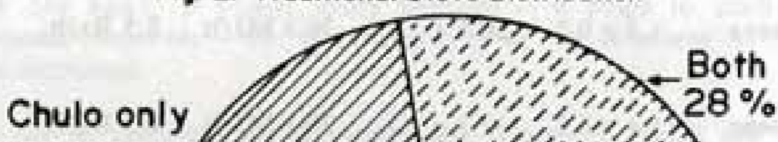
CONSERVATION OF BIOMASS THROUGH IMPROVED COOKING-STOVES

Background

To meet domestic energy requirements, various technological options have been discussed. However, the development and dissemination of these technologies in rural areas are very limited. Therefore, rural people are forced to burn lower quality fuels such as twigs, branches, crop residue, animal dung, and even weeds or grasses. The situation is worsened by the use of inefficient cooking-stoves, resulting in a high consumption of fuelwood. According to a survey conducted by RECAST in selected villages, over 90 per cent of the people in one village used tripods, while only 7 per cent used tripods in another village. Home-made mud stoves (*Chulo*) were common in the second village and about 50 per cent of them had a single ring and the other 50 per cent had two. Another survey conducted by the Community Forestry Development Project (CFDP), covering a wider hill area of Nepal, showed that about 52 per cent of the households in the hill areas used tripods or three stones for cooking while 20 per cent used '*Chulo*', and the rest used both types of stove (Fig. 2).

Fig. 2: Traditional Stove Distribution



Source: Community Forestry Development Project (CFDP)

The need for ICS was realised and promotion of the same became one of the most important components of the fuelwood management programme. The use of improved cooking-stoves (ICS) can save 18 to 42 per cent of fuelwood use (Shakya 1985 and Sulpya 1984).

History of ICS Development

The history of the ICS is not new in the Nepalese context. The development of ICS can be divided into three phases. The first phase started in the 1950s by introducing *"Magan Chula"* which originated in India. At that time, the village development services, *"Gramin Vikash Sewa"*, started promoting ICS in some areas of Nepal. The programme was aimed at uplifting the living conditions of the people and reducing exposure to smoke. However, the programme lacked a scientific approach in terms of design, promotion, and testing. The programme was unsuccessful in terms of wider dissemination because of easy accessibility to the forest nearby as well as the low price of firewood.

Phases of Stove Development in Nepal

1950	1960	1970	1980	1990
First Phase:				
Socioeconomic and health aspects		**Second Phase:**		
		Technical/scientific aspects	**Third Phase:**	
			Technical/scientific, health, and socioeconomic aspects	

The second phase started in the early 1970s and focussed on improving fuel efficiency. Technological know-how about large mud stoves with a number of rings, known as the *Lorena* Stove, came from South America (Guatemala). The Women's Training Centre of Nepal was involved in training women in the construction of *Lorena* Stoves. The main objective during this period was to find a solution to the fuelwood crisis and accompanying deforestation. The dissemination of these stoves was slow because of lack of scientific and critical application. In the late seventies, RECAST became involved in the improvement of these stoves and renamed them Nepali *Chulo*.

The third phase, which began in the early 1980s, was taken up by research and development (R&D) and laboratory-based work. This included a detailed assessment of cooking-stove performance, standardised procedures for testing, and design methodologies to obtain higher performance and efficiency. The *Lorena* Stove was replaced by ceramic Insert and Double Wall Stoves. These cooking-stoves were designed by RECAST under a contract with the HMG/UNDP/FAO Community Forestry Development Project (CFDP). Large-scale distribution was carried out by the CFDP. After some years, with support from UNICEF, the ceramic cooking-stoves and the New Nepali *Chulo* were also introduced through the Agricultural Development Bank, Nepal (ADB/N), the Small Farmers' Development Project (SFDP), and the Women's Development Division (WDD) through their Production Credit for Rural Women (PCRW) Programme. Thousands of these stoves were distributed. Some modifications to ceramic Tata Energy Research Institute (TERI) models were made, especially on the second ring and its size (Fig. 3). Distribution was limited and confined only to the field trail. As in the first phase, socioeconomic issues once again occupied the centre-stage of activities. ICS production was reviewed and planned for a self-propelling distribution process.

Later the *Tamang* Stove (Improved Village Stove) was introduced. It consisted of a mud-brick or mud-stone ICS with an iron tripod which was driven into the combustion chamber to form a better foundation. It is a two-ring stove with a chimney (ceramic or mud-block). The stove can withstand excessive force, such as that exerted during cooking maize porridge. The chimney was modified for easy cleaning.

