Rural Energy Systems: Woodfuel Production, Consumption and Development Issues in Rural Areas of China

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General Background

This paper intentionally separates the two types of energy supply systems which are distinct and prevalent in urban and rural areas of virtually all developing countries in Asia. The urban energy system primarily supports the industrial and commercial activities that are important in terms of a country's economic development, and which together account for the largest share of commercial energy consumption (mostly supplied from the capital intensive centralised production systems such as hydro-, thermo-, nuclear-power, or from imported commercial sources such as coal and petroleum products). The energy demand of the household sector in urban areas, mostly for cooking and, to a lesser extent, for space heating, may be substantial given the population size and the level of household incomes, but its share in total energy consumption may still be insignificant compared to that of the industrial and commercial sectors, depending on a country's level of development. Conversely, in rural areas, the bulk of the energy is consumed at the household level. Its supply is met basically from traditional sources (i.e. woodfuel and other forms of biomass, including residues). Rural energy systems in some areas may include diverse sources such as biogas, micro-hydro, solar and wind power, mostly at a small scale. The energy is primarily used for cooking food for the family and feed for the livestock, and for space heating in cooler places. The energy requirement of other sectors is quite limited or insignificant in most rural areas. Processing of agricultural produce for home consumption and/or for sale are the other important aspects of the rural socio-economy which rely on traditional sources for energy. The characteristics of rural energy systems: supply sources, energy mix patterns, problems and potentials for development, vary from place to place, depending on numerous factors such as availability, accessibility, affordability, alternatives, income level, socio-cultural practices, climate, etc. Therefore, it is difficult to generalize about rural energy systems purely in terms of explaining only one of the different traditional energy sources that are commonly used in rural areas, or purely from the point of view of wood energy alone. The same may apply also from the point of view of identifying strategies for its development - a holistic approach will be required. The specific aspects of rural energy development: planning, policy and strategy formulation, programme design, implementation, and evaluation, must be based on the specific needs of a particular area and vary from the simple to the more complex type depending on the characteristics of an area. Hence there is a need for decentralisation. Moreover, as the prevailing level of socio-economic development in any rural area is also reflected by the area's energy consumption/requirement, this must be taken into account when considering any efforts at further socio-economic development. This visible linkage of rural energy systems with the activities of other sectors of the national economy, local culture and use patterns clearly point out the need for integration of policies, plans and programmes of various sectors in rural areas with the programmes of the energy sector. Integration will be necessary right up to the implementation stage and means a need for integrated rural development plans and programmes which incorporate rural energy.

It has been increasingly felt that the traditional approach to planning and management of the energy sector has not meet the energy requirements of the poor, landless and marginal farmers who live in rural areas. In many developing countries in the Asia region, rural households' consumption of traditional energy constitute the bulk of national energy requirements. The share of traditional energy sources in aggregate national energy consumption has declined over the years in most countries due to the rapid growth in commercial energy consumption, and the supply sources of traditional wood energy, mostly public forests, have also declined for various reasons such as population growth, deforestation, land degradation, inadequate management, open grazing and fires. Hulscher (1995) suggests the fuelwood problem is more "the result of deforestation than a cause of deforestation". At certain localities (i.e. mountainous catchments, fragile ecosystems), it may be true that the rate of deforestation has accelerated due to the haphazard extraction of woodfuel, but it should not and can not be blamed as the sole cause of deforestation in Asia. The critical issue now is the fulfilment of basic needs of the people by pursuing new and innovative strategies that allow their participation in natural resource management, and by changes in the traditional values and practices of foresters; in effect asking them to adopt the new role of catalysts (or facilitators) rather than simply to continue to act as a policemen or law enforcers.

Recently conducted studies indicate that the contribution of non-forest sources of woodfuel supply in some countries is as high as 90%. The overall estimate for South and Southeast Asia is 75% of the total consumption. This important role played by non-forest supply sources is not fully understood. The common perception of deforestation largely points to the increasing demand of woodfuel as its main cause - a theory based on a "supply gap" only. It tends to ignore the prospect for woodfuel development in non-forest lands due to new and/or additional economic potentials.

