.

82. The Panel reiterated its recommendation that the results of the assessment of the fuelwood situation be presented in the form of a map which would provide a clear indication of the magnitude and location of the fuelwood problems.

III. THE POTENTIAL FOR IMPROVED PRODUCTION AND USE OF FUELWOOD

83. The Panel identified within its area of responsibility five major undertakings which could result in a substantial improvement of the rural energy situation and could be developed immediately on the basis of technically and economically feasible solutions. Applied without delay and on a large enough scale, those undertakings would produce more wood for fuel and improve the efficiency with which it is used. The Panel also identified an area of essential complementary action in substituting fuelwood for traditional wood energy tasks under emerging situations.

A. Increasing the productivity of existing fuelwood resources

84. Remaining wood resources usually offer good prospects for increasing quickly and at low cost the production of wood for fuel through better management. Substantial additional fuelwood supplies could result from mobilizing more of the available biomass and increasing productivity not only from forests but also from scattered trees, open woodlands, shrublands, small woodlots at farm or village levels, as well as from trees grown for other purposes such as fruit, fodder and shelter. Basic silvicultural knowledge does exist, but in many cases adapted treatments need to be further developed, ones which can, within the limits imposed by ecological conditions, stimulate the production of wood for fuel, combining it with the output of industrial raw material and the provision of environmental and social values. Positive and imaginative approaches involving rural communities in the management and control of the fuelwood resource are needed in order to commit local populations to its protection and sustained production.

85. Fuelwood may be produced either as the primary product of forest management or in conjunction with the output of other products. Existing wood resources currently are seldom deliberately managed with fuelwood or energy as a main production objective. Nevertheless, good possibilities exist for increasing the availability of fuelwood through the application of simple and conservative silvicultural practices which make fuller use of the forest biomass. Recent FAO studies of available volumes of wood for fuel estimate that there exist 100^3/ha-200 m^3/ha in tropical high forest in Suriname, 75 m^3/ha in the Terai area in Nepal, 50 m^3/ha in the Ivory Coast and about 88 m^3/ha in the Cerrado region in Brazil. Large volumes of wood available for fuel are currently burned and wasted by shifting cultivators or even in major governmental land-clearing programmes.

86. Present methods of cutting and harvesting industrial wood usually leave a large volume of waste, which is suitable for use as fuel. Large amounts of branches, twigs, bark, small non-commercial wood or big dry trees corresponding to approximately 30-40 per cent of the volume of wood removed from the forest are currently wasted. Improved methods and equipment can make for a more efficient harvesting. Fuelwood supplies can be expanded through the use of forest residues after their transformation into more suitable forms for handling and transport. Technologies on a large and small scale exist for the

agglomeration or densification of residues into briquettes or pellets. Simple existing technologies which can be diffused at village level could produce compressed residue-based fuel with a heat value similar to that of fuelwood. Such improved wood fuels can then be transported and marketed.

87. The potential for increasing the productivity of existing fuelwood resources is related to the nature of the resource, the type of fuelwood situation or the ownership category. Since fuelwood is by nature a location-specific source of energy, each situation will require a particular approach and set of solutions, closely related to ecological and human characteristics.

Closed high forests

88. Such forests are usually large areas located on State-owned land where current policies do not consider fuelwood as a major production objective. Current regulations are more concerned with the preservation of the resource; they are mainly centred on limiting the access to the collection of fuelwood by people living within or near the forest. Knowledge of the existing and potential fuelwood resource is often lacking. The wood supply is essentially managed as a source of revenue with little or none returned to forest investment. This results from insufficient perception of the importance of forestry in supplying basic energy needs. The immediate priority attached by people to their basic fuelwood need is often ignored. Increasing the flow of fuelwood from this type of resource depends mostly on recognizing the importance of fuelwood in forest policies and in building up the capability of managing the entire fuelwood supply base, including low-grade wood and harvesting residues. The production of fuelwood from closed forests can be organized on a scale which can make a major contribution to the supply of large-scale demand, such as that of major urban centres. The active participation of local communities in the management of the resource would create a positive commitment to maintaining a sustained supply of wood for fuel from the forest. It would also facilitate the control of the large number of people presently involved in licit and illicit cutting and transport of fuelwood to major markets.

