Women, energy and sustainable development

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Sustainable development is an equitable, empowering, environmentally sound, economically viable process of growth. Energy is the key indicator of sustainable development. About 74% of the population of India live in rural areas. 80% of their energy needs are derived from biomass. About 92% of this energy is consumed in cooking activity. Women play a major role in biofuel management. Rural women's perspective in sustainable development is therefore critical.
Declining biofuel resources, poor quality of the available biofuels and inefficient devices have pushed women into greater hardships. This paper examines the role of rural women in biomass management. The energy resources that rural women use, the strategy that the government and other organisations have adopted to alleviate rural energy problems and how these strategies have benefited women and improved their quality of life, the importance of incorporating the concept of "gender and development" in alternative energy strategies to achieve the objectives of sustainable development are discussed in this paper.

1. Introduction

Sustainable development is an equitable, empowering, need-oriented, self-reliant, environmentally sound and economically viable process of growth. It involves successful management of natural resources for various developmental processes to satisfy the changing needs of humans while maintaining and enhancing the quality of the environment. Energy is the most important indicator of sustainable development. Hence the key to sustainable development lies substantially in designing energy strategies.

Nearly half the world's population depend on biomass for their energy needs and 75% of India's households use biofuel for cooking. Nearly 80% of India's domestic energy needs are derived from biomass. India lives in rural areas. Of the 74% of the total population that lives in rural areas, women constitute nearly 50%. Rural women play a major role in biomass management. Unfortunately information related to women and their role in biomass management is largely based on presumptions. While there is a transition in the energy scenario in urban areas from biofuels to petroleum-based fuels, results obtained by the National Council of Applied Economic Research (NCAER) show that biofuels dominate the rural household energy consumption and continue to stay at 92% [TEDDY, 1999]. This means with all the vigorous economic, sociological, and technological progress that the country has undergone in the past two decades, the quality of life of rural women has not changed much compared with that of their urban counterparts. Despite considerable efforts and increased attempts to understand the role of women, and involve rural women actively in programmes related to energy and thereby sustainable development, the success rate has not been very significant in the past two decades.

Since women are recognised as efficient managers of biomass, their perspective in sustainable development is critical. Their choice of alternative developmental strategies and their approach in accordance with their interests, aspirations and talents are essential to achieve the goals of sustainable development in the present millennium. It is important therefore to address the nature of their role and involvement in biomass management if the goals of sustainable development are to be achieved.

This article focuses on the role of rural women in biomass management, for the reason that they are directly involved in the production and protection of biomass energy, the major rural energy resource which plays a critical role in attaining the goals of sustainable development. The article examines the role of women in biomass management, dependence of women on different sources of energy, the characteristics of the energy sources and devices used by women, their impact on the quality of life of women, programmes and practices adapted to improve the quality of life of women, and future programmes on energy for sustainable development in relation to women – on the social, cultural, administrative, educational and economic dimensions.

2. Role of women in biomass management

Constituting nearly half of the rural population (approximately 301 million, in about 104 million households, 1991 Census), women play a very important role in biomass management in rural areas in various sectors.

2.1 Biomass and the domestic sector

Rural women spend 8.73 hours/day/household [Shailaja and Ravindranath, 1990] in various domestic activities on an average, irrespective of the season. Cooking is the major year-round biomass-consuming activity in the domestic sector (Figure 1). Women spend 55 to 171 minutes/day/household in this activity depending on the cooking practice [Ravindranath and Hall, 1995]. Cooking consumes about 95% of total rural biomass energy. About 80% of total rural energy is biomass. Amounting to about

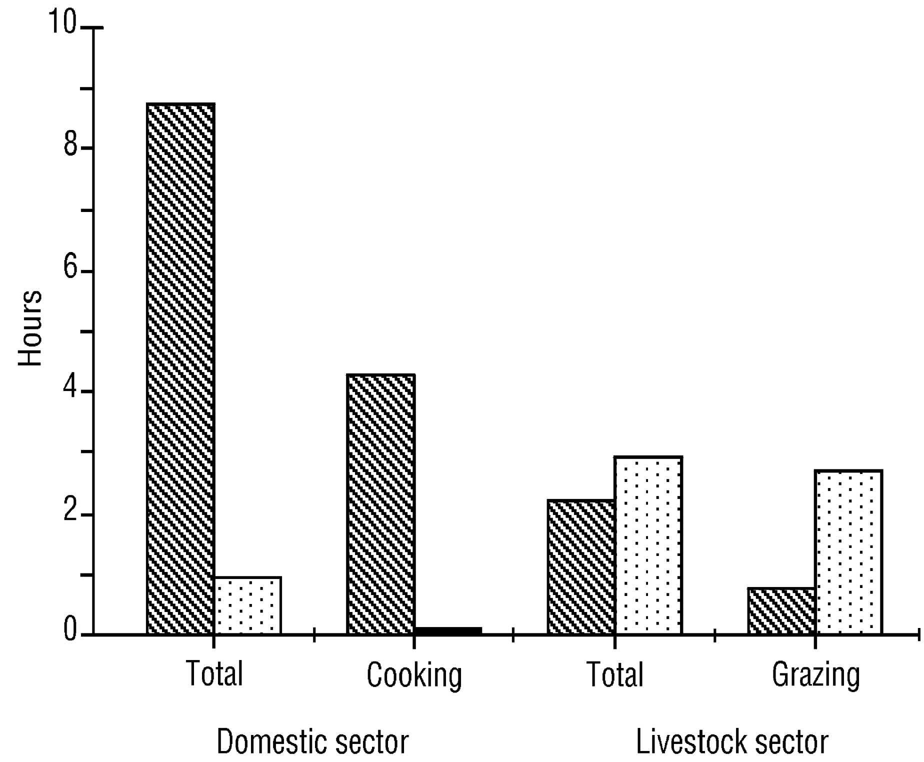

Figure 1. Comparison of woman-hours (bar on the left in each pair) and man-hours (on the right) spent in the domestic and livestock sector in a semi-arid village in Karnataka [Shailaja and Ravindranath, 1990]

254 million tonnes excluding kerosene, annual fuel consumption for cooking in rural households ranges from 290 kg to 840 kg per capita depending on the zone [TEDDY, 1999, Table 1]. Fuel-gathering is another major activity wherein women along with children contribute about 56.8% of the total labour (Figure 2). Women spend about 2 hours/day/household on an average on fuel-gathering activity. About 75% of the rural households depend on the gathered fuel. The cooking fuel mainly consists of cut wood, twigs, small branches, thorns, small herbs and crop residues and dung-cakes. There are regional variations. While dung-cake is the chief source of fuel in the Upper Gangetic zone, fuel wood is the main source in the Western Himalayan zone (Table 1). Women also perform activities such as carrying food to the farm, fetching water and cleaning activities in addition to cooking and fuel-gathering. These activities require about 4 hours per day per household.

2.2. Women in animal care activities

Women spend 2.2 hours/day/household in animal care activities. Men contribute about 50% of the labour involved in grazing activity only (Figure 3). All other activities such as shed-cleaning, milking, harvest and transport of grass for livestock are performed exclusively by women. Women spend about 31% of their labour in animal care activities (Figure 1). Women and children together put in about 60% of the labour in various livestock maintenance activities. In a Himalayan village in Uttar Pradesh women spend about 547.5 hours/person/year in animal care activities and 1621 hours/person/year in fodder collection activities along with children, mainly girls [Agarwal et al., 1999]. Studies in Pakistan, Egypt and Chile have shown that rural women do about 80-100% of the work of maintaining and managing poultry.

2.3. Women in crop production

Women are responsible for over half the food production in developing countries. The major component of women's labour in crop production is utilised in transplanting, weeding and harvesting activities (Figure 4). These activities are arduous, time-specific and critical operations, and determine the productivity of crops. According to one study, of every 100 ''man-hours'' in various agricultural operations, 74 are woman-hours [Shailaja and Ravindranath, 1990]. Women generally are not involved in activities where bullocks are used such as ploughing and transport. Studies on agricultural operations show an increasing involvement of women in crop production [Padmanabha, 1981; Ratna Nanda, 1991]. However, the role of women in the planning of agricultural development is marginal.

2.4. Women in non-timber forest produce (NTFP) collection

NTFP in some parts of the country is a major source of income and nutrition. Data from Bankura South division in West Bengal where the Joint Forest Management (JFM) programme is successfully operating shows that a variety of products are collected primarily by women [Narain, 1994]. While wild mushrooms are collected by men, women help in the collection. Sal *(Shorea robusta)* leaves and seeds, tendu *(Diospyros melanoxylon)* leaves, mahua *(Madhuca indica)* flowers and seeds, and medicinal plants are all exclusively collected by women and girls. The

Table 1. Biomass fuel consumption in different agroclimatic zones

Agroclimatic zone	Fuel consumption (kg/capita/day)			Fuel mix (%)		
	Firewood	Crop residue	Dung-cakes	Firewood	Dung-cakes	Crop residue
Western Himalayan	2.0	0.1	0.2	87	13	-
Eastern Himalayan	1.7	-	-	77	7	15
Middle Gangetic	0.8	0.7	0.5	39	34	26
Upper Gangetic	0.4	0.4	0.4	19	79	3
Trans-Gangetic Plains	0.4	0.1	0.7	30	43	27
Eastern Plateau & Hills	1.6	-	-	93	-	7
Western Plateau & Hills	0.8	0.4	0.5	59	10	31
Southern Plateau & Hills	0.6	0.3	0.2	47	12	41
East Coast Plains & Hills	0.6	0.1	0.1	45	21	34
West Coast Plains & Ghats	1.3	0.2	-	78	12	10
Gujarat Plains & Hills	0.9	0.3	0.2	62	16	22
Western Dry Region	1.1	-	0.4	45	45	10
Lower Gangetic	-	-	-	55	25	30
Central Plateau	-	-	-	52	34	14
All-India	-	-	-	59	18	23

Note

Based on Integrated Rural Energy Programme estimates. Source: TEDDY, 1999.