The need for the development of the rural energy sector has been increasingly realised over the last two decades or so, but there remains a lot to be done in terms of policy and strategy formulation, programme planning, resource management and conservation, etc. All these important aspects of rural energy systems have been affected by inadequate or insufficient data, lack of trained manpower, limited institutional capacity, lack of a sole agency responsible for comprehensive development in the energy sector. Even the basic issues of production, flow and utilization of wood energy are not sufficiently understood or known and thus cannot be used to explain the diverse situations prevailing in different countries. The issues of wood energy development in rural areas, where most of the household level energy requirement is met with non-traded, self collected (free) supply sources, have not been fully addressed by current national development planning methodologies. Therefore, most of the existing public sector agencies responsible for the development of energy (i.e. ministries and departments related to power, energy, water resources, etc.) have not come up with any concrete plans to overcome the problem of rural energy systems in a comprehensive way. Most of the activities related to rural energy development have been so far limited to afforestation of fast growing trees or management of degraded forests with peoples' participation. These programmes fall under the jurisdiction of the forestry sector, which may not always look at these programmes solely from the rural energy development point of view. It is often true that most foresters treat woodfuel only as a byproduct of forests. Therefore, their support to woodfuel production is only marginal. The power sector, on the other hand, treats wood energy as "dirty" or "poor man's" fuel and does not see it playing an important role in the long run, which may not be true for most countries for many years to come.

Wood Energy In China

Most rural areas in China, as in many other developing countries in Asia, rely on traditional fuels (i.e. fuelwood, charcoal and other biomass residues) for the supply of domestic energy. Reliable data on the actual amount of traditional fuel consumption by different sectors, for different end-uses and by fuel types, are not readily available and this makes the task of estimating the share of commercial and traditional fuels in the national energy balance difficult. Information presented in different publications varies considerably. One estimate shows the household consumption of traditional fuels to be about 13% of total energy consumption, and is mostly used for cooking and in cooler areas also for space heating (Ramani et al, 1993). Another source shows a much higher share of traditional fuels used in the domestic sector - as much as one-fourth of the total energy consumption. Almost 70 percent of the rural energy demand is being met with traditional sources (Tong, 1991). The estimate of RWEDP (in RWEDP, 1996) shows an approximately 10 percent share of woodfuels in total energy consumption in 1992. WRI (1996) on the other hand shows an approximately 7 percent share only, which has remained unchanged over the past decade or so.

During the period 1971-1991 there was an annual 5 percent growth in commercial energy production (i.e. electricity, coal, LPG, kerosene, etc.), which was almost on a par with the growth in commercial energy consumption (predominantly coal). The per capita commercial energy consumption in 1992 was estimated as 600 koe, and at that level of consumption China was already spending about 4 percent of her total merchandise export earnings for the import of commercial energy. The growth in commercial energy consumption in recent years is primarily due to the restructuring and growth of the economy, accelerated rural-urban migration, penetration of energy intensive technologies (including increasing use of fertilisers, personal vehicles, electrical appliances), development of energy intensive industries, population growth, etc.

Biomass Energy Consumption and Value of Woodfuels

Large variations exist between different data sources. This calls for the periodic collection and updating of data on traditional energy use to support planning and development in the wood energy sub-sector. Government published statistics show that total energy consumption in rural China in 1986 was 487.87 Mtce (or 348.48 Mtoe). Out of this, about 141 Mtoe (or 29%) was accounted for by the share of fuelwood and 136 Mtoe (or 28%) by biomass residues. The remaining 43 percent comprised coal (25%), electricity (10%) and dung and other sources (8%). In total traditional fuel consumption, the share of rural industries was very small, only about 1.2 percent in the northern provinces and 6-8% in the southern provinces. A drastic change in the energy use pattern is anticipated in the coming years in terms of amount and type of fuel consumed, supply sources, etc. due to the rapid growth in the economy that has been taking place over the past decade or so, particularly in the southern and eastern coastal provinces (Mantang, 1995).

