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ENERGY FOR WOMEN & WOMEN FOR ENERGY

(Engendering Energy and Empowering Women)[1]

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1. Women in Energy Consumption Patterns

Energy analysis was traditionally restricted to the supply side of the energy fuel cycle[1]. Fortunately, there has been a shift of attention to the demand side over the past two to three decades. However, even this shift has by and large focused on sectoral demands and end-uses with little attention being paid to the gender distribution of energy consumption.

Perhaps an exception to this gender blindness has been the work on rural energy consumption patterns, particularly that carried out in the 1980s by the ASTRA[2] programme of the Indian Institute of Science in Bangalore, India. Even the first papers on rural energy consumption patterns from this programme brought out clearly the gender aspects of energy[3],[4],[5]. Subsequently, there was an illuminating report on the gender aspects of the ASTRA energy consumption studies by Shailaja and Ravindranath[6]. These gender aspects were reflected in the book Energy for a Sustainable World[7].

Prevailing energy consumption patterns have to be the baseline for analysis of the gender aspects of energy. This baseline must include the pattern of expenditure of energy (including human energy), the type of tasks performed by women, the impact of mechanization and commercial energy inputs, the intake of food energy, and the health impacts of women's labour.

1.1 Rural Energy Consumption Patterns

The vast majority of the women in developing countries live in rural areas, mostly in villages. Hence, it is necessary at the outset to examine the nature of energy consumption patterns at the village level.

There have been several studies of the patterns of energy consumption in villages. Among the earliest of the studies was that of six villages in the Ungra region of Tumkur District, Karnataka State, South India, carried out in the late 1970s[8].

Pura (latitude: 12 49'00" N, longitude: 76 57'49" E, height above sea level: 670.6 m, average annual rainfall: 127 cms/year, population (in September 1977): 357, households: 56) is one of the six villages surveyed in the Ungra region in Kunigal Taluk, Tumkur District, Karnataka State, South India.

The energy-utilizing activities in Pura consisted[9] of: (1) agricultural operations (with ragi and rice as the main crops); (2) domestic activities -- grazing of livestock, cooking, gathering fuelwood and fetching water for domestic use particularly drinking, (3) lighting and (4) industry (pottery, flour mill and coffee shop)[10].

These activities were achieved with human beings, bullocks, fuelwood, kerosene and electricity as <u>direct</u>[11] sources of energy.

An aggregated matrix showing how the various energy sources were distributed over the various energy-utilizing activities is presented in Table 1 in the units appropriate to the sources.

Using appropriate conversion factors, a source-activity matrix for Pura village was obtained (Table 2). The matrix yields the following ranking of sources (in order of percentage of annual requirement): (1) fuelwood 89%, (2) human energy 7%, (3) kerosene 2%, (4) bullock energy 1%, (5) electricity 1%. The ranking of activities is as follows: (1) domestic activities 91%, (2) industry 4%, (3) agriculture 3% and (4) lighting 2%.

Human energy is distributed thus: domestic activities 80% (grazing livestock 37%, cooking 19%, gathering fuelwood 14%, fetching water 10%), agriculture 12%, and industry 8%. Bullock energy is used wholly for agriculture including transport. Fuelwood is used to the extent of 96% (cooking 82% and heating bath water 14%) in the domestic sector, and 4% in industry. Kerosene is used predominantly for lighting (93%), and to a small extent in industry (7%). Electricity flows to agriculture (65%), lighting (28%), and industry (7%).

There are several features of the patterns of energy consumption in Pura that must be highlighted -- even though all of them are not directly relevant to gender aspects, the overall context needs to be appreciated.

(1) What is conventionally referred to as <u>commercial</u> energy, i.e., kerosene and electricity in the case of Pura, accounts for a mere 3% of the inanimate energy used in the village, the remaining 97% coming from fuelwood.[12] Further, fuelwood must be viewed as a <u>non-commercial</u> source since only about 4% of the total fuelwood requirement of Pura is purchased as a commodity, the remainder being gathered at zero private cost.

(2) <u>Animate</u> sources, viz., human beings and bullocks, only account for about 8% of the total energy, but the real significance of this contribution is revealed by the fact that these animate sources represent 77% of the energy used in Pura's agriculture. In fact, this percentage would have been much higher were it not for the operation of <u>four</u> electrical pumpsets in Pura which account for 23% of the total agricultural energy.