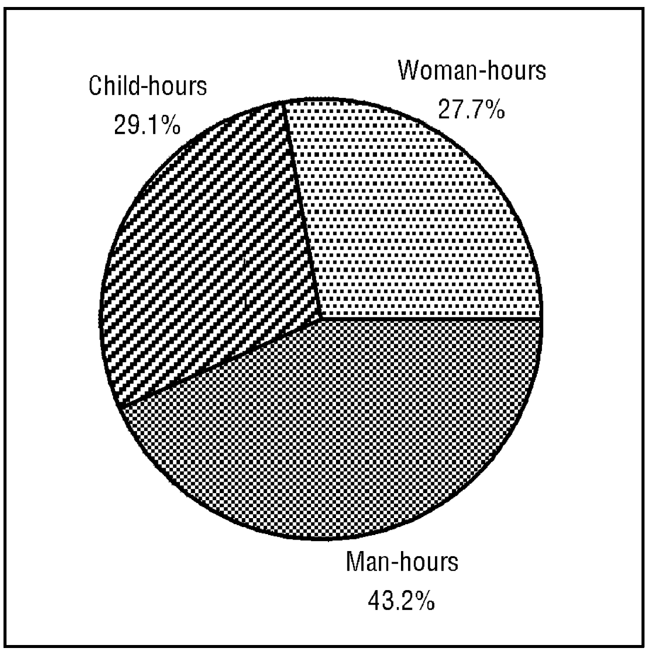

Figure 2. The percentage of total woman-, man- and child-hours spent in fuel-gathering in a semi-arid region of Karnataka

Source: Shailaja and Ravindranath, 1990.

price of sal seeds is Rs.1 per kg (Rs. 43 = US$1). 1 kg of seeds is also exchanged for 1-2 kg of salt. In about 2 hours women collect about 4 to 5 kg of seeds. For 8 hours of collection women earn about Rs. 10 to 15. Mahua flowers fetch about Rs.3 to 6 per kg and each household collects up to 100 kg per season (3 months) and earns up to Rs. 600 to 800. Similarly tendu leaves are sold at Rs. 10 for 2000 leaves and sal leaf plates at Rs. 2.5 for 100 [Narain, 1994]. Mushrooms fetch Rs. 20-35 per kg [Narain, 1994].

Women also sell head-loads of fuel wood in nearby towns. For some women this is the sole source of income. It is estimated that in India about 2-3 million people, of whom the majority are women, are engaged in selling head-loads of fuel wood [Venkateswaran, 1992]. Women also contribute a share of the labour in forest-based industries such as nurseries, plantations, logging, and wood-processing. There are very few studies on how much women depend on NTFP, particularly flowers, seeds, leaves, fruits, and medicinal plants, for their livelihood. However, women are often the main collectors, sellers and users of NTFP and this activity involves walking and transportation. In 1986, NTFP accounted for nearly two-fifths of forest departments' revenue and three-fourths of net export earnings were from forest produce. The bulk of labour involved in the NTFP economy came from women [Venkateswaran, 1992]. According to a report [Kaur, 1988], in Manipur 87% of the total population depends on NTFP as the major source of income and for about 65% of women, it is the only source of livelihood. Approximately 572 billion woman-hours per year are estimated to be spent in forest-based enterprises and about

90.5% of these in small-scale enterprises involving NTFP as raw material [Kaur, 1988]. Sal and tendu are the major NTFP and earn good money. It is estimated that annually about 350,000 tonnes of tendu leaves are harvested by 600,000 women and girls [Narain, 1994]. NTFP collection is one of the major employment and income sources for rural women and rural households as well in some parts of the country. Besides, women use various forms of NTFP to supplement the nutritional status of the household. Detailed information needs to be collected on the role of women in NTFP harvesting and marketing activity and the problems involved therein because there is a major gap in the data.

2.5. Involvement of women in other activities

Women participate in construction activities and small-scale production units such as brick- and jaggery-making. These jobs essentially involve transportation, such as in carrying materials from one place to another, or long hours of sitting, such as in *agarbatti* (incense-stick) preparation and weaving.

2.6. Contribution of women to the village ecosystem

Women work for longer hours than men. A study shows that women's contribution is twice that of men [Shailaja and Ravindranath, 1990]. In domestic activities and animal care women exclusively put in their labour (energy) and manage the biomass resources. These are not paid activities and hence do not contribute to the household economy. In crop production women spend substantial time and energy. Women form a major labour force in crop production. A study in a Himalayan village has shown that out of the 92 main workers 50 are women [Agarwal et al., 1999]. However, they earn between Rs. 25 and Rs. 30, depending on the type of work and region, for an 8-hour work day, while men earn between Rs. 35 and Rs. 40 for the same activity. Their long hours and hardship in the village agricultural economy are inadequately shared by men. Their contribution to the household economy through NTFP collection is significant. Rural women continue to work throughout the year irrespective of the season.

The above analysis shows that the chief source of energy which women depend upon in India is biomass, which is a traditional, renewable resource. They also rely on their muscle power as a source of mechanical energy to perform various activities which contribute to the functioning of the village ecosystem.

3. Sources of biomass energy

Women use diverse types of biomass, depending on the type of activity. Trees, shrubs, crop residues, and dung are examples of sources of biofuels used by women. About 253 million tonnes (mt) per year of biofuels are estimated to be used in the rural areas in the domestic sector (Figure 5). Out of this 181 mt is estimated to be fuel wood, 40 mt crop residue and 32 mt dung cake [Joshi et al., 1992]. While the forests contribute about 32% of fuel wood, the rest comes from various sources such as plantations, crop land, common land, homestead gardens, trees and shrubs along roads, canals and streams (Table 2). Sawdust and wood chips from forest-based industries are also used as fuel. The quantity of these fuels is not known.

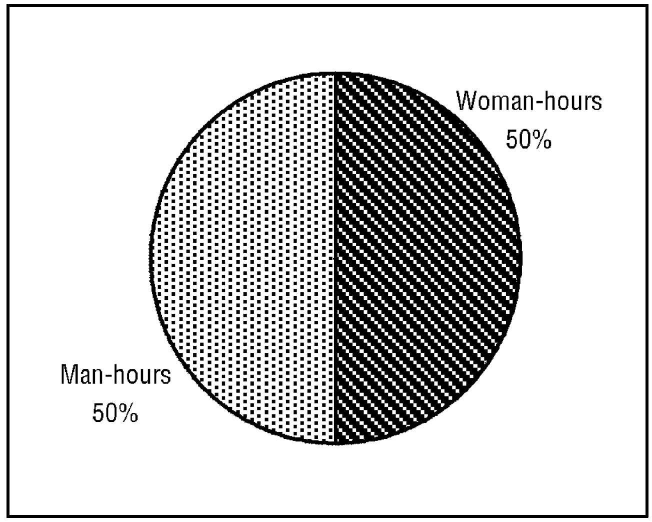

Figure 3. Comparison of woman- and man-hours spent in grazing. (Woman-hours include child-hours.)

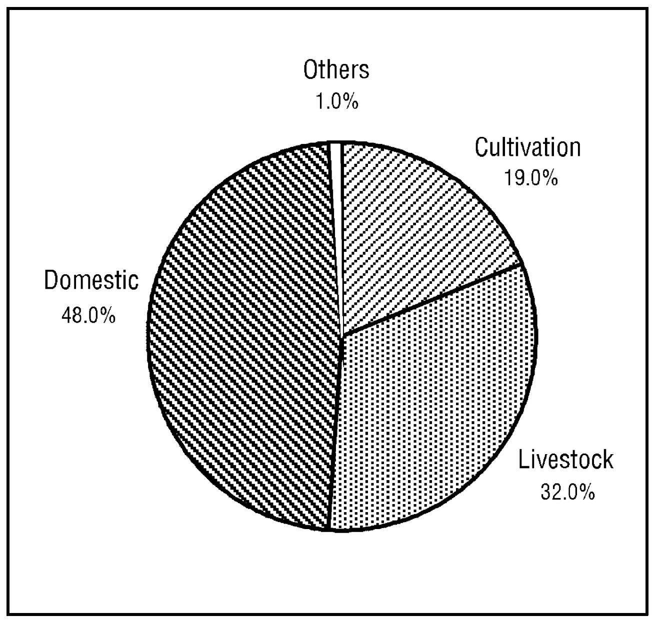

Figure 4. Women's energy use in different sectors of a semi-arid village in Karnataka

Source: Shailaja and Ravindranath, 1990

The fuel potential per year of crop residues is estimated to be 52 mt. However, only about 40 mt/year of crop residue is used as fuel. The major crop residues used as fuel in India are pigeon-pea; residues of oilseeds such as groundnut, castor, coconut and arecanut; and stalks of cotton, mulberry, coffee and tea. The type and the quantity varies depends on the area and season. With the total bovine population of 288.24 million in India (1992), the potential dung-cake production per year is estimated to be 123 mt of air-dry weight. Just about 26% of this is used as fuel [Ravindranath and Hall, 1995]. An NCAER study of 1992-93 has shown that the share of biofuels such as crop residues and cowdung may not increase and hence

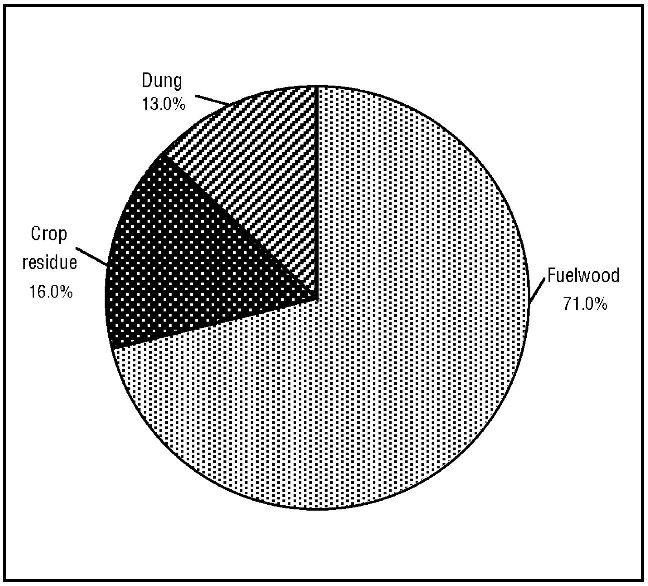

Figure 5. Percentages of various biomass fuels consumed in the domestic sector. The total quantities consumed per year are 181 million tonnes (mt) of fuel wood, 40 mt of crop residue and 32 mt of dung.