Taking into account the social context of stove construction, one-ring and two-ring stoves were introduced. These stoves were built by making metal moulds with locally available materials such as the clay and agri-residues used to make local mud stoves (Sulpya 1990). The moulds were to maintain standard dimensions. The stove is chimney-less, but in the two-ring model the chimney can be fixed on afterwards with minor on-site modifications.

Types of ICS and Their Theoretical Potentials

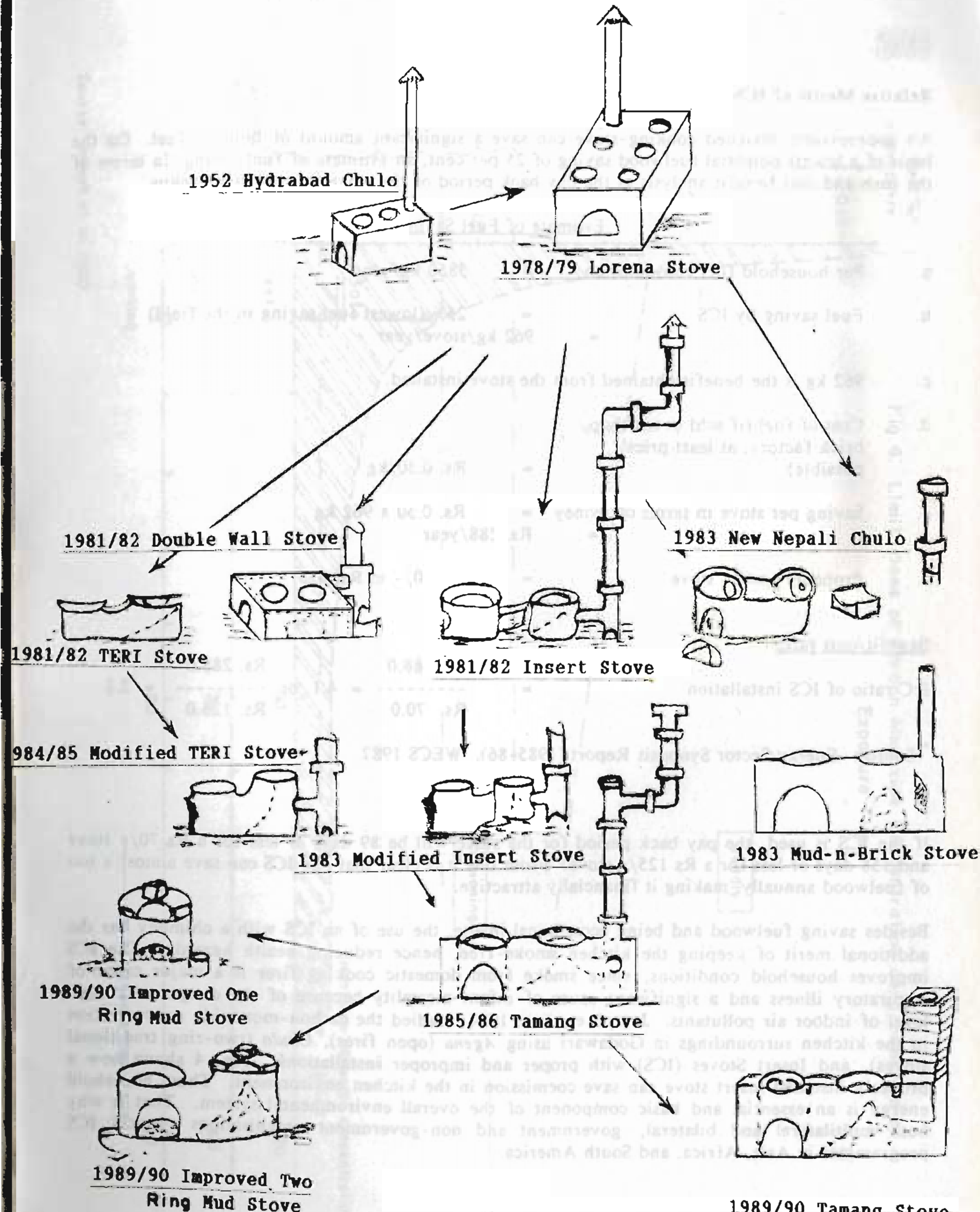
There are various types of ICS, namely, the Insert Stove, the Double Wall Stove, the Modified TERI Stove, the New Nepali *Chulo*, the *Tamang* Stove, the Mud-n-brick Stove, the Single-ring and the Two-ring Stoves, and the Metallic Stove. The efficiency of stoves varies from 21.5 to 26.7 per cent in field conditions (RECAST 1984, 1987, 1988) (Fig. 3 and Table 2), while the performance efficiencies of the new Nepali *Chulo* and the Metallic Stove are not known. Potential fuelwood savings range from 25.6 per cent to 40 per cent over the 16 per cent fuel efficiency of the traditional stove. MPFS projected that the number of ICS in use would increase to 290,500 in 2001 and 753,500 in 2011, covering 9.2 per cent of all households in 2001 and 20.8 per cent in 2011 with a subsequent annual growth rate of 10 per cent. If the ICS programme was accelerated to reach 70 per cent in the Seventh Five Year Plan, fuelwood saved would still be only 2.4 per cent in 2000/01 and there would be a 5.8 per cent fuelwood demand in the Middle Mountains, Siwaliks, and the *Terai* by 2010 (Table 3).