(3) Virtually all of Pura's energy consumption comes from traditional renewable sources -- thus, agriculture is largely based on human beings and bullocks, and domestic cooking (which utilizes about 80% of the total inanimate energy) is based entirely on fuelwood.[13]

(4) However, the environmental soundness of this pattern of dependence on renewable resources is achieved at an exorbitant price: levels of agricultural productivity are very low, and large amounts of human energy are spent on fuelwood gathering (on the average, about 2.6 hr and 4.8 km per day per family to collect about 10 kg of fuelwood).

(5) Fetching water for domestic consumption also utilizes a great deal of human energy (an average of 1.5 hr and 1.6 km per day per household) to achieve an extremely low <u>per capita</u> water consumption of 17 litres per day.

(6) 46% of the human energy is spent on grazing livestock (5.8 hr/day/household) which is a crucial source of supplementary household income.

(7) Only 25% of the houses in the `electrified' village of Pura had acquired domestic connections for electric lighting, the remaining 75% of the houses depend on kerosene lamps, and of these lamps, 78% are of the open-wick type.

(8) A very small amount of electricity, viz., 30 kWh/day, flows into Pura, and even this is distributed in a highly inegalitarian way -- 65% of this electricity goes to the 4 irrigation pumpsets of 3 landowners, 28% to illuminate 14 out of 56 houses, and the remaining 7% for one flour-mill owner.

It is obvious from Table 3 which shows the end-uses of human energy in Pura that the inhabitants of Pura, particularly its women and children, suffer burdens that have been largely eliminated in urban settings by the deployment of inanimate energy. For example, gathering fuelwood and fetching water can be eliminated by the supply of cooking fuel and water respectively. The serious gender and health implications of rural energy consumption patterns, have been brought out in several studies[14],[15],[16],[17],[18].

Since then, there have been innumerable studies[19] of rural energy consumption patterns. The actual numbers show differences depending upon the region of the country, the agro-climatic zone, the proximity to forests, the availability of crop residues, prevalent cropping pattern, etc., but the broad features of the patterns of energy consumption in Pura, highlighted above, have been generally validated.

1.2 Women expend more human energy

The Pura study showed that women contributed a vital 42%, 80%, 15%, and 44%, of the labour hours for gathering fuel, fetching water, grazing livestock, and agricultural work. All told, women contributed 53% of the total human labour hours in Pura and % in Ungra, i.e., they work more than men. Their labour contributions are vital to the survival of families.

1.3 Women perform the back-breaking tasks

There is a gender preference in agricultural operations (Table 4). For instance, men carry out the operations of land-preparation (including ploughing and harrowing), whereas women carry out the operations of transplanting, weeding and harvesting. The thumb-rules appear to be: (1) if the operation is assisted by animal power involving the use of bullocks, men take charge of it; and (2) if the operation requires continuous bending or sitting postures and is back-breaking and strenuous, then the women do it. For instance, transplanting of rice and weeding are critical operations performed manually by women in ankle-deep slush, often under a steady drizzle. Barefoot, women transplant and weed continuously for 6 to 10 hours a day.

1.4 Women are displaced by agricultural mechanization

Unfortunately, agricultural mechanization does not seem to relieve women of the hardship of back-breaking jobs. As soon as a machine is developed to eliminate the hardship of an agricultural operation, it is appropriated by men with the culture that machines are the prerogative of men and that men are the most suitable beneficiaries of training. Not only are women relieved of the hardship, they are relieved of the job itself, i.e., women lose employment by female jobs being converted into male jobs. For instance, when power threshers are introduced to reduce the burden of winnowing (carried out by women), the operation of the threshers is taken over by men resulting in the displacement of women. The introduction of mechanical harvesters also leads to the loss of employment by women.

1.5 Women intake less food energy

If women work more than men, are they compensated by greater intake of food energy? The universal but sad truth in developing countries is that women traditionally eat last and least in a family -- this is a result of the dominant cultural value assigned to male adults and to boys.