Source: Joshi, et al., 1992

Table 2. Cooking fuel and supply

Cooking fuel sources	Supply/availability (mt/year)
Firewood from trees (twigs + branches + cut wood)	
Forests	70.5
Degraded land	26.4
Tree plantation	40.0
Crop land trees	46.0
Homestead gardens	16.0
Firewood from shrubs	19.6
Total	218.5
Crop residues	52.0[1]
Dung	123.0[2]

Notes

1. Available as fuel.
2. About 26% is used as fuel, the rest as manure.

Source: Ravindranath and Hall, 1995

not help in supplying the growing energy demand [Agarwal et al., 1999]. The stagnation of the cattle population in India for some time due to the acute fodder shortage and the increasing number of biogas plants have reduced the availability of dung for dung-cakes. Dung-cake usage has fallen from 22.5% to 14% from 1978-79 to 1992-93. The NCAER study also reports a reduction in the usage of crop residues from 17.4% (1978-79) to 13.35% (1992-93). This is because the hybrid crops cultivated yield a lower proportion of stalks. But the share of fuel wood in the form of logs has gone up from 18.95% (1978-79) to 32.49% (1992-93), according to the NCAER report [Agarwal et al., 1999]. This is attributed to invasion by *Prosopis juliflora*, an exotic species, forest protection and the practice of agro-forestry by many rural communities in India, and decreasing urban demand to a certain extent.

Women depend on biomass for, besides cooking, fodder and NTFP. In the case of dry fodder, the annual requirement is estimated to be 353 mt [Mudgal and Pradhan, 1988]. But the available dry fodder is 308 mt [Ravindranath and Hall, 1995]. Out of 308 mt about 286 mt of dry fodder comes from crop residues and the rest from crop land bunds, plantations, forests, and village common land. Similarly, a large proportion of NTFP is collected from the forests. Only a small proportion comes from village common lands, crop lands, homestead gardens, roadside trees and shrubs. However, the exact quantities are not known.

4. Characteristics of rural energy and its impact on women

As mentioned earlier, biomass is the principal source of fuel and women's energy (muscle power) is the chief source of mechanical energy. The basic features of the energy consumption pattern in rural areas are a high degree of inefficiency, low productivity and attendant health problems. In urban areas, women have access to other sources of energy such as kerosene, LPG, and electricity. The per capita consumption of energy for the same activity for the urban poor is less than that for the rural population. To understand these features, it is essential to understand the nature of work women perform and the technologies and devices women use.

4.1. Fuel-gathering

High quality cooking fuels such as kerosene, LPG, and electricity are expensive and not easily available to rural women. Biomass hence continues to be the major cooking fuel source in rural areas. According to a study carried out in 1985 by the Advisory Board on Energy, fuel wood consumption will increase up to 300 to 330 million tonnes by 2005 [Agarwal et al., 1999]. Rural women gather fuel wood from their farms, other farm land or common lands. Degradation of village common lands in some areas has led to the decline of fuel wood sources. While the large farming families either purchase or procure fuel from their own land, women belonging to landless, marginal farming families and tribals suffer more. Sometimes forest guards either take a part of the fuel wood collection or a small amount of money from fuel-gatherers. Women collect head-loads from forest lands if there are forests near by. According to reports the price of the fuel wood per tonne is stabilising. However, it was Rs. 1,200 to 1,600 in 1999 in the rural and peri-urban markets, too expensive for rural women. Hence, women spend more time and walk longer distances in search of fuel. Studies conducted during 1983-84 have shown that women walk about 4-10 km per collection trip. Women went on collection trips every day, once in two days or twice a week [Agarwal, 1986], depending on the fuel requirement and availability in the region. The NCAER study of 1992-93, however, does not show to what extent the increase in log consumption has shortened these fuel-gathering trips.

4.2. Fuel quality

The quality of fuel varies with each agroclimatic zone but within one agroclimatic zone, there is little variation in the type of fuel used by the households. The calorific value of fuelwood varies from 15,000 to 19,000 kJ/kg of oven-dry wood, that of crop residue is 12,500-17,000 kJ/kg and dung is even lower around 12,500 kJ/kg. Low-density fuels have low calorific value. This only means that a large quantity of fuel is needed for cooking and it needs continuous feeding and tending by women. If the moisture content in the fuel is high, incomplete combustion takes place, thereby increasing emissions. Women prefer logs to other biofuels such as twigs, crop residues and dung-cake. But when it is difficult to obtain logs women use twigs, crop residues, dung-cake and even dry leaves (Figure 6). In some districts of West Bengal where logs are not easily available women collected leaves of *Acacia auriculiformis* for cooking during the mid-1980s [Agarwal et al., 1999].

In dry lands of India *Prosopis juliflora*, an exotic species which has spread widely, has become the main source of fuel. But harvesting and gathering wood from *Prosopis juliflora* is a difficult task. As the plant is thorny, women suffer in the process of collection.

4.3. The forests and the fuel

The total area under forests in India during 1997 according to the Forest Survey of India (FSI) was 62.86 Mha, which is 19.12% of India's geographical area [FSI, 1997]. Considerable forest area was lost before 1982, but the area has been stabilizing since 1982. A marginal decline of 0.07%, i.e., 47,500 ha, in the forest area between 1982 and 1988, most of it taken over for river valley projects, and an increase of 0.8% of the forest area annually between 1988 and 1990 indicate that progress is being made in forestry programmes [Ravindranath and Hall, 1995]. Although there is no significant shrinkage in the forest area, there is qualitative degradation [WRI, 1995a]. The per capita forest area also has decreased to 0.075 ha. Taking all forest types into consideration, the mean standing biomass is 126 t/ha [Ravindranath et al., 1992]. One estimate of increment of forest biomass is 138 mt. Out of this 42 mt is twigs and branches [Seebauer, 1992]. The above analysis indicates that the forests can supply fuel wood in the form of twigs and branches which are low-quality fuel.

4.4. Wood fuel use and deforestation

Out of the total 227 mt of fuel wood used in India, about 22% comes from forest harvests and degraded land. The remaining 78% of the fuel wood comes from illegal cutting of trees, which has contributed to forest depletion [FSI, 1988]. However, other studies do not provide evidence of the deforestation caused by rural and tribal people meeting their firewood requirements. On the contrary, there are reports which point out that the harvesting of twigs and branches by the local community has led to profuse growth of trees and in turn sustainability. According to a recent national study [Seebauer, 1992], ''Illegal cuttings were not so rampant in primary forests or in plantations.'' It should be noted here that the urban fuel wood demand, generally in the form of logs or cut wood [Ranganathan et al., 1993], and the demand from industrial establishments contribute more to forest degradation than the rural cooking fuel demand. There is an assumption that at global level one-eighth of the net deforestation results from cooking fuel needs [Ravindranath and Hall, 1995]. There are reports to show that fuel-wood gathering may not contribute to either biodiversity decline or land degradation.

Figure 6. Low-quality biomass fuel gathered and transported largely by women and girls

Figure 7. Traditional stoves and smoky kitchens

Figure 8. Women transplant rice in large tracts of land by hand, in knee-deep slush and with bent posture

4.5. Impact of cooking on health

The wood-burning cook-stove is the major cooking device that most rural women use. Traditional cook-stoves have 2 or 3 pot-holes (Figure 7). There are some minor variations in the stove design across the country. Traditional fixed mud stoves predominate in rural households. Few households use portable stoves. The design of the stove leads to high radiation losses, thus reducing the thermal efficiency of the stove, which is of the order of 10% to 15%. Fuel consumption is, therefore, high in these stoves. Because of this inefficiency the cooking time increases. A study conducted in a village in South India has shown that the cooking time ranged from 3.3 to 4.6 hours per household per day [Reddy, 1982]. Another study in 10 villages in Gujarat state showed that about 3.1 to 3.4 hours are spent on cooking per household per day [Veena, 1988]. Traditional cook-stoves do not have chimneys and hence emit smoke into the kitchen, particularly in the cooking zone. Added to this, the house and kitchen design features, such as low roofing, poor ventilation, and close settlements, aggravate the problem of smoke. Cooking is inconvenient in smoke-filled kitchens. It creates health problems. Biomass fuels emit 6 major pollutants, viz., particulate matter, carbon monoxide, oxides of nitrogen, formaldehyde, sulphur dioxide and benzopyrene. In addition, hundreds of other simple and complex organic compounds including polyaromatic hydrocarbons are also emitted [WHO, 1992]. In biomass combustion, exposure to particulate matter is between 17 and 26 mg/hour/m^3. It is even higher for dung-cake. In the case of LPG and kerosene exposure to particulate matter is 0.4 mg and 2.4 to 3.6 mg respectively [WHO, 1992]. For every kg of wood burnt, 40 mg of carbon monoxide, 2g of particulates, 1mg of benzopyrene and 200 mg of formaldehyde are emitted [Agarwal et al., 1999].