Residual forests

89. Residual forests are usually small extensions of forests owned by communities or by private farmers in predominantly agricultural lands. Under pressure from the increasing demand of wood for fuel and other domestic uses, those areas of forest are frequently over-exploited; they are also frequently under pressure of competing land-use claims. Adequately managed, they could be an important element in improved fuelwood supplies. Blocks of some tens to hundreds of hectares are sufficient to meet the immediate needs of a rural community. Existing policies however are usually not geared to stimulating the awareness and involvement of local people in the management and control of locally available resources. The involvement of the local people can also be limited by their perception of other priority needs or by the lack of adequate technical support from the forestry institutions.

Scattered tree resources

90. On intensely cultivated lands, scattered trees are usually farm trees or homestead gardens: they are a small element in a predominantly agricultural estate. They may be forest trees grown for fuel and other products and services, or they may be fruit or fodder trees which may have fuelwood as a by-product. Such resources not only meet the needs of the farmer, they can also be an important cash crop. The potential of farmlands to produce fuelwood is usually not fully recognized, and there is insufficient institutional and political support to stimulating the farmer's interest in his own fuelwood resources.

Open wood and shrubland

91. Open wood and shrubland are mostly located in arid and subarid regions, where they constitute an indispensable source of fuel and fodder. The limited productivity of that fuelwood resource as compared to needs has not raised sufficient attention to their potential. Considerable additional quantities of fuelwood could be produced if some form of protection and management of the regrowth of tree vegetation were applied. The current constraints lie in the lack of knowledge of the resource, of the capability of existing forestry staff to apply adapted intensive protection and silvicultural treatments, and of attention to those resources in current policies.

92. The main constraints which apply to all categories of existing fuelwood resources are the insufficient general awareness of the fuelwood needs and of the potential supplies, the lack of information and knowledge of management possibilities for proper utilization of existing fuelwood resources, the low priority consequently attached by national authorities to the integration of energy as a major objective in forest policy and forest management, and the lack of institutional framework to stimulate people's involvement in sustaining fuelwood supplies.

93. The Panel stressed that the effective management of existing fuelwood resources usually represents a major potential for increasing substantially and quickly the availability of fuelwood at a relatively low cost. The Panel made the following recommendations for removing existing constraints:

(a) The production of wood for fuel from existing resources should become a major objective of national forest policies, which should consequently be geared to stimulating their intensive management, particularly with the support and active participation of local populations;

(b) National policies should reconcile government responsibilities in preserving the forest resources for production and protection purposes and the need to develop the accessibility of people to the fuelwood resource;

(c) Legislation on forest lands, land use and rural development should be reviewed and revised as necessary, in order to stimulate the involvement of local people in the control and management of the fuelwood resources;

(d) The capability of forestry institutions and staff to work in rural areas and support people's interest in managing fuelwood resources should be substantially strengthened;

(e) Knowledge of the fuelwood potential for existing resources should be increased through inventory of these resources and the diffusion of applied management techniques.

B. Creating new fuelwood resources

94. The establishment of new fuelwood resources, through short-rotation plantations, does not present serious technological problems. In the selection of species the factors of suitability to the particular fuel wood and use deserve much attention: fast-growing plant species with high calorific qualities which are able to coppice are best suited for fuelwood production. The particular burning properties and effect on flavour and so on are of great importance for the user. For rural plantation programmes specific needs and preferences of the users need careful consideration; multipurpose species can be selected which combine the production of fuelwood with food, fodder or other goods or services and improve the soil productivity through nitrogen fixation.

95. The problems of man-made fuelwood resources are mainly economic, social and institutional and compete for the availability of suitable land vis-à-vis other food and fibre crops. At the same time fuelwood plantations can have a beneficial impact which goes far beyond the supply of wood for fuel and includes the protection of soil and water resources and maintaining or even improving agricultural productivity. The cost of establishing fuelwood plantations varies widely from $US 200-2,000 per hectare; recent comparative analyses show that fuelwood from plantations delivered to the user range from $2-4 per GJ. It compares to crude oil at $5 per GJ, which represents usually a direct foreign-exchange cost. When the beneficial effects of fuelwood plantations are totalled, investment in such plantations appears more favourable.

96. There is a need to establish additional fuelwood supplies within the reach of the masses of rural people who depend on them, under conditions of economic accessibility, which meet the limited possibilities of the poorest. In the case of concentrated demand from urban centres or rural industries, large-scale plantations which will produce fuelwood at a cost comparable to existing market prices and to the economic possibility of the users may be required. Three major types of plantations can be envisaged: large-scale plantations usually maintained by forest services; community or village woodlots maintained under the responsibility of village associations or groups; and farm or individual plantings.