Quantification of this truism is a more difficult proposition because its involves studies on intra-family distribution of food. One approach is via multiple regression analysis of the total cereal consumption of households versus the number of males, boys, girls and women in the households. The coefficients then yield the consumption per gender category, for instance, per male and per women consumption. Thus, the gender biases in food consumption can be determined.

It turns out that the greater energy output of women is not compensated by a proportionately greater intake of food. In fact, men eat more -- the ratio of intra-household male-female food distribution can be 2:1. Studies in several locations corroborate the gender bias in access to food within the family[20],[21],[22],[23],[24]. This means one more hole in the "leaky bucket" of women's health and nutrition -- overwork and underfeeding.

Surveys by the National Nutrition Monitoring Bureau in India have found that the weights of adult women are well below par all over the country. Further, while women's weight-gain ceases after the age of 16 years, men continue to gain weight until at least 25 years[25]. What is more, weight-gain in pregnancy of rural women is a mere 4-6 Kgs, as opposed to the desired norm of 10-12 Kgs.

1.6 Negative Health Impacts of women's labour

Among the most serious cost of energy scarcity for women is the range of health problems caused, directly and indirectly, by the dependence on increasingly scarce biomass to meet daily subsistence needs.

(a) Health hazards of biomass cooking fuels: First and foremost are the health hazards caused by the use of biomass fuels for cooking in most poor households in the world. It is estimated that "more than half the world's households cook daily with unprocessed solid fuels, i.e., biomass or coal"[26]. Evidence from around the world indicates that firewood, dung cakes, and other fuels, release toxic emissions such as carbon monoxide, total suspended particulates (TSPs) and hydrocarbons[27].

Furthermore, these fuels are used primarily in traditional open cookstoves with a fuel efficiency of roughly under 10%[28], in poorly-ventilated one- or two-room homes. Even where ventilation is relatively good (such as in thatch-roof dwellings), the emissions are of such a magnitude that the health effects are still alarming.

For instance, one of the earliest studies, conducted in Gujarat state of Western India, found that fuels like firewood, dung cakes and crop wastes emit more TSP, benzo-pyrene, carbon monoxide and polycyclic organic pollutants than fossil fuels like coal or natural gas. The study showed that, in clinical terms, women spending an average of 3 hours a day on cooking are exposed to 700 micrograms of particulate matter per cubic meter (as against a permissible level of less than 75 micrograms), and inhale benzo-pyrene equivalent to 400 cigarettes[29],[30]. Moreover, the study found that women began regular cooking at around the age of 13, which meant a much longer period of exposure to pollutants.

Similar studies -- though few in number, and not always focused on the health effects -- have been done in Africa, Latin America, Southeast Asia and in China (where the focus has been on coal-burning stoves).

The health hazards of dependence on biomass cooking fuels are not limited to those arising from air pollution alone. Experts contend that each part of the fuel cycle -- from production, collection, processing and actual cooking -- has health implications which can be serious. Table 5 shows a list of potential health hazards arising from different functions in the fuel cycle.

(b) Health and Nutrition Effects of Energy Scarcity: Apart from the direct health effects of cooking fuels used by the poor, there are clear indications that the growing scarcity of, and difficulty in obtaining, biomass fuels for cooking affects the health of the poor in several indirect ways.

Firstly, the scarcity of biomass fuels like firewood -- and the high time and labour cost involved in obtaining them -- may result in measures to economize on fuel consumption in cooking in various ways. For one, fewer hot meals may be prepared per day, leading to consumption of stale/leftover foods which may have become contaminated. This could lead to nutrient losses, and increased risk of infections. Under-cooking may also be resorted to in order to save fuel, which can cause health problems particularly in the case of some pulses and oils which are toxic when undercooked. Another health effect could result from the switching-over to cereal staples which require less cooking, but which may be less nutritious (from wheat or coarse grains to rice, for instance). While there is no documented statistical evidence for any of these problems, they have been widely observed by grassroots workers in many developing countries[31].