In order to reduce the cooking time, women increase the burning rate, which increases the indoor emissions and decreases thermal efficiency. Studies on precise correlations between the biomass emissions and the specific health effects are few because the effect is not immediate. The suspected adverse effects of smoke are impaired lung function leading to chronic obstructive pulmonary disease, acute respiratory infection, chronic bronchitis, and damage to the eyes leading to impaired vision. A study shows that about 23% of women using biofuels suffer from respiratory diseases, as against 13% using kerosene and 8% using LPG [Dutt et al., 1996]. According to an estimate made by Smith in India in 1989, about 0.9-3.6 million deaths out of 8.2 million deaths every year in India are caused by particulate matter present in the air [Smith, 1987]. Rural women are the most exposed to particulate matter in developing countries. Particulate matter concentration in rural households is about 551 kg/m^3, which is 9 times higher than in developed countries. It is almost twice as high as outdoor particulate matter, which is 278 kg/m^3 [Smith, 1993]. A study in India has recorded almost 50% greater chances of still-birth in pregnant women cooking on traditional wood-burning stoves [Mavalankar, 1991]. Indoor air pollution can affect new-born babies. It can affect their immune system and make them more susceptible to diseases. Cor pulmonale (enlargement of heart) is found to be prevalent in non-smoking women who cook on wood-stoves in India [Padmavati and Arora, 1976]. However, it is not clear if lung cancer is caused by biomass smoke inhalation. A number of studies on air pollution monitoring show that human exposure to biomass pollutants often exceeds the levels recommended by WHO by a factor of 10 to 20 or even more [Smith, 1987].

There are adverse effects of biomass use on the health of women in each part of the fuel cycle, starting from production, collection, and processing to combustion. There are concerns about the ill effects of indoor emissions among researchers, development workers, and decision-makers. Health concerns about other parts of the fuel cycle such as fuel collection and processing activities, which cause faecal and enteric infections, skin diseases, trauma, allergic reaction, severe fatigue, and snake/insect bites, need to be addressed. The heat from biomass combustion is reported to cause eye cataract. About 18% of blindness in India is caused by biomass-burning [Mishra et al., 1997].

4.6. Health impacts from fuel shortage

In order to manage the fuel shortage and the cumbersome cooking process, women reduce both the number of times a day they cook and the quantity of cooking. They even substitute nutrient-rich food with less nutritious but faster cooking foods [WHO, 1991]. These strategies increase the risk of food-borne diseases. Intake of nutrients such as vitamins, minerals, and energy will reduce as a result, thus impairing the absorption of proteins. In rural areas, the traditional practice is that women eat last after serving men and children. As a result women from poor families do not get the required quantity of food. This reduces their energy intake which does not match their energy expenditure, which is always higher.

4.7. Impact of other biomass-related activities on health

There are studies to show that long hours of standing in a half-bent posture during transplantation, weeding and harvesting lead to ill health, intestinal infections and crippling ailments such as rheumatic joints and arthritis. Working long hours in slushy soils causes burning of fingers and toes, and nail infections (Figure 8). Activities such as fetching water, fuel and other transportation activities involve walking long distances carrying headloads. This may cause severe pain in legs and heels, and splitting of heels, besides fatigue, especially during summer [Mencher and Saradamani, 1982].

4.8. Women and non-fuel biomass

Non-fuel biomass includes mainly fodder and NTFP. Grazing and fetching fodder for animals are the major women-dominated animal care operations. Fodder availability is decreasing. Out of the total fodder requirement, about 285 million dry tonnes per year comes from crop residues. Every hectare of non-cropland area can support just about 2 head of livestock. The low productivity of grass of 0.4-1.6 tonnes per hectare per year [Ravindranath and Hall, 1995], coupled with the dominance of non-palatable exotic species such as eupatorium and parthenium, is narrowing the fodder base for women belonging to tribal, landless, marginal and small farming families. Overgrazing and increase in cross-breed livestock have led to increased stall-feeding, which has only increased the workload of women in fetching green fodder for animals.

There are few studies to show the drudgery of women involved in other NTFP collection. Data from West Bengal shows the struggle of women to collect sal seeds, which fetch Rs. 16 for 8 hours of collection [Narain, 1994]. The disappearance of a wide range of these NTFP such as plant medicine, flowers, fruits, and leaves and limited access to these resources have narrowed their small income-fetching seasonal activity and thereby threatened their livelihood. Because of the Green Revolution the yield of the desired part of the plant has increased. Men, who are anxious to increase the yield of marketable products, try to minimize the straw component, which has low market value. But straw is an excellent fodder for livestock. The Green Revolution has further increased the labour women have to put in in livestock maintenance. Improvements in irrigation systems are catalysing changes in the cropping pattern from diverse crop species to monocultures of cash crop varieties. There is a fear that this change in cropping pattern may reduce the food availability at the local level. This will only increase the dependence of women on men, even for food grain supply and small cash.

4.9. Women and education

The female literacy rate is low in India. About 39% out of the total population of women are literate in India. Women's literacy in rural India is still lower. This limits their access to technologies. Female extension workers are also few, due to low literacy levels and social constraints. In Punjab, while there has been considerable improvement in farm technology, such as tractors and threshers, for activities performed by men, there is hardly any improvement in cooking devices. In addition, development schemes rarely address women's issues even though women play a major role in the rural economy.

Thus, the working environment of women, and technologies, devices and energy sources that women use have not improved much in the past two decades despite the vigour in technological, social and economic advances. Rural women still continue to use their muscle power largely as the source of mechanical energy. Almost all activities that women carry out, such as cooking, fetching water, fuel, fodder, harvesting, and transporting are laborious, time-consuming, back-breaking and strenuous, leading to inefficiency, drudgery, and loss of productivity, and causing serious health problems.

5. Rural energy programmes

In recent years, the concept of sustainability has been incorporated as a rule in most developmental programmes. This means any developmental programme has to address the objectives of sustainability such as need, equity issues, empowerment, self-reliance, environmental soundness, and economic viability. Energy strategies are key to such developmental activities. Let us examine how various energy-related programmes leading to sustainable development have helped women.

Even before the realisation of the energy crisis in 1970, India had planned out programmes related to energy. In fact, it was M.K. Gandhi who first brought out the concept of cook-stoves before Independence as a major tool to improve the living conditions of rural women. India had programmes on improved cook-stoves, biogas and energy plantations during the 1950s. During the first oil crisis, India realised the importance of renewable energy resources which would reduce its dependence on oil imports. India has an independent Ministry for Non-Conventional Energy Sources (MNES). The objectives of this Ministry are to improve the quality of life, provide opportunities for economic development in an environmentally sound manner and reduce the existing health hazards, drudgery and inefficiency of traditional bioresource use. All these objectives address the problems of women. To what extent are these objectives of MNES fulfilled through its programmes?

The major programmes of the Ministry are related to wood fuel and other non-renewable energy sources such as solar, wind, and micro hydel. The focus of MNES is, therefore, to initiate and develop renewable energy sources and technologies in order to meet the growing need for energy. "They are renewable and indigenous and these sources provide clean energy and help in preserving the environment and ecology" [MNES, 1993]. About 62% of the budget for the Eighth Five-Year Plan (1992-97) was allocated to biomass-related programmes. Wood fuel programmes included:

1. fuel conservation through biogas and improved, fuel-efficient cook-stove technologies;
2. conversion of low-quality energy to high-quality energy, i.e., solid fuels such as wood to liquid or gaseous fuel through various technologies such as biomass gasification; and
3. raising of energy plantations to increase fuel-wood supply.

The funds were used for research, technology development and dissemination. Even during the Seventh Five-Year Plan (1985-1990) research related to improved stoves, biogas, biomass gasification and energy

Figure 9. SWOSTHEE – a portable improved stove in Karnataka

plantations [MNES, 1993] was initiated.

5.1. Improved cook-stoves

As discussed earlier, rural women have limited access to conventional energy sources. The dependence of rural women on biofuel is hence increasing. The consumption of fuel wood is expected to increase to about 300-330 mt in 2005 [Agarwal et al., 1999]. The improved cook-stove therefore receives the topmost importance and priority today.

In India, Magan *chulha* (a wood-burning stove) was the first improved cook-stove to be developed, in 1947, followed by the HERL *chulha* (a stove developed by Hyderabad Engineering Research Laboratory, HERL) in 1953. These stoves primarily aimed at the removal of smoke from the immediate vicinity of the cook and had other health benefits. Thus, to start with, improved cook-stoves considered the drudgery in cooking the primary problem to tackle. These stoves did not gain much importance and therefore were not disseminated in large numbers. Nada *chulha* was the first improved stove to gain popularity, in 1980 [Sarin, 1990]. Local women of Nada village in Haryana were involved in its development.

In 1983, ASTRA stoves, developed by the ASTRA (Application of Science and Technology to Rural Areas) group of scientists from the Indian Institute of Science, Bangalore, became popular in Karnataka [Ravindranath et al., 1989]. Encouraged by these developments, a full-fledged National Programme on Improved Chulha (NPIC) was initiated in 1985. It had the following multiple goals:

1. to conserve fuel;
2. to reduce smoke in the cooking zone and to improve health conditions;
3. to reduce deforestation;
4. to reduce the drudgery of women and children;
5. to reduce cooking time; and
6. to improve employment opportunities for the rural poor.

The most important aspect of this programme was energy-saving. The problem of the drudgery of cooking, which was the main consideration in earlier programmes, was pushed to second place. Stoves which had a minimum efficiency of 20% (fixed stoves) and 25% (portable stoves) were branded ‘‘improved stoves’’ and were included for dissemination in this programme [MNES, 1993].

Today about 35 fixed designs and 16 portable designs of family size improved stoves (ranging from single pan to three pans) are being disseminated in India. These stoves are designed to reduce the heat losses through convection and radiation, thereby improving the fuel efficiency. These improved designs also have chimneys which help in reducing indoor pollution. Some of the stove designs, such as ASTRA and SWOSTHEE (single pan portable stove designed by ASTRA scientists – Figure 9), are highly efficient. The field efficiency recorded for these stoves ranges from 28 to 35%. The majority of the stoves built are mud constructions with some steel components. With proper maintenance, the life of the stove could be around 5-8 years. About 28.5 million improved stoves were built in India by March 1998 [TEDDY, 1999]. The Government (Central and State) is the dominant disseminating agency for these stoves. Various other agencies, such as voluntary agencies, autonomous organisations, individuals, and small entrepreneurs, disseminate the stoves on a small scale. Subsidies in the range of Rs. 50-75 per stove are provided by the MNES depending on the location and socio-economic condition of the household [TEDDY, 1994]. In addition, State Governments also provide small subsidies. However, the pattern of subsidies has been rationalized in the past few years to encourage market support. Improved stoves are estimated to save about 11 mt of fuel wood equivalent every year [TEDDY, 1999].