Table 3: Projected Fuelwood Savings from ICS ('000 t)

Zone	1985-86	1990-91	1995-96	2000-01	2005-06	2010-11
Moderate Programme						
Mid-Mountains	9	43	59	81	110	151
Siwaliks	2	10	14	20	29	41
Terai	10	50	72	104	150	215
Total	21	103	145	205	289	407
% of consumption	0.1	0.8	1.0	1.3	1.8	2.3
Accelerated Programme						
Mid-Mountains	9	61	95	149	234	366
Siwaliks	2	14	23	37	61	100
Terai	10	70	116	192	317	524
Total	21	145	234	378	612	990
% of consumption	0.1	1.2	1.7	2.4	3.8	5.8

Source: Master Plan for the Forestry Sector, HMG/ADB/FINIDA, 1988.

Fig. 3 ICS Technology Development in Nepal



Relative Merits of ICS

An appropriatly designed cooking-stove can save a significant amount of biomass fuel. On the basis of a lowest potential fuelwood saving of 25 per cent, an estimate of fuel saving, in terms of the cash and cost benefit analysis as the pay back period of the stove, is calculated below.

<u>Estimate of Fuel Saving</u>

a.	Per household fuel consumption	=	3850 kg/year*
b.	Fuel saving by ICS	=	25% (lowest fuel saving in the field)
		=	962 kg/stove/year
c.	962 kg is the benefit obtained from the stove installed.		
d.	Cost of fuel (if sold to tea shop, brick factory, at least price possible)	=	Rs. 0.30/kg
e.	Saving per stove in terms of money	=	Rs. 0.30 x 962 kg
		=	Rs. 288/year
f.	Probable cost of stove	=	Rs. 70/- to Rs. 125/-

<u>Benefit/cost ratio</u>

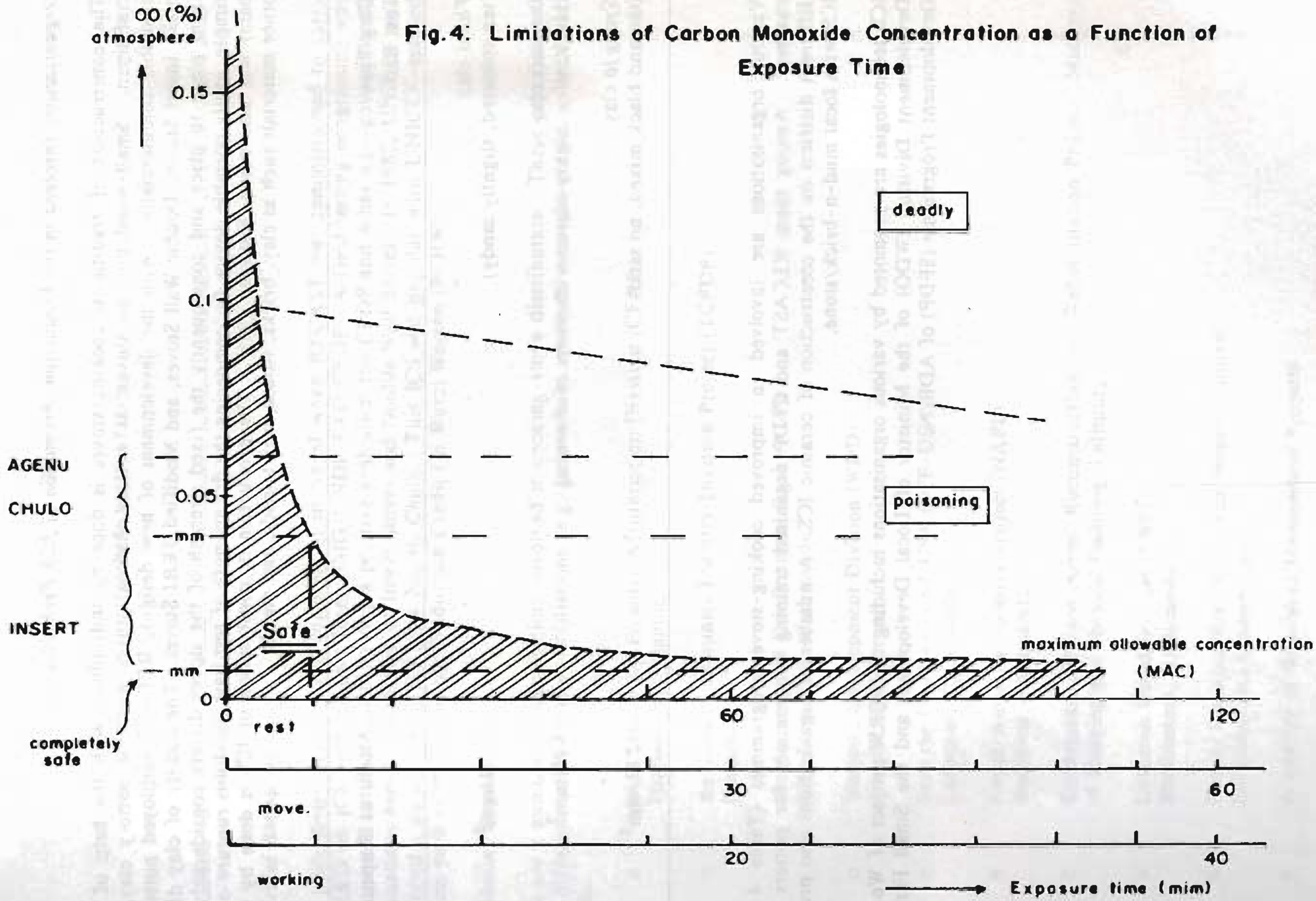
B:C ratio of ICS installation = $\frac{\text{Rs. } 288.0}{\text{Rs. } 70.0} = 4.1$ or $\frac{\text{Rs. } 288.0}{\text{Rs. } 125.0} = 2.3$