97. The establishment of village or farm plantations meets both prerequisites of physical and economic accessibility. Schemes which use rural labour for most operations and which rely on the active involvement of the village for maintaining and managing the plantations can supply fuelwood with a minimum cash

input of less than $1 per GJ. Most of the actual cost is, in this case, the local labour. Some incentive may be required to compensate the costs incurred by local people in time, labour, land and so on, and possibly the food production foregone while working on tree plantations, before they benefit from the new plantations. The active participation of the villagers is a prerequisite to the success of such schemes.

Large-scale plantations

98. Large-scale plantations are usually established on public lands, mostly in forest reserves by forest services. In some cases the availability of suitable land located at distances which would affect substantially the transportation cost of fuelwood may be a constraint. The main constraints which affect the implementation of large-scale plantation programmes are the lack of adequate infrastructure (nurseries, roads, equipment for land preparation) and a sufficient number of adequately trained technical staff for preparation and execution, the relatively large investments which are involved and the relatively long time during which resources are tied up before the production becomes effective. Another constraint may be with the large number of people who are traditionally engaged in fuelwood production and transport at costs substantially lower than the economic prices of plantation production.

Community or village woodlots

99. Woodlots meet the prerequisites of physical and economic accessibility in rural areas. Schemes which use rural labour for most operations and which rely on the active involvement of the community for maintaining and managing the plantation can supply fuelwood with a minimum cost input of less than $1 per GJ. The limiting constraints are the competition for land between trees and food or cash crop production, a land tenure and use system which may discourage people from growing trees, the relatively long time required for tree-growing, the divergence of perceived priorities and needs at community level, the lack of community mechanisms which can take the responsibility and stimulate the involvement as well as ensure an equitable distribution of benefits to community members, and the lack of awareness of the potential for the community to organize its fuelwood self-sufficiency.

Farm or individual planting

100. Small-scale plantings may include house gardens, fences and planting for shade, protection, fruit or fodder production where fuelwood is even a by-product of other crops and benefits. On village plantations, most of the actual cost is land and local labour. The constraints are similar to those for village plantations: availability of land; land tenure; land-use systems; divergence in perception of needs and priorities; insufficient awareness of tree-planting opportunities; lack of incentives which compensate the costs incurred before the fuelwood goes into production; lack of infrastructure to support the planting efforts (nurseries, extension service etc.).

101. In a number of situations, rural communities traditionally grow fuelwood in close integration with food crops. Even in high-density populations such as Java or the delta of the Mekong River, traditional farming systems illustrate the efficiency of tree-planting patterns where 2-5 per cent of the agricultural land is made available for plantations. Without substantial loss of agricultural production, a sustained supply of fuelwood may reach several cubic metres of fuelwood per year and per hectare of agricultural land. Any loss in agricultural production is either minimized or compensated by additional benefits, such as cash income from tree-planting. A number of technical solutions, mostly based on the lessons of such traditional systems, are available or are being developed. Selected tree species are planted in agro-silvicultural or silvo-pastoral systems, in shelter-belts or windbreaks or under other combinations of trees and crops. In addition to providing a sustained local supply of fuel, they improve food production and control land degradation.

102. In more difficult ecological conditions the need may arise to consider irrigated plantations which, despite high establishment costs, will reduce the impact of fuelwood over-cutting and the negative effect of the resulting desertification on agricultural productivity.

103. The general constraints which apply to the creation of new resources are the lack of support given by national policies to tree-growing in rural areas, the insufficient awareness of tree-planting opportunities, the lack of interest from local populations which still perceive fuelwood as a traditionally free good, the lack of awareness at government levels of the efforts required to meet future energy needs, the inadequacy of the institutional framework to implement major fuelwood programmes and the limited capability to organize and support tree-growing at village or farm level.

104. The Panel fully realized the magnitude of the financial efforts involved in any sizable plantation programme designed to meet the energy needs of fast growing populations. The Panel stressed however that the costs of such plantations would be mostly local land and labour. Any programme of comparable impact based on other sources of energy for domestic needs would likely have substantially higher costs, partly in foreign currencies.