Available statistics do not show a decline in biomass energy consumption over the years. As the size of the rural population has grown (average annual growth during the 1980s was about 1.42 percent), biomass energy demand at the household level might also be increasing in absolute terms in the absence of easily available, alternative commercial fuels (Bhattarai, 1995). The expanding economic and social development efforts in rural areas must also be adding to the demand for traditional energy. The high share of woodfuel in total roundwood production in 1994, about 67 percent (204 million m^3 fuelwood out of a total of 306 million m^3 roundwood) is a clear manifestation of the high significance of wood as a source of rural energy. There was a 25 percent augmentation in biomass energy consumption over the period 1983-1993. Out of the 75-80 percent rural population (or 900 million out of total 1, 200 million) more than half live in mountainous regions with annual incomes 50 percent lower than the average per capita income at the national level. For them, biomass fuel is, and will continue to remain, the most reliable source of energy for many years to come. If one tries to assign a monetary value to the amount of biomass fuel used in China, by comparing it with the value of imported energy substitutes, it amounts to over US$ 9 billion per year. At the same time, it also contributes to rural employment generation. Woodfuels may provide 20 times as many jobs as petroleum fuels (RWEDP, 1996).

Rural Energy Development Programmes

The English language abstract entitled "A Research Report on the Division and Technical Policy of Fuelwood Forests in China" (Gao, et al. --) projects the fuelwood consumption figure for the year 2000 as 125.9 Mtoe, at the rate of 0.11 toe per capita annual consumption. It clearly shows a woodfuel supply gap of 51.34 Mtoe. And to maintain a 28% share of woodfuel in rural energy consumption in 2000, it suggests the establishment of an additional 4.20 million ha woodfuel plantations before the year 1995. It reports the existing area of woodfuel forest in the country as 4.44 million ha. A different area figure is presented by another source, which shows 5.5 million ha already planted and an additional 1.5 million ha required for new woodfuel plantations. The authors recommend the promotion of people's participation in the establishment of additional plantations.

The negative impacts of unsustainable woodfuel use in China, particularly on the existing natural resources and environment, has been increasingly recognised in the years following the formation of the People's Republic. This concern led to the formulation and implementation of a "Rural Energy Construction Programme" as early as the 1960s. Since then, China's rural energy development has passed through three distinct stages.

During the 1960's (the first stage of development), the effort was confined to hydro-electricity development. Hydropower generation reached over 3.7 billion kWh from a bare 20 million kWh in 1945, corresponding to 7% of the total electricity production. During the 1970's, (the second stage of development), it incorporated rural electrification and biogas digesters into the programme. The most important lesson learnt during this stage of development was the recognition of the needs for programme management, project ownership, and the involvement of the people in project decision making. As locals were excluded from the decision making

process in the beginning, there was a lack of feeling of ownership of the completed projects. This frequently led to a situation whereby local people neglected the essential maintenance of the centrally planned and executed projects in rural areas. This strategy was later changed, and the development principles adopted for rural energy construction in 1979, included:

> *"suiting measures to local conditions, making different sources mutually complementary, utilising in a comprehensive way and seeking for benefits"; and "laying equal stress on exploitation and conservation, putting energy conservation first in the near future".*

Since the 1980's, active participation of local beneficiaries in decision making, including local governments, communities and individuals, has been made mandatory before any new rural energy development proposals are submitted to the Central Government for approval, even if the required fund is arranged by local governments, communities and/or participating farmers themselves. The new development strategy aims to integrate conservation with development and comprises an extensive programme package which includes fuelwood saving stoves, biogas plants and rural electrification. About 7 million biogas plants were built before 1985, out of which five million units were concentrated in Sichuan Province (Barnard and Kristoferson, 1985). Moreover, the number of households reached by fuelwood saving stoves in 1993 was 150 million (Deng and Zhang, 1994).