5.1.1. Benefits of the improved stoves

Studies conducted on fuel savings by measurement method on various improved stoves in Karnataka, Rajasthan, Haryana, and Tamil Nadu show the saving ranges from 25 kg to 153 kg per capita per year. Ministry of Environment and Forests data (1993) based on the studies at various locations showed a saving of about 116 kg per capita per year. According to Ravindranath and Hall [1995], at the national level, about 60% of the stoves disseminated are in use and the fuel saving ranges from 19 to 23%. The stoves, therefore, have contributed to energy conservation to a certain extent. More importantly, the

Figure 10. Small kitchens and large stoves – ASTRA stove in Karnataka.

fuel wood saving is expected to reduce the time and drudgery involved in fuel-gathering.

Smokelessness is another major feature of these improved stoves. About 70 to 80% of improved stoves are reported to have reduced the smoke in the immediate cooking zone. Women at various places have expressed their liking for the stove only because of the smokelessness. In fact, in many areas, smokelessness seems to be the primary factor for the adaptability and usability of the stoves [Sarin, 1990]. This shows the priority of women and their concern about the drudgery aspect. Actual measurements to show that there is significant reduction in indoor smoke are few. Despite the chimney, there is some amount of leakage of smoke in the cooking zone. Some studies have shown that the best reduction of smoke that can be achieved is about two-thirds [WHO, 1992]. There is a certain amount of reduction of smoke in the cooking zone.

Not many studies have looked into the aspect of saving in cooking time. In Karnataka, about 81 to 93% of housewives reported reduction in cooking time. Measurements of cooking time with ASTRA stoves in Karnataka showed a reduction of 25-36% [Ravindranath et al., 1989]. There is a reduction in cooking time with the Nada *chulha.* About 24% of Nada *chulha*-users have liked this feature of the stove [Sarin, 1990]. Saving in cooking time is an important aspect for women in improving their quality of life. Women can either spend more time in economically productive activities or can relax from their domestic chores. But this aspect is rarely considered an important feature by researchers and policy-makers. ‘‘What will women do with the spare time’’ was the remark made by one women’s organisation! One must remember that the reduction in cooking time reduces the exposure period of women to smoke and drudgery.

Some of the stoves also offer such benefits as cleaner or brighter kitchen walls due to chimneys, reduced fire hazards, and cleaner vessels, which are important from women’s point of view.

5.1.2. The problems involved

- *Dissemination period*

  The average number of stoves constructed per year in India has increased from 2 to 2.5 million since 1993. About 120 million improved stoves are required in India, including the urban demand [MNES, 1993]. At the rate of 2.5 million stoves per year, 37 years may be required to provide stoves to the remaining 91.5 million households considering the fact that about 28.5 million stoves were built by March 1998. Lack of trained human resources and lack of financial and infrastructure resources essential for construction and servicing are the reasons for this delay.

- *Stove design*

  Some stove designs are quite sensitive to dimensions. Even small changes may affect operational aspects such as efficiency and smoke emissions. Some stove designs have large dimensions and are specific to fuel type or vessel size. These are not appropriate features if large-scale dissemination is planned (Figure 10). In cases where the chimney is not cleaned regularly, the unburnt highly inflammable carbon particles settle down on the inside surface of the chimney and create serious fire hazards. If not constructed properly, the stoves consume more fuel and time compared with the traditional stoves and emit smoke in the cooking area. This results in the rejection of stoves. An NCAER

Table 3. Renewable energy technologies in India

Systems	Estimated potential	No. of installations up to March 1997
Improved cook stoves	120 million	23.7 million
Biogas plants	12 million	2.5 million
Solar cookers	–	0.43 million

Source: MNES, 1999

report [1992] shows only 14-15% rejection. But Ravindranath and Hall [1995], on the basis of various reports, give a figure as high as 40%, which means a rejection of approximately 11 million stoves. An evaluation study by the NCAER for the period 1992-95 has shown that nearly 25% of stoves installed stopped functioning within one year after the installation and stoves were not maintained properly [MNES, 1999].

- *Training and monitoring*
  Improved stoves require proper training in construction and appropriate user education. Monitoring and evaluation of the stoves for quality control is necessary. In a vast country such as India, where there is lack of resources, allocating resources for training and education, monitoring and evaluation becomes difficult. In addition, disseminating bodies delay decisions, or take improper decisions such as building stoves in houses where there are no human dwellings. Funds also leak. The stove usage pattern shows that there is a clear lack of understanding among researchers of the socio-administrative and economic systems that operate in India, their strengths and limitations. Lessons learnt on stove designs, training and educational inputs during the stove evaluation and monitoring studies are not incorporated in the programme improvement. Many stove designs are not based on the requirement or convenience of women.
- *Cost*
  The cost of the improved stove varies according to the design. For example, the ASTRA stove costs about Rs. 150 to Rs. 170, including the steel and labour components. For poor households with earnings of Rs. 20-30 a day, this cost is high because traditional stoves cost nothing. The financial benefits the improved stove offers through the fuel savings do not influence the poor because they gather the fuel. Even for households that purchase fuel wood, the financial benefits are not attractive because they are not immediate, taking at least 3 to 6 months to cover the cost. In spite of the subsidy, the cost is high for socially and economically weaker sections of society. Some investigators recommend providing loans for the purchase of cook-stoves [Ravindranath and Hall, 1995]. Cooking is always considered the problem of women. It is economically a non-productive activity. Hence men do not even consider the idea of taking loans for stoves. The majority of women legally do not own any property and hence are not considered for loans.
- *Lack of information*
  Information about the improved stove programmes and designs is not readily available. Details of the cost of the stove, the benefits derived, and whom to approach are not known to many rural households. They are not informed about problems associated with the design. Women are not given information that will help them to choose the type of improved stove they would like to own: on a variety of improved stoves developed elsewhere, about the design, the cost, the benefits and the problems. There is a wide gap in the information flow on improved stoves.
- *Accessibility*
  Most stoves have components that are not readily available in the local markets. Even some portable stoves are not readily available in the local markets, for example SWOSTHEE stoves in Karnataka (Figure 10). Most stoves require trained builders because of their structural complexity. In places where people want to construct them, the stove materials and builders may not be available readily.

Some of the stove designs have been successful in the field. However, research, training and information dissemination have to be strengthened in this programme. Most importantly women must be involved from the conceptual stage to the implementation and dissemination stage to sustain the programme and improve the quality of stoves. This programme will reduce energy (fuel)-related problems of women to a large extent if managed properly, involving women as decision-makers.

5.2. Biogas programme

This was the dominant bioenergy programme in India especially in the Eighth Five-Year Plan, accounting for 37% of MNES funds. The objectives of the National Programme of Biogas Development (NPBD 1981-82) are to provide clean cooking energy, produce enriched manure, improve the quality of life of rural women and improve sanitation and hygiene.

The biogas programme in India is based on the resource of cattle-dung. Between 59% and 80% of rural households in India own cattle [Ravindranath and Hall, 1995]. The biogas programme includes both family-sized biogas plants and community or institutional biogas plants. While the objective of family biogas plants is to provide clean and convenient fuel for cooking for the family, the objective of community biogas plants is to provide the benefits of cleaner, convenient fuel to the community including poorer sections of society who neither own cattle nor have funds for a family biogas plant. A national study of 500 family biogas plants showed that about 60% of them were owned by small and marginal farmers having less than 2ha of land, and people belonging to Scheduled Castes and Tribes. (These are the most severely socially disadvantaged groups recognised under the Indian Constitution as requiring special protection.) About 38% were owned by marginal farmers. Only a small percentage were owned by large farmers.

Monitoring and evaluation of 27,000 family biogas plants in 3600 villages of 251 districts in 20 States and

Union Territories (territories directly controlled by the federal government) of India showed that about 77% of plants were functional, the range being from 25% in Delhi to nearly 100% in Punjab [NCAER, 1992]. By March 1998 family biogas plants built in India numbered 2.7 million, representing about 22.5% of the estimated potential of 12 million plants [MNES, 1999]. The physical target for India in the Eighth Five-Year Plan was 1.25 million, accounting for 250,000 plants per year. The number of community biogas plants was 2362 up to 1998, including institutional plants and night-soil plants [TEDDY, 1999]. There are 1.2 million family biogas plants targeted during the Ninth Five-Year Plan [TEDDY, 1999]. There are few studies on the performance of community biogas plants. Information is available for about 37 community biogas plants out of which 65% are working, 28% have failed and 8% were not installed [Venkataramana, 1991].

5.2.1. Impact of biogas programme on women

Most family biogas plants meet the family's cooking energy needs. Women benefit from clean cooking energy. The drudgery involved in fuel-gathering is reduced. Saving in cooking time, easy lighting, control of flame intensity, clean kitchen, and reduced fire hazards and health problems are some of the important features of this technology. However, community plants do not supply the entire cooking needs of the community due to resource limitations. In most cases, lighting needs of the households are met. This does not help women much because lighting is not their major energy need.

In Pura, a village in semi-arid Karnataka, a community biogas plant supplies electric energy for house- and street-lighting and to lift water from the well and supply it to households through pipelines [Rajabapaiah et al., 1993]. Women are happy to receive tap water near their doorstep. It has saved them the drudgery of fetching 2 pots of water per trip from a stream, which is 2km away. It has also reduced the drudgery involved in pumping/dragging water from borewells and open wells. It has also saved their time.

The biogas system will help to increase the efficiency and the productivity of women's energy. This clean cooking energy will improve the quality of life of women, and improve sanitation and hygiene, in addition to conserving fuel wood and providing enriched manure. These plants will also help in meeting household lighting needs and thus help women to do their domestic chores. This 40-year old renewable energy programme is very valuable in terms of meeting cooking energy needs of women and improving their health status.