105. On the basis of recent assessments of current fuelwood situations made by the World Bank and FAO, the Panel stressed that major efforts in creating new fuelwood resources were required in order to provide additional supplies in those areas where large deficits already existed or were developing. If a sizable impact on fuelwood supplies/demand was to be reached by the year 2000, current rates of annual tree-planting - either large scale, community or farm planting - must be increased fivefold on average. This was a formidable task which would require early and massive action in order to remove the major institutional and social constraints and mobilize the necessary resources, particularly financial, and the local resources in land and labour.

106. In addition the Panel made the following recommendations for removing the constraints to a massive tree planting effort:

(a) National policies should strongly stimulate and support the establishment of new fuelwood resources, particularly by encouraging rural people to grow more wood for fuel.

(b) The institutional framework should be reviewed in order to remove those aspects of land tenure and land-use systems which restrain the insertion of trees in rural areas and to encourage the organization of credit and incentives as compensation to the local costs incurred by rural people before they benefit from the new production.

(c) Programmes should be developed which insert trees in rural areas through agro-forestry or silvo-pastoral systems combining fuelwood with other products and through the use of all non-conventional areas (roads, canal sides etc.).

(d) Training in communications and extension should be intensified and generalized in order to enable the forest services and their staff to provide information and technical support to rural populations in their planting efforts.

(e) Information and knowledge of tree-planting opportunities should be improved and diffused to local populations in order to enable them to create, manage and control their own fuelwood supplies.

C. Organizing the distribution of fuelwood

107. Because of its low density and energy values, the collection and delivery of fuelwood is an important aspect in organizing an adequate continuous supply. Traditionally, the rural consumers collect fuelwood manually and transport it over short distances to their homes at practically no direct cost other than in time and labour. When a large urban market exists, large numbers of rural people tend to turn to fuelwood collection. The transport, distribution and sale of that fuelwood and/or charcoal is usually organized by private entrepreneurs in the same manner as it is for food and other commodities.

108. Large concentrations of demand in high population density areas or in urban areas place heavy pressure on surrounding fuelwood resources, and supplies may be tapped from increasingly distant sources. Since charcoal has a higher energy density and can be transported over longer distances than fuelwood, the transition to charcoal in urban areas usually expands the area of over-cutting and shortage. Despite the additional source of income, rural communities in the area are directly affected, since fuelwood is diverted from local use to urban markets. Thus the local communities suffer both the direct effect of disappearance of the wood vegetation and its effect on natural resources and soil productivity. At the same time, more distant fuelwood supplies may remain untapped because of the cost of transportation and the lack of infrastructure.

109. Three case studies were prepared on the feasibility of transporting wood fuels over long distances to correct regional fuelwood supply/demand imbalances. The conclusions confirm that under the current prevailing market conditions and

the assumptions made, fuelwood cannot be economically transported over distances which exceed 100 km, although charcoal might be transported up to 800-1,000 km. Of basic importance is the existence of a large concentrated market and of an efficient communications network: good organization of production, transport and marketing are required. Recent analysis indicates that under current economic conditions, the transport of charcoal from wood-rich countries of West Africa to deficit areas in the Sahel can be seriously envisaged, since the cost of the delivered charcoal compares favourably with the price of local supplies, provided political and price stability can be ensured.

110. Distribution is one of the keys to ensuring access to continuous supplies of fuelwood from existing and new forest resources. In that context, a distinction must be made between urban and rural users. For the latter, distribution is mainly based on individual collection, whereas urban users must rely on a distribution system.

111. Where it has not already been done, the distribution of fuelwood supplies to urban areas needs to be organized, in order to ensure stable and equitable access. Distribution systems, pricing mechanisms and the particular problems of the rural sector are aspects of the problem which have received too little attention until now.

112. While it is accepted that the organization of fuelwood/charcoal distribution through co-operatives, marketing boards etc. can ensure stability of price and supply, it must be recognized that there is an inherent danger in a too centralized organization, which can have a serious effect on incentives for the basic production of fuelwood.

113. The constraints inherent in organizing more efficiently existing systems are: lack of storage facilities (to act as buffer stocks) to ensure supply during periods of low producer supply - for instance, during rainy seasons; difference in equipment required for large-scale distribution; inadequate transport and communication facilities; financial and social cost relative to acceptable prices for users; the impact of heavy demand by an organized distribution system on the availability of supplies for rural people who have had traditional collection rights.