Conservation of coal and firewood by using improved stoves, expansion of biogas production from residues, establishment of firewood forests through extensive tree planting, and development of small hydropower wherever feasible has been the combined strategy under the "Rural Energy Construction Management" programme since 1980. And the responsibility for the implementation of different components of the package programme was assigned to related line ministries of the government, for example the Ministry of Agriculture, for nation-wide exploitation/development of coal, biogas and firewood saving stoves in rural areas, and also for the development of renewable sources like solar, wind and geothermal power for use in agriculture and pasture related activities; the Ministry of Water Resources and Electricity, for small hydropower construction in rural areas; the Ministry of Forestry, for firewood forest development; and the Ministry of Energy, for rural electrification. The overall responsibility for coordination is vested with the State Planning Commission (MOA, 1992).

The total tree plantation area in China in 1990 as reported by the World Resources Institute in its 1994 report is about 33.3 million ha. Tong (1991) reports that 5.3 million ha tree plantations have been established exclusively for woodfuel production. But to maintain even the present level of woodfuel demand, from its 445,000 rural enterprises and 680-750 million rural people, the achievement in tree planting was considered insufficient. To enhance woodfuel production in the future, Liu et al (1992) identify an additional 153 million ha land suitable for afforestation. They suggest that if these suitable lands are developed into new woodfuel plantations, then it would not only enhance future production but also increase the forest cover in China from its present 12% to 28%. The projected fuelwood production after implementation of this strategy was 1 billion tons per year, at a moderate annual growth rate of 7 ton/ha. This amount is expected to be more than enough to meet the present level of biomass consumption in China.

The basic thrust of the energy development programme is to:

- Increase people's awareness of the need to conserve the environment and natural resources and utilize renewable energy on a rational basis;
- continue the efforts to enhance energy use efficiency and reduce environmental pollution;
- strengthen the R&D activities, particularly those related to the development and promotion of renewable energy to meet the demand in rural areas;
- introduce manpower training programmes to strengthen the professional and managerial capacity for rural energy development.

Further, biomass has been identified as the most reliable form of energy for the rural population and its development has been encouraged in the short-term. Its significance will be further enhanced if one were to assess the extent to which sustainable bioenergy development (by utilising the residues for both fuel and fertiliser) makes a positive contribution to soil nutrient replenishment—a prerequisite for sustainable land resources management.

It is also reported that the important role played by wood energy in rural development was recognised a long time ago. The 6th (1980-85), and the 7th (1986-90) Five Year Plan already incorporated research and development activities for woodfuel production enhancement. Ever since, wood energy has become an important sub-sector of national development and is included in the list of key national projects. This activity is currently managed by the Ministry of Forests. The findings of the R&D work during the 6th (1980-85) and 7th (1986-90) Five Year Plans were published in 1991. A brief English language abstract of the same is available with the title: "Research on Forest Energy" (Mantang, 1995). A massive tree planting programme on 4.2 million hectares was recommended to maintain a 28 percent share of woodfuels in total energy consumption in the year 2000. It is also reported that "woodfuel forests" had been established on 4.44 million hectares before 1995. Most of these plantations were established through mobilisation of local people in order to enhance woodfuel supply in rural areas (Gao, et al. --).

However, the supply of woodfuels is yet to be managed sustainably. It is reported that 50 percent of Chinese rural households faced a severe fuel shortage for more than three months in 1979. Available supply, then, was 20 percent below the family fuel requirements (Deng and Zhang, 1994). A comparative assessment of the annual woodfuel supply potential versus consumption shows a clear deficit in 1986 (e.g., potential supply 105.6 Mtce against 141.2 Mtce consumption). But the potential supply of agricultural residues versus consumption, on the other hand, shows a surplus (e.g., 213.5 Mtce potential supply against 135.7 Mtce consumption) (Mantang, 1995).