There are other health impacts on the poor resulting from their dependence on human energy in the absence of alternative sources for performing survival tasks. Chief among these is the impact on the nutrition and health status of poor women and girl children, in societies where the performance of these tasks is along gender lines. A benchmark study of the early eighties[32], based on the Pura village energy matrix data cited earlier, highlighted the relatively greater health costs borne by poor women, particularly in nutritional terms, as a result of the daily chores of cooking, fuel gathering, water fetching, and grazing. The study showed that these daily subsistence activities lead to a higher calorie expenditure per woman per day than per man, particularly since these domestic tasks are perennial, while agricultural work (where men's energy contribution is higher than women's) is seasonal.

The reduction of water consumption, particularly for personal hygiene, because of the time and labour costs involved in water collection, also has negative effects on women's health: lack of adequate water for bathing/washing has been cited as a major contributing factor to the high rate of genito-urinary and reproductive tract infections in poor women. One recent Indian study found that 92% of the sample women had reproductive tract infections (RTIs), many of which had gone untreated for years.[33] This can be a significant contributing factor to female sterility, cervical cancer and uterine prolapse. The last is also related to excess load-carrying (of water, firewood, etc.) by women.[34]

It is clear that the health costs of the nexus between energy scarcity, the resultant dependence on biomass fuels and human energy to meet basic needs, and the gender division of labour are extensive. They include widespread protein-calorie malnutrition, poor immunity and high risk of and morbidity and mortality from infectious and communicable diseases, chronic anaemia, higher maternal/female morbidity and mortality, poor reproductive outcomes, including low birth-weight infants with reduced chances of survival, and increased infant and child mortality, poor reproductive health status of women and girls, and depletion of women's health from repeated childbearing, overwork, and inadequate food.

The burden of this syndrome is carried mainly by millions of women who are already the most socio-economically disadvantaged segment in most countries. Consequently, it has serious implications for the health and development status of entire nations. The quality of life for the majority of people cannot be improved without urgently addressing these problems, which arise directly and indirectly from unmet energy needs.

Another health dimension of the energy scarcity syndrome, combined with the absence of labour-saving appropriate technology (and once again borne by women) is the possible health hazards for pregnant women and their unborn infants as a result of traditional rice cultivation methods. A study conducted in a sample of 30,000 population in Western India in 1982 showed a sharp increase in stillbirths, premature births and neonatal mortality during the rice-planting months, when women labour for hours, bent almost double, transplanting rice. The fact that no maternal deaths occurred was probably due to the presence of an effective non-governmental community health care project in the area.[35],[36]

2. Engendering Energy

2.1 Social and gender impact of scarcity of energy services

The need for social justice -- including gender justice -- is universally accepted. Eradicating discrimination on the basis of gender, caste, class, race, ethnicity, and nationality, both formally and substantively, is a prerequisite for creating a just society. At the most fundamental level, substantive justice means meeting the basic human needs of all citizens, and providing equal access to productive resources.

It is self-evident that energy plays a key role in achieving both the twin goals of meeting the basic human needs of all citizens, and providing equal access to productive resources. In the case of women, lack of fulfilment of basic needs (for food, water, fuel, shelter, health and education) perpetuates their social, economic and political disadvantage and powerlessness. The energy question must be addressed both for the sake of social justice as for economic growth, and investments in improved energy systems serve both ends.

Low levels of energy services are a serious obstacle to raising the social status of women and other oppressed groups, since it lies at the heart of any strategy to alter or mitigate the gender-, caste- or class-based division of labour and its consequent physical and social impact. When survival is dependent on human energy and primitive technologies, a whole range of obstacles to social and gender equality are set in motion.

(1) The poor in general, and poor women and girls in particular, are trapped in an unceasing cycle of work which condemns them to poor health, little or no education, and deprives them of equal participation in local development programs (e.g adult literacy, credit and income-generation schemes), self-government bodies, or local social/political movements. This means a nation with a seriously undeveloped human resource base.

(2) Schooling is an unaffordable luxury for poor children whose labour is required for family survival, resulting in low literacy levels.

(3) Girls are deprived of education altogether, or are allowed fewer years of schooling compared to boys.

(4) When female illiteracy is high, this acts as a barrier to new knowledge and ideas which might catalyse women to question the patriarchal order and demand change, or to gain economic mobility.

(5) The demand for children's labour perpetuates the need for large families -- this contributes to high birth rates which further depletes the health of poor women by keeping them trapped in the cycle of childbearing and rearing, and thus further circumscribing their participation

in change processes and development programs.