* Source: Energy Sector Synopsis Report (1985-86). WECS 1987.

If the ICS is used, the pay back period for the stove will be 89 days or less for a Rs 70/- stove and 158 days or less for a Rs 125/- stove. From this it is clear that one ICS can save almost a ton of fuelwood annually, making it financially attractive.

Besides saving fuelwood and being economical in use, the use of an ICS with a chimney has the additional merit of keeping the kitchen smoke-free, hence reducing health hazards. The ICS improves household conditions, since smoke from domestic cooking fires is a major cause of respiratory illness and a significant cause of infant mortality because of the dangerously high level of indoor air pollutants. Joseph et al. in 1984 studied the carbon-monoxide concentration in the kitchen surroundings in Godawari using *Agenu* (open fires), *Chulo* (two-ring traditional stoves), and Insert Stoves (ICS) with proper and improper installations. Fig. 4 shows how a properly installed insert stove can save coemission in the kitchen environment. Thus, household energy is an essential and basic component of the overall environmental system. That is why both multilateral and bilateral, government and non-government organisations support ICS programmes in Asia, Africa, and South America.

Fig. 4: Limitations of Carbon Monoxide Concentration as a Function of Exposure Time



Source: Joseph et. al. 1985.

Organisations Involved in the Production/Promotion of ICS Technologies

The construction of traditional cooking-stoves is done by individuals with the help of local craftsmen. Small-wood burning stoves, as well as charcoal stoves made of pottery clay, are available commercially. With the development of new designs, RECAST employed potters to make Insert Stoves, Double Wall Stoves, and Modified TERI Stoves. The quality of clay differs from place to place and consequently the fixed strength of the stoves differs considerably. A simple, easily portable device for comparing the dry strength of test bars (modulus rupture of test bars) was also made (Hausner 1985). The production or construction of ICS is done by using other materials such as clay, bricks, stones, iron tripods, and metals.

Clay Type	Modulus Rupture of Test Bars
Thimi clay (tan coloured, slightly sandy)	11 N/mm^2
Damauli clay (black, silty, highly plastic with traces of dixenite)	5 N/mm^2
Syangja clay (tan and black mixed, no sand)	12 N/mm^2

Various organisations are involved in improved cooking-stove programmes (Table 4 next chapter). Among them RECAST and CFDP organised training programmes for potters from different districts on the construction of ceramic ICS. A number of organisations also produce ICS with local mud-n-brick/stone.

ICS technologies are promoted by various organisations including the PCRW project of Women's Development Division (WDO) of the Ministry of Local Development and the Small Farmers' Development Programme (SFDP) of ADB/N.