5.2.2. Problems associated with the biogas programme

- *Lack of financial resources*
  The rate at which installation of plants in the current biogas programme is going on is 250,000 per year. At this rate it will take 37 years to achieve the potential of about 9 million family biogas plants. The funds allocated are not sufficient to develop or improve the designs, to build up human and infrastructural resources for biogas plant construction and maintenance, to offer subsidies, and to evaluate and monitor the programme.
- *Cost*
  The capital cost of the plant is high. The repair and maintenance cost of the plant is also high. The cost of a family biogas plant varies from Rs. 5325 to Rs. 10,700, according to the design. The subsidy offered by MNES (24 to 65% based on the design, size and area) has been reduced to a great extent. There are no insurance facilities against the failure of plants.
- *Other problems*
  The species and number of farm animals change from season to season in agricultural ecosystems. This may create fluctuations in dung availability. Water scarcity, gas leakage due to cracks in the construction, corrosion in the steel drums, and lack of infrastructural facilities at local level to repair plants are some of the drawbacks in the biogas programme.

While community biogas plants are an alternative, ideal method of distributing cleaner fuel, they are facing problems, similar to those of family biogas plants. In community plants, problems of benefit-sharing, equitable distribution due to inequalities in cattle ownership and lack of village-level organisation to maintain the plant are the main causes of failure.

5.3. Solar cookers

The solar cooker is another technological intervention to meet cooking energy needs. The main objective of this programme is to conserve fuel wood, to reduce atmospheric pollution, to meet the cooking energy demands of rural women and to provide them with a cleaner energy resource. Solar cookers have been disseminated in large numbers. There were about 460,000 solar cookers distributed as in March 1998 [TEDDY, 1999], while the physical target in the Eighth Five-Year Plan was 700,000. Every year since 1990 about 40,000 to 55,000 solar cookers have been disseminated. India has the largest solar cooking programme in the world [WRI, 1995a].

- *Problems*
  Solar cookers are gaining popularity in urban areas more than in rural households. This is because they are not compatible with the rural user's requirements. Solar cookers do not suit the basic cooking pattern of the rural household, including cooking timings, types of dishes cooked and the location of cooking. Solar cookers are expensive. The cost for a family size cooker is around Rs. 1600. The use of solar cookers involves cooking during sunshine hours and outside the kitchen in an open space. Rural women do not prefer this type of cooking. There is no infrastructural facility for maintenance and repair. Education and awareness regarding the use of solar cookers is totally lacking. According to the Comptroller and Auditor-General of India (1992), ''In Uttar Pradesh, sales were confirmed to urban areas whereas the main object was to reach the rural people, and in West Bengal free cookers distributed were used as box/mirror since there was no awareness generated for their proper use'' [TEDDY, 1994]. There is no information on the number of cookers that are in use. An evaluation report on

the promotion of solar cookers in rural India states, ‘‘Since tradition in cooking method plays a very major part, it is doubtful if much could be done in changing traditional methods . . . Efforts made to introduce solar cookers in villages have completely failed’’ [Agarwal, 1986]. This technology has potential but requires further research and development in order to fulfil the requirements of the users.

5.4. Other energy technologies

The other renewable energy technologies such as biomass gasifiers, wind power, and solar photovoltaics are used mainly for power generation for agricultural requirements and house/street-lighting purposes. However, these technologies do not help women much. Most of these technologies are still in the demonstration stage. Women have limited access to these gender-neutral energy technologies. Most women do not have the capacity to pay for the benefits derived from these technologies. They are also not allowed to take decisions on the payment for the benefits. Under the ‘‘India Renewable Resources Development’’ project, funded by international and bilateral sources, there are plans to establish 100 MW small hydro power plants, 85 MW wind farms and 2.5 MW solar photovoltaic plants [WRI, 1995a]. This will only help women to a small extent.

5.5. Programmes on biomass production

There are several programmes for increasing the biomass production for various needs including wood fuel. The major agency for promoting the afforestation programme is the Ministry of Environment and Forests (MOEF) in cooperation with the (states’) forest departments. MNES and several other organisations are also involved in the afforestation programme to a small extent. MNES is mainly involved in research, demonstrations, and developing a package of practices for high biomass yield.

India has one of the largest afforestation programmes in the world. Natural regeneration and plantations are the two main methods India has adopted in its afforestation programmes. Between 1950 and 1980, the area afforested was 3.6 Mha [Ravindranath and Hall, 1995]. This includes afforestation by natural regeneration in the existing tree forests, coppicing, and artificial regeneration by afforestation in the existing tree forests [Ravindranath and Hall, 1995]. After 1980, the afforested area has increased significantly. The area afforested from 1980 to 1992 is estimated to be 17 Mha. This increase has taken place due to the social forestry programme in India. This programme was launched in India during the early 1980s on the recommendation of the National Commission on Agriculture [NCA, 1976]. This has novel objectives of increasing the supplies of fuel wood, fodder, small timber and NTFP to the rural population, restoring the proper ecological balance and optimum utilization of land, water, livestock and human resources. However, the prime objective is to supply the large fuel wood demand and reduce pressure on forests [Ravindranath and Hall, 1995]. Various external agencies such as the World Bank, SIDA, and USAID have funded this programme. Community forestry on village common lands, territorial forestry on degraded forest land, farm forestry on farmers’ lands, strip or row plantations along the roads, streams and irrigation tank beds were all included in the social forestry programme. About 50% of the social forestry is farm forestry and the rest is on degraded forest and village common lands.

The major species grown in this programme are eucalyptus species, *Acacia auriculiformis, Tectona grandis, Casuarina equisetifolia, Acacia nilotica, Leucaena leucocephala.* Eucalyptus species and *Acacia auriculiformis* together form about 80% of the tree population at national level [Seebauer, 1992]. The productivity at the national level is 2-4 t/ha/year on degraded village common land and 4-8 t/ha/year on farm plantations, depending on the location, land and plantation type [Ravindranath and Hall, 1995].

5.5.1. Impact on women

The social forestry scheme sounded as if it was tailor-made for women. But it has failed to satisfy their needs. The species mix in the social forestry programme indicates that it provides only fuel wood and/or pulpwood and no other needs of the local community. The major complaint about the programme is that the wood produced in this programme is largely supplied to industries and the urban market either as pulpwood or as structural timber. Taking an average annual productivity estimate of 3.4 t/ha/year for social forestry, the annual production for 17 Mha is 57.8 mt. The assumption is that about 17.8 mt is used as industrial and structural wood and the rest is used as fuel [Ravindranath and Hall, 1995]. In the remaining 40 mt, the proportion of the branches and twigs of the trees is very high. Due to the high cost of transportation and loading problems, this portion is left behind and used by the rural poor as fuel [Ravindranath and Hall, 1995]. The quality of this fuel is low. There is inadequate data on how this fuel wood is distributed.

In terms of employment, the social forestry scheme has generated about 7-8 person-days per tonne of wood production [Ravindranath and Hall, 1995]. There are 2 levels in raising social forestry – one is raising a nursery of tree saplings and the other is planting. The nursery activity includes raising seedlings on beds, transplanting them into polythene bags, watering and weeding, and women dominate these operations. The planting activity includes earthwork, planting, harvesting and transporting the wood, and men dominate these operations. The 7-8 person-days per tonne of wood production mentioned above is limited to only planting activity. On the basis of a study done in Ungra, a semi-arid village in Karnataka, it is estimated that about 3000-3500 woman-hours may be required annually to raise and maintain a nursery having 15,000 to 20,000 saplings (Figure 11).

5.5.2. Problems

The social forestry programme has attracted criticism throughout the length and breadth of the country.

- *Species selection*

  The species selected for social forestry happen to be the main concern. According to forest departments the species selected are fast-growing, some are coppicing

Figure 11. While women dominate nursery operations, men supervise them

and hardwood, not grazed because leaves are unpalatable, their survival rate is high and planting operations cost less. The mean survival rate of saplings is 77% [Seebauer, 1992]. But researchers, NGOs and the local people feel that the forest departments prefer these features in order to supply quick wood to industries and the urban market. There are instances where shisham *(Dalbergia sissoo)* and sal were cut down to establish a plantation of eucalyptus [Agarwal, 1986]. In the Bastar area of Madhya Pradesh, about 40,000 ha of deciduous forest was to be clear-felled to plant pine forests as raw materials for the paper industry under World Bank funding [Agarwal, 1986]. There is a serious allegation that the forest departments are ‘‘tree-oriented and not people-oriented’’. This ‘‘for the people programme’’ does not supply local needs except for a certain quantity of low-quality fuel, which is a by-product of the logging operation. Social forestry is a failure today. In some areas the programme has been strongly opposed by the local people. In the Jharkhand area of Bihar state teak trees planted by the forest department have been pulled out. In some villages of Tamil Nadu and Karnataka eucalyptus saplings have been uprooted [Shailaja and Ravindranath, 1990]. The social forestry programme has not promoted biodiversity. Hence it is unable to yield diverse products in which women are interested.

- *Women's participation*
  Communities, particularly women, are not a part of the decision-making process in social forestry. In some cases the programme has faced extreme hostility from the people. According to Verma [1983], at the end of the World Bank-aided Rajasthan Social Forestry Programme all that the people of Rajasthan will have is 50,000 tonnes of corded barbed wire stretched across the heart of Rajasthan for over 100,000 km. Several cases have been reported where forest guards have not only claimed a share of the forest produce collection but have also punished collectors in physical and financial terms [Agarwal, 1986]. The majority of the collectors are women. The Madhya Pradesh Government has legal claims to teak and sissoo trees grown on private land. In several instances the government has harvested and sold the tree produce from the social forests on private lands. Fruit trees planted by the villagers have been declared government property in some cases. Thus in many places the local community, women in particular, do not want to plant trees on their private land without a written assurance.
- *Problems encountered by the forest department*
  There is about 66 Mha of degraded land in India [MOA, 1992]. The cost of the afforestation per hectare is Rs. 10,000 to 15,000 which is a low estimate considering the present method of afforestation [NWDB, 1991]. A considerable amount is spent on protection and on organisation expenses such as staff and transportation. At this rate, the minimum cost required to afforest the 66 Mha is Rs. 660 billion. The current annual funding for afforestation is Rs. 8 billion [PC, 1992]. At this rate, it will take about 80 years to afforest 66 Mha of degraded land. Another important aspect of social forestry is low productivity, particularly in the forest department-owned plantations. The productivity ranges from 1.5 to 2.6 t/ha/year. The current biological production of degraded land is lower than its potential. The afforestation programmes do not

involve fertilizer application. Forests are raised under rain-fed conditions. In addition, the soil fertility improvement is very slow because the biomass is harvested and removed from the land. Scientific methods need to be followed in selection of appropriate species, depending on the soil and climatic conditions, health of seeds and seedlings, after-care and harvesting practices, in order to achieve significant increase in the yield. Such considerations are mostly neglected at present.