114. The Panel stressed the importance of distribution in organizing a stable supply of fuelwood under conditions which met the needs and possibilities of the users. The Panel recommended:

(a) The establishment of storage facilities for urban distribution and adequate financing for buffer stocks;

(b) A review of objectives of the existing forest reserve system and the conditions of access to supplies;

(c) An improvement in transport facilities from distant provinces, as required in light of local conditions;

(d) Technical and financial support to efficient distribution systems, co-operatives, associations etc.

D. Improving conversion technologies

115. Improvements in conversion technologies are of great importance since they are the main means, in both the short and the long term, of reducing pressure on the fuelwood resource by reducing the demand for wood in deficit areas. Only in areas with acute deficits or with local fossil fuels will substitution by local or imported fuel play the major role. The most efficient technologies for the use of wood energy from stump to pot must be introduced, where lacking. The preferred technologies in most cases will use improved stoves and cooking habits.

116. The Panel identified three major areas of action involved in the improvement of conversion technologies:

(a) Improvements in pre-processing fuels;

(b) Improvements in charcoal making;

(c) Improvements in wood-burning stoves and cooking habits.

Because of their importance, the last points will be considered below under separate headings.

Pre-processing fuels

117. The pre-processing of fuels means increased efficiency in their use. In many instances the main fuels available to rural people are twigs, branches, straw, hay and dried leaves, which burn rapidly and at different rates so that it is difficult to maintain a steady fire for proper cooking and hearing. Improved combustion of such materials may be achieved by pressing them into bundles and by agglomerating the biomass and making it more dense. This can be accomplished by simple technologies.

118. The proper seasoning and storage of fuels to reduce moisture content and so increase usable heat may be considered a form of pre-processing.

119. A problem influencing the pre-processing of fuels arises when the fuel sources are far from the users. Some form of distribution system is required, applying local solutions which will minimize labour and/or cost.

Improvements in charcoal making

120. In areas where fuelwood deficits exist or are expected, charcoal production and use should not be encouraged if there are any viable alternatives. Where charcoal is currently used, efforts should be made to replace it by direct use of the wood as fuel. Traditional charcoal making on a small scale is very wasteful of wood: at least 60 per cent of the initial joule value of the wood is lost in the process. Improvements in charcoal making at the village level for domestic and light industrial use can be made through the introduction of the brick kilns used successfully in Argentina and Brazil. Improvements in the

total charcoal yield from wood by the simple briquetting of charcoal dust should be promoted. The introduction of improved charcoal kilns and production techniques should be combined with a policy to control the scale of charcoal production so that additional wood resources are not consumed.

121. The constraints to improved conversion of wood to charcoal are:

(a) The relatively high cost of even intermediate technology;

(b) The socio-cultural-economic constraints to innovation and its organizational implications;

(c) Lack of available information, particularly on the construction and operation of suitable charcoal kilns.

122. The improvement of charcoal making operations requires raising the level of technical know-how and of equipment, promoting co-operatives, associations etc., organizing and controlling production and marketing, and promoting efficient industrial technologies in areas of concentrated demand.

Wood-burning stoves

123. Traditional methods of using wood and charcoal for cooking and heating are generally wasteful of fuel, and there is considerable room for improvement. Because of the great differences in the nature and availability of fuel, materials, skills, foods, cooking habits etc., stoves and cooking methods are specific to each local area. Improvements have to be developed locally, since there are no general solutions. But recent analyses of cooking-stove designs clearly indicate that the efficiency of fuelwood use for cooking can be raised substantially: current designs can be improved or new designs developed with a potential savings of 30 per cent or more in fuelwood consumption. The efficiency should, however, be tested under actual use conditions, and the experimentation should actively involve the potential users - essentially women - before any extensive diffusion is attempted.

124. Efficient wood-burning stoves can be designed and built at little or no cost ($0-$10) using locally available materials and skills; the same applies to charcoal stoves. The efficiency of the burning equipment is an essential element of the over-all energy efficiency of fuelwood and charcoal. It is closely related to the nature, dimension and preparation of the fuel, since specific fuels require specific types of stoves, and vice versa. Technologies which improve the efficiency of stoves need to be closely related to technologies for harvesting fuelwood or for improving the handling and fuel qualities such as agglomeration or densification. Applied research under conditions as close as possible to those of actual use is essential for developing direct combustion technologies which are significantly more efficient than traditional uses.