The concept of an integrated rural energy development programme (IREDP) was visualised in 1991, with support from UNDP/World Bank under the Energy Sector Management Assistance Programme (ESMAP). Implementation of this concept was spread over 141 counties by 1993 and included both natural resources rich and poor counties.

Wood Energy Development Programmes

It is reported that forest cover in China has increased from about 8.7 percent of the total land area in 1949 to the current 13.6 percent, as a result of 38.3 million hectares of tree plantations having been established (ESCAP/UNEP/ADB 1995). But another source reports that only about 5.3 million hectares of the plantations established up to 1991 were exclusively for the purpose of producing fuelwood, and this will not be sufficient to meet the growing fuelwood demand from the households and rural enterprises (Tong, 1991). However, reports that an additional 153 million hectares of land suitable for raising fuelwood plantations are still available in the country, suggest that there will be more than enough to supply the woodfuel demand in the long run (Liu et al, 1992).

Important reforestation/afforestation programmes in China that could directly (or indirectly) contribute to woodfuel supply may include the following:

- Programme for the Establishment of Fast-growing and High-yielding Timber Bases
- Three-North Shelterbelt Development Programme
- Programme on Soil and water Conservation Forests in the Upper and Middle Reaches of the Yangtze River
- Coastal Shelterbelt Programme
- Plains Afforestation Programme
- Combating Desertification Programme
- Industrial Plantations.

Trees planted around agricultural fields, mostly in the form of shelter-belts in the plains of Sanjiang, Songliao, Hunanghuaihai, in the middle and lower reaches of the Yangtze River, and in the Zhujiang Delta, correspond to 9-13 percent of the annual reforestation target ever since 1960. In addition to their direct contribution to agricultural production, shelterbelts are now yielding 6 million m^3 of timber and 3 m^3 of fuelwood each year, from thinning and regeneration cuttings (APAN, 1996).

Together with the growing rural population, consumption of biomass fuel might also be increasing in absolute terms. Most of the incremental demand of woodfuel in the domestic sector is being met increasingly with diversification of biomass fuel used, inferior biomass fuel substitutes like crop/animal residues; dead stumps/roots, twigs, leaves, etc. are being used, particularly in areas with limited potential for developing new supply sources. In areas where woodfuel plantation were established with people's participation, local people have started sharing the benefits of their earlier tree planting and management efforts.

Wood Fuel Production Constraints and Issues

The issues of wood energy development include all aspects of woodfuel production, flow and utilization, including physical, social, economic and environmental contexts in which the development has to take place. The crucial ones may include, among others, the following:

- Low value/high volume characteristics of woodfuels makes long distance transportation uneconomic
- Not all lands suitable for tree planting may be economically feasible or socially acceptable for tree planting. Competition exists between different uses of land in the subsistence economy
- Availability of and access to alternative fuels (i.e. commercial fuels or other inferior biomass fuels), may limit the prospect of wood energy development
- The free availability of biomass material for self collection at source must change if woodfuel is to become a tradable commodity commercially produced
- The rapidly growing population poses a threat to the protection of woodfuel plantations, due to land hunger
- Lack of provision of financial support/credits to private entrepreneurs and the competition for labour with agriculture during peak farming seasons inhibit the establishment of economic woodfuel plantations
- Imperfect market conditions and undesirable subsidies on commercial alternatives need to be removed
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- Although limited infrastructure limits commercial woodfuel production potential, a larger market for woodfuel could add pressure to an already insufficient transportation network
- Ambiguous land and tree tenure, right systems (e.g., who owns? who harvests/uses/sales?, etc.) do not encourage private sector participation, even where woodfuel markets exist
- Traditional role of foresters and their perception of forests, should change to promote participatory forestry development
- Lack of information (about area based energy systems, energy content of different species, efficiency of technology in use, etc.), calls for periodic collection, analysis of data, reporting of findings in universally understandable units/measures.