5.5.3. Joint Forest Management (JFM)

Realising the importance of the participation of local communities in managing forests, a joint programme involving local communities and the forest department was launched under legislations of 1988 and 1990. The aim of this programme is to protect and promote natural regeneration in the degraded forest lands. This is considered the most democratic method. The programme was initiated in West Bengal, and is now operated in 14 states. These 14 states have 72% of the country's 75 Mha of public forest land. JFM focuses on forest regeneration for the people's needs, forest protection and management. It recognises people's involvement in forest regeneration, protection and management. JFM is based on the fact that local communities who depend on forest resources for their survival will manage the resources sustainably if empowered to manage and share the benefits equitably. ''People's involvement'' means involvement of both men and women. Women's participation is essential to achieve the goals of JFM because they spend more time in forest-related activities. Data from three districts of West Bengal show that between 1984 and 1990 about 191,750 ha of degraded forest land was revegetated through the social forestry programme [Poffenberger and Singh, 1992].

- *Women's involvement and benefits to them*

  JFM has proved successful in West Bengal where there is greater cooperation between forest department officials and the local community. It has not caught on well in other states. In some areas women cannot graze animals. They have to harvest the fodder and stall-feed the animals. This has increased their drudgery [Kaur, 1991]. In Orissa, some youth clubs have imposed a total ban on collection of firewood [Narain, 1994]. In some areas of Gujarat the forest area was closed for firewood collection by local men involved in forest protection [Narain, 1994]. Such decisions have resulted in increasing drudgery in firewood collection. In Chali village in Panchmahal district of Gujarat, women are spending 5 hours per day for the collection of firewood compared with 2 hours before JFM [Narain, 1994]. This also has resulted in more trips, walking longer distances and carrying heavy loads. This shows the lack of concern for women's problems and needs in JFM and the lack of women's involvement in decision-making. There are reports from Gujarat which say women were ''beaten by thick, heavy *dandas* (sticks)'' if they continued extracting NTFP in the forests [Sarin, 1993]. The forest department has transferred the power to local men in JFM in Chali village. As a result, it is feared that timber-yielding trees predominate over trees yielding multiple benefits. Studies show no clear effect of JFM on the increased availability of NTFP [Narain, 1994]. In Bankura area of West Bengal, while mushrooms are available in abundance, tendu and sal leaves have become scarcer. This may be due to (bad) management practices adopted. Here the trees are allowed to grow taller, reducing the availability of suitable leaves. Men are engaged in the collection of NTFP such as mushrooms which fetch more money. In this area it has been noticed that income from NTFP has increased for men and decreased for women [Narain, 1994]. Here, JFM is tending to further marginalise women. In some cases, NTFP collection by women has become illegitimate! The recent draft of the new Forest Act (1994) intends to restrict people's rights in reserved forest and to sharply limit the area of village forests [Guha, 1995]. This bill, which has been drafted to replace the Indian Forest Act of 1927, has invited adverse comments from environmentalists and NGOs. If it is passed, the bill will further attenuate women's right to access to their means of livelihood.

  It is difficult to evaluate the involvement of women in JFM and the benefits derived by them in the absence of proper data. On the basis of a few case-studies, a generalisation may be made that the involvement of women in JFM is limited and they are passive participants. There are a few instances in which the forest protection committee (FPC) has a majority of women members. Some forest areas have been protected successfully in such instances [Narain, 1994]. In Bankura area of West Bengal, where an all-women's FPC is working successfully, women are managing a nursery through which they are earning Rs. 4000 per season [Narain, 1994].

The abovementioned rural energy programmes have not benefited women significantly. These programmes have not significantly increased their efficiency and productivity and improved their health. These programmes have also not improved women's employment opportunities and income. The progress of these programmes is so slow that it is difficult to observe any measurable changes. There are several NGOs working to improve the quality of life of women in various fields such as technology dissemination, improving water, sanitation, health and nutrition status, improving the educational status, employment generation and so on. Funded by both national and international agencies, working in small pockets, most of these programmes have not made any major impact on women. Many programmes lack in-depth understanding of the roles, needs, responsibilities, problems and constraints of women. Most of the programmes are superficial and are not implemented, monitored and evaluated seriously and carefully. Many programmes do not take root. If they do, they get distorted in the field. UNFEM [UN Report, 1995] campaigns for social and economic rights for women. Now it has joined hands with various UN agencies and NGOs in launching ambitious programmes for providing credit for women in developing countries, for providing women-centred technologies and for devising technical guidelines for sustainable development programmes. However, the programme requires substantial financial assistance.

6. Gender and access to energy resources

Gender discrimination and sex stereotyping is the major obstacle to gender equity. Household responsibilities are considered essentially the domain of women even though there is no physiological basis for such considerations. The devaluation of domestic work and regarding capabilities of women as inferior are the basis of inequality. Their secondary social status holds them back from equal opportunities to those enjoyed by men in non-domestic, economically productive domains. The gender roles and status determined by the socialization process start right from birth. Cultural and religious attitudes, social barriers, and discriminatory laws have excluded women from becoming equal partners in the social, economic and political life of the nation. The outcome of this system is unequal access to resources and inefficient and economically unproductive use of women's energy, which is the most valuable human resource necessary for sustainable development. The attempts of the World Women's Conference (the most recent was the 4th UN World Conference at Beijing in September, 1995) to improve the status of women, with the goals of equity and development, are far from being implemented.

The generally accepted recent concept of ''gender and development'' views women in relation to men and not in isolation. This is unlike the earlier concept of ''women in development''. This relational concept views women as equal to men. It recognises the need for equal participation of women and men in production, management and utilization of biomass resources. It also implies that there should not be gender-based inequalities as far as access to and control over natural resources are concerned [WRI, 1995b]. Gender relations should be based on interdependence and complementarity.

Realising the importance of ''gender and development'', there have been efforts to involve both women and men in participatory programmes, particularly in JFM, in India. It has been noticed that women's participation is limited due to various factors. The gender roles within a household in every sector, from labour and responsibilities to access to and control over resources, are determined by socio-economic, educational, cultural and religious beliefs. These vary from household to household and community to community. Hence, the efforts to involve women in the development of technology or Joint Forest Management have not been very effective. Women are losing confidence because they have limited access to technology, training, education and information. Most women do not own resources, particularly land. The interests of men and women being different, the decisions that men, who are generally the head of the household, take may not necessarily be in the collective interest. This leads to skewed distribution of benefits in favour of men.

Traditionally women do not come together either to discuss or to solve their problems. Social norms prevent women from participating in community affairs. In JFM there is an assumption that women's participation in decision-making would increase their work burden [Narain, 1994]. There is no data to support this assumption. However, women should be given an opportunity to decide about their level of involvement in the decision-making process. Some evaluation studies on JFM have shown that the involvement of women as members of forest committees is marginal. It varies from 2% to 7% in states where there is joint membership. Usually men decide on the women's membership. Women in most committees are passive participants [Narain, 1994]. Women's membership seems to be more for the sake of policy and a formality. This stems from the lack of understanding of the needs, roles and responsibilities of men and women within a community on the part of governmental and non-governmental personnel and their gender perception.

There are attempts to hand over the responsibilities of nurseries to women to increase the level of their participation. However, a study by the Aga Khan Rural Support Programme (AKRSP) in Bharuch district of Gujarat showed that out of 150 nurseries, 35 were owned by women, 40 were jointly owned by men and women and the rest by men [Narain, 1994]. Attempts to increase self-confidence among women and to change the attitudes of men towards women and make them more gender-sensitive may help to correct the gender bias. There are reports that once women come out of their traditional roles, their involvement will become deeper than that of men in programmes related to sustainable development. The world famous Chipko movement has shown that women can come out of their traditional roles, lead groups effectively and can impart similar dynamism to other women. Women have been involved in watershed development committees. In a village in Madhya Pradesh women are actively participating in building check-dams and trenches, and have set up a nursery with 700,000 seedlings. They have learnt technical aspects of the watershed programme. Sitabai Choubey, the president of the committee, confidently says ''We can definitely handle the work without government help. We still don't know many things, but we will learn everything soon'' [Down to Earth, 2000]. Women have performed wonders in Andhra Pradesh by turning 280 ha of crop land into production in just 3 years using traditional farming practices. But such instances are few and we still have a long way to go before men change their attitudes and women get equal access to energy resources.

7. Future steps in energy planning

Energy is the most important factor that interlinks various components like land, livestock, vegetation, water and humans, particularly in a rural ecosystem. It is, therefore, necessary to keep in mind all these interlinkages and interdependence while formulating energy strategies for women, in particular, in order to achieve sustainable development. Energy planning is a crucial process in sustainable development, involving the estimation of future energy demands and identification and combination of appropriate energy resources and technologies. It includes both energy generation and saving options. Different approaches and various levels of involvement are necessary in energy planning. The approach should be multi-disciplinary, involving scientific, technical, educational, economic, cultural and administrative dimensions.

The present pattern of energy use, in which conventional energy sources play an important role, is non-sustainable, leading to economic and foreign exchange problems, environmental degradation, and social and gender inequity. It is not a self-reliant system. In the name of development women's access to bioenergy is reducing day by day. Raising the level of women's education and improving their skills and capacity in bioenergy production, utilisation and management, including decision-making, are not considered in the present development strategy. The poverty rate has increased by 47% among rural women over the past two decades compared with 30% among rural men. Women in rural India play a major role in biomass management, leading to sustainable development. Hence, it is important to redefine sustainable development and redesign the strategies to achieve it.