125. The constraints to improved end-use methods are:

(a) Lack of proven and reliable designs for efficient wood and charcoal stoves for each type of end use and for each local situation. Research and development at present under way will significantly reduce this constraint within a few years.

(b) Lack of extension service to stimulate the manufacture of improved stoves and their widespread introduction into households in both rural and urban areas.

(c) Investment costs of some types of improved stoves.

(d) Need for qualified artisans and local, small industries for making and maintaining improved stoves.

(e) Among local populations, lack of awareness of the urgency and seriousness of the problem, and resistance to change.

126. On the basis of available information and of the studies carried out at its request, the Panel stressed that combined efforts on improved cooking stoves, improved cooking methods, better skills of fuel users, and conservation could lead to a reduction in fuel consumption of 30 per cent at least, as compared to current levels.

127. With regard to the development and introduction of fuel efficient stoves, the Panel recommended that:

(a) A continuing effort be made toward the further improvement of stoves and toward the adaption of their designs to the varied local circumstances;

(b) The design and development of stoves be carried out in close co-operation with local users and stove makers;

(c) Cooking methods requiring lower fuel use be developed in close co-operation with local cooks and nutritionists;

(d) Active support at the national level and the participation of many people at the local and village level, especially women and women's organizations, be sought in the introduction of proven stove designs and cooking methods;

(e) Widespread programmes of training of extension workers be undertaken in the dissemination of stove technology and training of stove makers;

(f) Each country ensure that the necessary institutional and financial support for all of the above measures is available;

(g) International organizations stimulate the dissemination of the improved technologies and make the financial resources available to implement those policies on the considerable scale required.

E. Substitution possibilities

128. Substituting other sources of energy for fuelwood and charcoal will be indispensable in a number of situations when existing fuelwood resources become insufficient to meet basic energy needs for cooking and heating and energy consumption is actually restrained at levels substantially below minimum requirements. The substitution can in some cases be a temporary measure in order to alleviate the pressure on existing fuelwood resources and to allow for their restoration. In cases where the gap between resources and demand is too wide, such as in high population density areas or under difficult ecological conditions, the substitution may be required as a permanent solution. Basic considerations for substitution are the conditions of access and availability of the substituting energy sources, the technologies and capital costs incurred, the suitability to meet the energy requirements, the nature and organization of the energy system, and the social, cultural and institutional implications.

129. Limited possibilities exist for substituting for other renewable sources of energy such as solar energy or biogas fuelwood and charcoal, especially in the case of domestic energy for cooking and heating. The limiting factors are the cost of equipment, the technical knowledge and the substantial social and consumption changes which are required. The potential for such alternatives to fuelwood and charcoal appears to be a longer term possibility depending on the development of cheaper and simpler devices. When the target groups are the poorest, their needs and possibilities require careful consideration. Applications by agriculture or rural industries will have a more direct and faster impact: they would introduce progressive changes in rural energy systems.

130. Substitution may be the obvious alternative in some cases where establishment of fuelwood resources will take some time or cannot be arranged, owing to climatic conditions. There are thus two major kinds of solutions which have to be considered - temporary and permanent ones.

131. Substitution by fossil fuels is one alternative, which a few countries have already moved to. Their cases illustrate the difficulties and put in evidence the factors which inhibit the change from wood fuels, especially for domestic energy consumption. Fossil fuels, such as kerosene, gas, coal or commercial electricity, are technically suitable, but the cost for the individual and for the nation is usually high and includes capital costs for distribution and use. The availability of transportation and distribution systems and the cost of the fuels and their related burning equipment limit their applicability to urban areas and, within those areas, to higher-income households and to industrial uses such as bakeries, brickmaking etc.

132. Substitution by fossil fuels is therefore limited by:

(a) External problems such as the balance-of-payment situation, vulnerability to world energy situation;

(b) Internal problems with social causes - especially lack of financial resources available to the Governments and/or to the final users.

133. Agricultural residue, a good, free, fuel is the substitute for fuelwood to which rural people naturally shift when fuelwood becomes scarce. In rural areas it constitutes the next immediately available fuel, and is gathered and used for direct combustion in ways very similar to those for fuelwood. Generally, the diversion of large quantities of animal and crop residue to fuel use decreases the availability of organic fertilizer and results in lower levels of crop production. The loss of nutrients otherwise normally returned to the soil can be very significant.