Possible Strategy for Supply Enhancement

The issues and constraints specified earlier are not specific to China alone, but common to most RWEDP member countries too. Attempts should, therefore, be made to address them while formulating the strategies for development in the energy and forestry sectors. Similarly, the policies and strategies of other sectors should also be coordinated at the national level in order to make them conducive to economic, environmental and social development in the country. A narrow sectoral policy could have a far reaching adverse impact on the national economy and the environment. Since woodfuel could be both a source of income as well as energy for the poorest of the poor, the human dimensions of the system should not be neglected while formulating and implementing plans and policies of the energy sector (RWEDP, 1991). During formulation of future strategies for wood energy development, the following list may serve as a useful guide:

- Remove capital cost and price subsidies in competing conventional energy supply systems, wherever woodfuel has a potential to develop and substitute for commercial fuels

- Increase government investment and community participation in woodfuel development in areas where private sector is least interested (e.g. through community/social forestry)

- Reform policy to induce private sector investment in areas having potential for woodfuel trade (e.g. through private, leased/contract forestry)

- Simplify/abolish licensing and permit requirements for local level production, transportation, trade and utilization of woodfuels produced by local communities and the private sector

- Arrange credit services for raising feasible firewood forests with private sector participation, for financing wood-based renewable decentralised energy systems (e.g. gasification, densification, thermal-power generation, etc.)

- Treat wood energy as an important, not marginal sub-sector for development while planning and allocating resources for the energy sector

- Support, with R&D, the production of woodfuel on degraded sites, its conversion into the most economic form of fuels, and the reduction of cost and handling hardship related to its long distance transportation and use

- Integrate wood energy development as a common policy of relevant sectors (i.e., agriculture, forestry, industry, energy, etc.)

- Introduce efficient technology in support of energy demand management and conservation

- Initiate management of existing forests and plantations for the sustainable supply of woodfuels

- Establish /strengthen institutions for wood energy development.

Socio-Economic Context of Woodfuel Use

Biomass energy production invariably competes with the agriculture sector in terms of land allocation. And most often it is the former which loses since the short-term interest of most politicians in the developing countries tend to favours enhanced food production, not woodfuel. Although not much data are available from China in this regard, it may also be true there because of its large and growing population, and the limited amount of arable land.

Poor and landless people meet their household requirement of energy by free collection of woodfuels from nearby forests. In forest deficit areas their problem may be severe as they do not posses the capacity to supplement woodfuel with other commercially available substitutes. If such a situation remains unresolved it may lead to further deforestation and/or rural-urban migration, and may add further hardship to the poor. Therefore, the broad objective of rural energy development should also aim to address the issue of rural energy, primarily woodfuels, in order to improve the socio-economic conditions of the majority of the people, including the poor, the landless and women.

Accurate and reliable information regarding woodfuel market/size, number of people employed in production/harvesting/conversion, means and methods of transportation, volume and nature of trade, etc. (or the woodfuel flow system) is not known for China. The same is true also for most other RWEDP member countries in Asia. Some of the important woodfuel based activities that are crucial to the rural socio-economy of China include: tobacco curing, tea drying, brick and tile baking, lime burning, ceramics, sugar making, charcoal making, etc. These activities may be employing a large number of people and contributing significantly to local income and employment (i.e. in tree planting and maintenance, in harvesting/conversion/transportation, and in trade). Besides, there may be numerous types of woodfuel based commercial activities that provide the only income earning opportunity in many rural areas. This calls for a thorough study on a selected area basis.

Institutional Development

The progress made by China, in terms of development and implementation of comprehensive plans exclusively for rural energy supply, has been widely acknowledged in the region. Its county level planning approach has been cited as an example of decentralised area-based rural energy planning. In part, the planning approach involves identifying local resources for assigning developmental priority, taking into existing technological absorptive capability in local areas. And it should be noted that the institutional base for planning and implementation has been significantly decentralised and integrated rural energy planning with both horizontal as well as vertical linkages has also been tried with notable success. Horizontal integration is felt to be necessary to co-ordinate the development of all possible alternative sources of energy concurrently, but with priority given to the renewables. And vertical integration is felt to be necessary to incorporate the rural energy sector's requirements into the development efforts of other sectors and to resolve the latter's undesirable implications for rural energy.