Appropriate management of bioresources leads to afforestation, and thereby reclamation of degraded land. It also promotes and protects biodiversity. It is also reduces net carbon emissions. In addition, atmospheric carbon would get fixed in the soil and standing biomass. A well-planned biomass system, therefore, can benefit rural women to a large extent. India has a good biomass base. Biomass plays a crucial role in the present energy scene and will continue to play an important role in the future energy scenario in rural areas compared with other conventional and non-conventional energy sources.

Given the scope, constraints and limitations of various biomass energy sources and technologies, what are the energy services that can be planned for women to improve their quality of life, to protect gender equity and sustainability? Two strategies are discussed here.

- Improving the present energy services with the available technological interventions.
- Designing new women-oriented energy technologies and programmes, leading to employment and income.

7.1. Improving the present energy services

7.1.1. Research and development

There is a need to take a fresh look at the roles and responsibilities, needs, strengths and constraints of women in relation to energy, to improve the present technologies such as wood stoves and forest management practices.

It is necessary, therefore, to assess the needs of women, simplify technologies in terms of design (structure), operation, and repair, and reduce costs. Simple, rapid assessment methods should be developed for monitoring and evaluating the programmes to give fairly accurate information. Improvements in the programmes have to be effected taking into account the socio-economic, educational and political structure, the present resource availability and consumption pattern of the area and also the size and scale of the programme dissemination. This will help in reducing the training requirements of builders and users. It will also simplify the quality control methods. This will promote easy adoption and rapid dissemination of the technology and hence may reduce the cost of dissemination. Research should take into account the components used in the technology. The components should be easily available in the local market. This will ensure easy continuous supply of the materials/components and help in building up financial resources in the local ecosystem. Use of local materials and skills will not only involve local people but also give people control over the programme. It will also ensure long-term sustainability. Research organisations should involve women in planning and design work in the technology improvement programme. Otherwise women may get displaced from their own domain. Once designed, the technology should not remain static. A process of improvement should go on and if necessary the technology should undergo a complete change.

In the case of cooking devices, simple procedures should be established for testing emissions. Recommended emission testing guidelines are essential for stove designers. More research is needed in the area of indoor air pollution. Aspects such as fire management, other uses of the stove, such as lighting, drying, and smoking, kitchen design, settlement space, durability, greater ease of cooking, comfortable cooking posture, and attractiveness, which are very important from women's point of view, should be taken into account while improving the design. It is difficult to meet a wide range of expectations though the interests of all women can be met to a certain extent and "The best compromise has the greatest chance of success."

As far as the production of biomass is concerned, research should aim at reducing the cost of plantation per hectare, increasing the rate of planting, increasing production and simplifying the planting and harvesting methods. Research should be undertaken on the different species mix, multi-tier forestry, density per hectare, optimum spacing, promoting biodiversity and preserving indigenous vegetation in various regions. Such forestry practices will help women in producing various biomass products including energy. They would also become a source of food, employment and income. Epidemiological research may be undertaken to assess the health problems of women associated with biomass production, collection and combustion. Research and development institutions need to work closely with the users, NGOs, private entrepreneurs, educational institutions, public health authorities and other governmental institutions in order to improve the programmes and help in large-scale dissemination.

7.1.2. Education and training

Education and training, which are lacking at present, for different actors should be incorporated into all the current programmes. The information and communication components should be sensitive to gender needs and interests.

It is essential to understand the definition of ''women's information needs'' before communication packages are developed. The rate of education and literacy is significantly low in women, especially in rural areas (30% in 1991). Hence an appropriate communication package should be devised for women based on their educational background.

Most of the improved stoves are constructed by men. Very few improved stoves are constructed by women, one example being the Nada *chulha*. Women are displaced from a domain which previously was theirs. (Traditional stoves are built by women.) This change is economically and technically disadvantageous to women. It is, therefore, essential to provide information which will empower women and build confidence in them to be more assertive in accessing and managing energy resources. ''Every adult woman like every adult man should have an equal access to information and a say in decision-making in any matter affecting her life. This right to equality is enshrined in the Constitution and needs to be respected as a human right'' [Sarin, quoted in Narain, 1994].

Women should also be involved in training processes which will strengthen their capabilities to deal with their problems either individually or collectively. The training should incorporate the technical knowledge, operational details, servicing systems, managerial skills, and health education on risk avoidance. Thus, information and training based on the educational background of women are necessary to realise their potential and contribute to programme improvement and sustainable development. Technical knowledge should be built into the training component for all the actors involved in the programme. In addition, disseminating agencies should receive inputs on the method for conducting surveys on resource needs, availability, programme monitoring and evaluation. Gender education to understand gender roles and to reduce the gender bias must be given to all the actors involved in the programme.

7.1.3. Dissemination of energy devices and technologies

The social, economic, political, cultural and educational background of the users plays an important role in the dissemination of a technology. At the moment the government is the major disseminating agency. With the problems of long bureaucratic procedures and delays in implementation, government should involve outside agencies such as NGOs, private local entrepreneurs, local organisations, and individuals in policy-making and dissemination. The government may provide funds and other incentives for disseminating agencies. Private entrepreneurs, preferably women, and entrepreneurs for women-centred programmes should be encouraged from within local communities so as to have control over the quality and also over the cost of energy services. This would promote local skills and use of local materials and help in delivering proper services in the immediate vicinity. Local commercialisation may lead to sustainability in the medium and long term.

Dissemination strategies should include some demonstrations. For improved stoves, an initial subsidy will help in dissemination, though in the long run it may lead to poor quality devices and services. This may affect the usage of the stoves. Dissemination should generate employment and income for women at the local level. There is a need to explore, publicise and disseminate programmes and technologies suiting the needs of women and developed in different parts of India. This will give women an opportunity to choose the programme/technology based on various options to suit their need, comfort and cost.

7.1.4. Social and institutional factors

The present social position of women limits their access to resources including land, information and credit. Comprising about 50% of the population and playing a major role in bioenergy management, women should have equal representation in village-level committees and organisations. The increased participation will build up women's confidence in voicing their opinions and decisions. Women should have access to and control over resources and should be encouraged to make decisions regarding a technology meant for them, in resource management, protection and benefit-sharing. Equal participation therefore will help in taking decisions leading to sustainable development. Credit facilities for women are necessary to encourage local women entrepreneurs. They will also help women install various energy-efficient technologies. Therefore, the methods to institute such credit facilities have to be worked out.

Many NGOs are using various methods to work towards increasing women's participation. Organising women in exclusive groups and in mixed groups of both men and women has achieved greater success [Narain, 1994]. This helps women to discuss their problems in exclusive groups and take decisions collectively. Women develop confidence and become more assertive in mixed groups. However, methods to increase women's participation have to be worked out, depending on the programme and the area.

7.2. New programmes and technologies for women

In India, programmes and devices targeted at women are few. In recent years there has been no major research in technologies or major programme for rural women which would help them to increase their efficiency, productivity and income. New programmes should aim at:

- increasing the efficiency of women's energy and hence increasing their productivity;
- increasing employment opportunities and income levels; and
- reducing the drudgery of women and improving their health status.

The points to be borne in mind while developing new programmes/technologies are the following.

- All the issues related to women should be understood, analysed and addressed from the social, cultural, economic, political and educational points of view to increase their acceptability.
- New programmes should have substantial advantages over the old programmes.
- Programmes should help in improving the knowledge and skills of women at the local level.

- Women should be involved from the stage of conceptualisation to the stage of implementation of the programme.
- Participatory project design and implementation with linkages between the designer institutions and field practitioners should be explored.
- The potential of indigenous knowledge systems should be explored. A blend of modern and traditional techniques should be attempted in the programme wherever possible. There are examples of the initiatives taken by some of the NGOs wherein the exchange between modern and indigenous knowledge systems have been worked out very well. This includes the ''Do It Herself'' project of Intermediate Technology Development Group (ITDG) and development of a ''Guidebook on Local and Indigenous Knowledge System in Animal Health and Production System'' by the World Women's Veterinary Association (WWVA) and World Council of Indigenous Peoples (WCIP).

Research, so far, has been restricted to only cooking energy in the domestic sector. In cooking energy, research has been limited to a few devices such as smokeless *chulhas,* biogas plants and solar cookers. However, the long-term goal should be to improve the quality of biomass energy and to provide high quality fuel, devices and technologies for women. The technical feasibility and the cost of fuel processing to upgrade the combustion characteristics should be analysed. In a village of Garhwal area in the Himalayas, an NGO called SIDORA trained women in briquetting technology where the segregated combustible portion of municipal waste along with agricultural residues is converted into beehive-shaped briquettes. This not only solves the fuel problem for women, but also generates income for them. Women sell extra briquettes [Bioenergy News, 2000].

Possibilities to improve the efficiency in domestic water supply, transportation and agricultural activities to reduce women's energy use and increase their efficiency should be explored. Research aimed at alleviating the drudgery and improving the health and safety levels of women should include development of specific tools and machines. Care should be taken that such tools and machines do not displace women from their employment opportunities or convert female jobs into male jobs.

Policies in the case of large- and small-scale electricity production programmes should help women to have equal access because such programmes provide benefits to both men and women in a community. Decentralised production of energy using renewable resources should aim at creating employment opportunities for local women. The role of and benefits to women in JFM and integrated land-use planning should be addressed if the development has to be sustainable and equitable. Also, the scope to increase the employment opportunities for women in JFM and integrated land-use planning like nursery-raising and dairy-farming should be explored. Women should have access to information on any new invention.

The majority of rural women live close to the biological subsistence margin. Access to fuel, fodder, small timber and other NTFP is vital for their survival. Understanding the gender roles, the struggle of women for access to and control over energy resources, their involvement in biomass management from various perspectives is necessary to integrate the needs of women in energy development programmes. The entire process should ultimately aim at solving the most critical problem of women and energy, leading to sustainable development. ■

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