Almost every one of these socio-economic preconditions for improvement in living standards depends upon energy-utilizing technologies. Infant mortality has much to do with adequate and safe supplies of domestic water and with a clean environment. The conditions for women's education become favourable if the drudgery of their household chores is reduced, if not eliminated, with efficient energy sources and/or devices for cooking and with energy-utilizing technologies for the supply of water for domestic uses. The deployment of energy for industries which generate employment and income for women can also help in delaying the marriage age which is an important determinant of fertility. If the use of energy results in child-labour becoming unnecessary for crucial household tasks (such as cooking, gathering fuelwood, fetching drinking water, and grazing livestock), an important rationale for large families is eliminated.

From this standpoint, it is obvious that the prevailing patterns of energy consumption in villages such as Pura do not emphasize energy inputs for providing safe and sufficient supplies of drinking water, the maintenance of a clean and healthy environment, the reduction, if not elimination, of the drudgery of household chores traditionally performed by women, the relief of menial tasks carried out by children, and the establishment of income-generating industries in rural areas.

Thus, current energy consumption patterns exclude the type of energy-utilizing technologies necessary to improve the living standards. In fact, they aggravate the conditions of poverty.

Alternative energy strategies can contribute to a dramatic improvement in the living standards if they are directed preferentially towards the needs of women, households and a healthy environment.[37],[38],[39] Energy strategies must provide the mundane, but momentous, energy inputs that would improve the quality of life. Otherwise, the strategies would be missing an opportunity to contribute to a reduction of the intensity of the poverty problem.

2.2 Energy Interventions to improve the Quality of Life for Women

An example of an energy intervention that is a small step towards establishing village-level conditions that would play a role in improving living standards will now be described. The purpose is to illustrate in a concrete fashion how augmentation of energy services can improve the quality of life. Fortunately, the intervention is in the same village of Pura the energy consumption pattern of which has just been described.

The traditional system of obtaining water, illumination and fertilizer (for the fields) in Pura village is shown in Figure 1. This traditional system was replaced in September 1987 with a Rural Energy and Water Supply Utility based on a community biogas plant system[40],[41],[42],[43] -- the main components and the flows of inputs/outputs of which are shown in Figure 2.

A comparison of the present community biogas plants system with the traditional system of obtaining water, illumination and fertilizer shows that women are winners on all counts. Not only have they lost nothing, but they have gained the following deep-borewell water which is better and safer than the water from the open tank, less effort to get this improved water, reduction in the incidence of water-borne intestinal diseases (because of the safer water), and therefore noticeable improvement in the health of children, better illumination than the traditional kerosene lamps or even the unreliable, low-voltage grid electricity, cheaper illumination for the households using kerosene lamps, less pressure to finish chores during daylight, improved fertilizer which has greater nitrogen content and is less favourable to the growth of weeds and proliferation of flies compared to farmyard manure, a dung delivery fee to those (mainly women and children) who deliver the dung to the plants and take back the sludge.

The system is still under development and has much further to go. The next stages include the provision of efficient cooking fuels/devices to households to reduce the burden of fuelwood gathering and the health hazards associated with current cooking patterns. But, even the first phase suggests the type of energy interventions that can influence living standards.

3. Empowering Women through Energy Entrepreneurship[4]

The most important point that emerges from the discussion of women in energy consumption patterns is that women have been playing, and are playing, a major role in the management of energy resources, particularly biomass. In fact, in order to survive, women willy-nilly become excellent managers of energy resources. This is because they pay an immediate price in terms of labour, if not money, if they are wasteful in energy use. Whether it is water or biomass fuel or livestock wastes, women are the traditional gatherers and users. And because they start this resource management training as young girls, they are forced to acquire the expertise.

When energy interventions are implemented involving new ways of producing and using energy, the experience gained thus far, for instance with rural energy and water supply utilities such as the one in Pura and other villages, shows that women begin to play a key role in the operation of these utilities. They are also the main beneficiaries. As such, they become as much, if not more, interested than men in the success of the utilities. And wherever women have opportunities, it becomes clear that they are potentially the best managers of energy enterprises, as they are in milk cooperatives.