The "China Association of Rural Energy Industry" has been established to support the development of rural energy industries. This institution is expected to develop gradually into a body which can take responsibility for supervising and providing production support to rural energy industries, and ensure quality control.

Conclusion

The issues related to bio-physical conditions of fast growing plantation establishment have been widely identified and adequately addressed in China by the R&D activities of the past. A vast area suitable for woodfuel production through afforestation is also available in different parts of the country. An enormous amount of information and knowledge has been acquired about different aspects of the establishment of fast-growing high-yielding plantations, including species selection, nursery, plantation, and management practices. However, not enough is known about issues such as the contribution of woodfuels to the rural socio-economy, environment and food security; the systems of woodfuel production and flows; technologies used for different applications; policy, legislation and institutions; information, extension and support services etc. These issues need to be critically analysed so that they can be clearly understood and adequately addressed.

Consideration of the socio-economic condition of potential beneficiaries and the bio-physical condition of sites available for tree planting may be sufficient for promoting community or user group based woodfuel resources development, purely for subsistence. The quality of newly established forests and the participation of the local people in development is bound to vary from place to place according to the willingness of the people to participate and the appropriateness of the technical know-how, including information, existing and planned support services, prevailing policies, rules and regulations, to address site specific problems.

When the objective of forestry development includes commercial woodfuel production, it should also look into the issues related to market and marketing. Similarly, if individuals are expected to invest time and resources for private or contract type of firewood forest development, the latter type of issues play more prominent roles. Improper or inadequate consideration of these factors during programme design and/or while implementing projects will limit the development potential of suitable sites for plantations. Inadequate consideration of these factors will limit the possibility of expanding both forest covered area as well as enhancing firewood production in the country, if not make it impossible.

China has initiated the groundwork required for the comprehensive development of integrated energy planning. The important role played by wood energy in the national economy, including the rural socio-economy has been recognised to some extent. Despite endowment of commercial energy reserves, China has also recognised the problems and limitations of using this resource in rural areas. Therefore, to overcome rural energy shortages it has assigned high importance to renewable resource development, more specifically to wood and other biomass energy sources in its Integrated Rural Energy Development Programme. The strategy followed for rural energy is the one based on the concept of self-reliance. It simultaneously pursues the

adoption of all feasible measures and the use of all available alternatives in the name of rural energy development.

To enhance biomass production, China established large scale firewood forests. To improve combustion efficiency and conserve available firewood, it has included a massive improved cook stove improvement programme. To promote feasible energy substitution, it has promoted the development of non-conventional renewable energy sources (e.g. biogas, solar, wind power, etc.). Last, but not least, to enable the country to adjust and accommodate new prospects and changes in the course of its economic development it continues to carry out research and development work in the areas relevant to all aspects of rural energy development.

Progress made in terms of research in the field of fast growing species: provenance identification, plantation establishment, management practices, firewood yield in different ecological zones and site conditions by species, etc are properly documented, and is being applied in the field during programme implementation. Identification of relevant issues and resolution of significant ones, keeping in view the changing social, economic and ecological conditions in rural China, have been an important consideration of the continuing R&D work of the forestry sector. In order to develop degraded soils, a new research project, **Alternative Socioeconomic Approaches to Reclaiming Degraded Lands (ASARDL)**, has been initiated, jointly by the Chinese Academy of Forestry (CAF) and the International Development Research Centre (IDRC) of Canada, under their research project entitled, International Farm Forestry Training Centre (INFORTRACE). This new strategy aims to maximise sustainable benefits from resource management, including from the establishment of firewood forests in degraded areas, which takes into consideration the social, economic, biological, physical and other aspects of rural China that affect development (e.g. support services, institutions, markets, policy, legislation, etc).

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