134. Substitution by agricultural residues and dung is limited by:

(a) Problems of handling and transporting bulky residues to urban centres;

(b) The important implications of diverting nutrients.

135. However, certain amounts of selected agricultural and processing plant residues, such as ground-nut, coffee or rice husks, are available in large quantities and can be used for fuel without major implications for soil productivity. If technologies for agglomerating the residue or making it more dense are used for briquetting or pelleting, the handling can be considerably facilitated. At the same time the energy content is raised to a level approximately equivalent to that of fuelwood: simple technologies suitable at the village or farm level are available. In such improved form, suitable agricultural residues can be transported economically, marketed for urban as well as rural use and converted efficiently into heat, provided that adequately designed stoves are utilized. Pyrolysis, biogas or fermentation techniques allow an expanded use of agricultural residues, but current technological and cost conditions limit their impact unless strong support for a change from traditional methods is provided. The above-mentioned conversion systems have been addressed in detail by the Technical Panel on Biomass.

136. Substitution is evidently likely to have limited impact over the next 20 years or so. There is need to develop further technologies and devices which generate energy and use it at the local village or household level, under conditions of cost and suitability which meet the needs of the target groups. In some cases substitution of fuelwood by fossil fuels is - although costly - the only measure which can provide for basic energy needs when fuelwood is not and will not be available. Emergency programmes which meet the needs of people under suitable conditions of availability and access may be needed. In other cases the use of agricultural residue, the natural substitute for fuelwood, is possible if a selective use of residues is organized and based on technologies which improve the handling and energy content. Agricultural residues need not only to be seen as a locally available part of the rural energy system but also to be compared to other uses in relation to agricultural practices.

137. When substitution is necessary, the Panel recommended that:

(a) As a temporary solution - except in very special cases - Governments make fossil fuels available to users by supplying fuel stoves at low cost. In the meantime appropriate wood resources might be built up.

(b) Agglomerating residues and making them more dense be considered as a way to provide expanded use of those residues for energy, since such measures improve the calorific value of the fuel, the economy of transport to urban areas, and may also improve the fuel situation in rural areas.

(c) Small-scale industry explore the possibilities of using coal or coke instead of fuelwood, thus releasing fuelwood and charcoal for domestic purposes.

Annex I

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Annex II

REPORTS PREPARED AT THE REQUEST OF THE PANEL OR AS VOLUNTARY CONTRIBUTIONS*

First meeting of the Technical Panel

"Issue paper on fuelwood and charcoal" (FP/1/1) (previously distributed)

"Report of the first meeting of the Technical Panel on Fuelwood and Charcoal" (FP/1/3) (previously distributed)

Harry Booth, "Charcoal in the energy crisis of the developing world"

Turi Hammer, "Environmental and social considerations related to fuelwood and charcoal use"

Stephen Joseph, "Problems and priorities in developing wood stove programmes"

Second meeting of the Technical Panel

Forestry Department, FAO, "A global reconnaissance survey of the fuelwood supply/requirement situations"

H. Chauvin, "Comparative evaluation of the possibilities for supplying fuelwood-deficit areas from distant, available resources"

G. de Lepeleire, K. Krishna Prasad and P. Verhaart, "A woodstove compendium"

E. M. Mnzava, "Fuelwood and charcoal in village industries: a case study"

J. Janczak, "Compendium of simple technologies for agglomerating and/or densifying wood, crop and animal residues"

H. E. Booth, "Portable steel charcoal kilns: a comparison with two traditional methods"

G. Foley and A. van Buren, "Coal substitution and other approaches to easing the pressure of woodfuel resources"

B. Ben Salem and Tran van Nao, Forestry Department, FAO, "Fuelwood production in traditional farming systems"

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* These reports are available for consultation in the files of the secretariat of the Conference.

"Fuelwood: energy for survival and development: a strategy"

K. Kuusela and A. Nyyssönen, "The forest biomass as an energy source: the role of the forest inventory"

Meta Systems, as a United States input for the Forestry Department, FAO, "Potential for fuelwood and charcoal in the energy systems of developing countries"

Timber Section, ECE/FAO Agriculture and Timber Division, Geneva, "Forest biomass as a source of energy in the ECE region"

AID Evaluation, Special Study No. 1, "The socio-economic context of fuelwood use in small rural communities"

"Report of the Technical Panel on Fuelwood and Charcoal on its second session"