It is also relevant that vast programmes such as the Grameen Bank have unambiguously testified to the crucial role that women can play in microenterprises. It is now clear that these projects are succeeding because they are overwhelmingly based on women who have established an outstanding record of timely repayment of small loans and utilization of these loans to raise the living standards of their families.

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[4] This section has been inspired by a personal communication from Phil LaRocco from which the quotations have been taken.

The explanation is simple: women "are better investors and planners than men. They think in terms of steps and consensus, borrowing step by step to generate income, investing in the mid- and long-term as well as the short term. When a woman has the capacity to invest, one of her first thoughts involve children, so women are prepared to invest in things men won't consider. The evidence on this is clear and becoming clearer...."

Experience is mounting to confirm that the decisions of women take into account the long-term and the next generation, a natural consequence of their linkage with children. They are prepared to sacrifice immediate gains for long-term benefits, i.e., the discount rate used by women is lower than that of men. It is precisely such a view that leads to sustainability. Hence, women are natural endowed to be the implementors of sustainable development.

Who will implement energy interventions of the type designed to improve the quality of life for women? Quite apart from the global tendency to diminish the role of government, governments themselves are becoming increasingly reluctant to take on additional burdens. Utilities are too preoccupied with their capital crises to devote attention to rural activities. It is clear that there is a need for entrepreneurs in general, and women entrepreneurs in particular. The idea is to push to its limit the sequence: women as victims of energy consumption patterns --> women as beneficiaries of energy interventions --> women as managers of enterprises --> women as energy entrepreneurs.

Women already have a track record of functioning as effective entrepreneurs in already successful organizations and networks (like Grameen, SEWA, etc). The challenge is to transform them and their organizations into energy entrepreneurs.

The role of the public sector, including state, multilateral and charitable sources, is to create support systems that promote entrepreneur response. What must be ensured is that entrepreneurs have choices and access to technology and resources.

What is needed therefore -- as LaRocco suggests -- is "to create a women's energy entrepreneur project which will have as it's objective the training and financing of developing country women to be new energy entrepreneurs..." The project will help women to learn to establish, own, run and manage energy enterprises. In the process, they will engender energy -- they will turn energy into an instrument of improving the quality of life and generating income. And they will acquire and increase control over their destinies -- they will be get empowered. From energy for women the process will lead to empowerment of women. This is the challenge.

Table 1: Energy sources and activities in Pura

	AGRICULTURE	DOMESTIC	LIGHTING	NDUSTRY	TOTAL
Human hours	34848	255506	-	20730	311084
(Man hours)	(19914)	(82376)	-	(16485)	(118775)
(Woman hours)	(14934)	(113928)	-	(4245)	133107
(Child hours)	-	(59202)	-	-	(59202)
Bullock hours	5393	-	-	-	5392
Firewood (kgs)	-	207807	-	8930	216737
Kerosene (litres)	-	-	1938	156	2094
Electricity (kWh)	7264	-	3078	820	11162

Table 2. Pura energy source-activity matrix (x 10^6 kcals/year)

	Agriculture	Domestic	Lighting	Industry	Total
Human	7.97	50.78	--	4.97	63.72
(Man)	(4.98)	(20.59)	--	(4.12)	(29.69)
(Woman)	(2.99)	(22.79)	--	(0.85)	(26.63)
(Child)	--	(7.40)	--	--	(7.40)
Bullock	12.40	--	--	--	12.40
Fuelwood	--	789.66	--	33.93	823.59
Kerosene	--	--	17.40	1.40	18.80
Electricity	6.25	--	2.65	0.71	9.61
Total	26.62	840.44	20.05	41.01	928.12

Total energy = 928 x 10^6 kcal/year; = 1.079 x 10^6 Wht/year; = 2,955 kWht/day; = 8.28 kWht/day/capita

Table 3. End-uses of human energy in Pura

	Human activity	Human energy expenditure		
		Hours/year	Hours/day/ household	kcal/ year x 10^6
1.	Domestic	255,506	12.5	50.8
1.1.	Livestock grazing	(117,534)	(5.7)	(23.4)
1.2.	Cooking	(58,766)	(2.9)	(11.7)
1.3.	Fuelwood gathering	(45,991)	(2.3)	(9.1)
1.4.	Fetching water	(33,215)	(1.6)	6.6
2.	Agriculture	34,848	1.7	8.0
3.	Industry	20,730	1.0	5.0
	TOTAL	311,084	15.2	63.8

Table 4: Human hours spent in agricultural operations/year in Ungra village

NO.	OPERATIONS	WOMAN HOURS/YEAR		MAN HOURS/YEAR	
		Total crop land	% to total	Total crop land	% to total
1.	Ploughing	-	-	31,753.38	23.63
2.	Harrowing	-	-	17,548.30	13.06
3.	Manure transport	-	-	4,115.99	3.06
4.	Bunding	-	-	9,222.17	6.86
5.	Transplanting	29,842.24	30.00	5,983.90	4.45
6.	Weeding + Interculture	9,323.80	9.40	4,874.24	3.63
7.	Fertilizer application	1,457.80	1.46	1,186.17	0.88
8.	Harvesting	23,994.92	24.13	10,272.81	7.64
9.	Bundling	13,092.43	13.31	7,978.71	5.94
10.	Produce transport	2,062.12	1.91	5,536.38	4.12
11.	Threshing	7,165.94	7.20	20,296.79	15.10
12.	Winnowing	9,065.79	9.11	6,892.33	5.13
13.	Rolling	-	-	3,486.33	2.60
14.	Others	3,095.53	3.50	5,242.49	3.90
TOTAL		99,100.57	100.00	1,34,389.99	100.00

Source: KARNATAKA State of Environment Report IV

Table 5: Health Effects of Biomass Fuel Use in Cooking[5]

PROCESSES	POTENTIAL HEALTH HAZARDS
Production	
Processing/preparing dung cakes	Faecal/oral/enteric infections Skin infections
Charcoal production	CO/smoke poisoning Burns/trauma Cataract
Collection	
Gathering/carrying fuel	Trauma Reduced infant/child care Bites from venomous reptiles/insects Allergic reactions Fungus infections Severe fatigue Muscular pain/back pain/arthritis
Combustion	
Effects of smoke	Conjunctivitis, Blepharo conjunctivitis Upper respiratory irritation/inflammation Acute respiratory infection (ARI)
Effects of toxic gases (CO)	Acute poisoning
Effects of chronic smoke inhalation	Chronic Obstructive Pulmonary Disease (COPD), chronic bronchitis Cor Pulmonale Adverse reproductive outcomes Cancer (lung)
Effects of Heat	Burns Cataract
Ergonomic effects of crouching over stove	Arthritis
Effects of location of stove (on floor)	Burns in infants/toddlers/children

[5]Based on data given in WHO,1992, Indoor Air Pollution from Biomass Fuel, and own observation/experience.

End-notes and References

1. The fuel cycle is a description of the flow of energy from source to service -- from primary energy as found in nature to its conversion into convenient carriers (secondary energy) to final energy as delivered to users and useful energy emerging from the end-use devices to provide the energy services that human beings require.

2. The ASTRA programme of the Indian Institute of Science, Bangalore, focused on the Application of Science and Technology to Rural Areas. Since science and technology could become weapons against poverty, the term ASTRA was appropriate because it means "weapon" in Sanskrit.

3. N.H. Ravindranath, H.I. Somashekar, R. Ramesh, Amala Reddy, K. Venkatram and A.K.N. Reddy, The Design of a Rural Energy Centre for Pura Village: Part I: Its Present Pattern of Energy Consumption in Employment Expansion in Indian Agriculture", ILO, Bangkok (1979), pp. 171-187.

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11. Direct energy is distinguished from indirect energy which refers to the embodied energy used in the manufacture of materials and equipment.

12. Pura uses about 217 tonnes of firewood per year, i.e., about 0.6 tonnes/day for the village, or 0.6 tonnes/year/ capita.

13. Unlike some rural areas of India, dung cakes are not used as cooking fuel in the Pura region. In situations where agro-wastes (e.g., coconut husk) are not abundant, it appears that, if firewood is available within some convenient range (determined by the capacity of head-load transportation), dung-cakes are never burnt as fuel; instead dung is used as manure.

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