Hidden Fires

Improving kitchens and stoves together with users

Report from a project in El Limón, Nicaragua

by

Maria Andersson

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Editing, Annette Wong Jere
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Preface

This report describes experiences from a kitchen and stove project in El Limón, Nicaragua. A feasibility study in 1989 was published as a memorandum titled *Tortillas must be Baked on Flames.*

The kitchen and stove project is a complement to a housing project to construct and/or improve 80 residences. The project was financed by the Swedish International Development Authority (SIDA) and implemented by CIPDC-Nicaraguác, a Nicaraguan non-governmental organization. Lund Centre for Habitat Studies (LCHS) at Lund University provided technical support with development of the project proposal, design of the pilot kitchens, and hiring a consultant to visit El Limón.

LCHS has worked with improved kitchen and stove projects in developing countries since the beginning of the 1980s. In the last few years these activities have expanded into a programme for applied research on intra-household energy end-use. The focus has been the home and the user, especially building design and materials, kitchen and stove, and patterns of energy use.

Some of these activities have been carried out under a SIDA funded programme, coordinated by the Stockholm Environment Institute (SEI), of pilot projects to explore appropriate methods in the field of energy. I would like to thank SEI and SIDA in Stockholm and the Swedish Development Cooperation Office in Managua.

The project in Nicaragua can be compared to a parallel kitchen and stove project in Vietnam. In both cases the kitchen and stove component was tacked onto a housing project, and one can conclude that kitchen and stove improvements should be integrated into the building programme from the beginning, not seen a separate projects.

The project in El Limón was well supported, particularly by the women's group. This was largely the result of personal efforts and the involvement of individuals. Special thanks to the women's group, the project leader Herminia Martinez, the architect Carolina Madriz and CIPDC-Nicaraguác.

At LCHS Maria Andersson, social geographer and Spanish speaker, was project leader, pusher and coordinator. Auke Koopmans, consultant, travelled to Nicaragua to identify suitable clays, develop the stove model, train the stove builders, and generously provided expert advice whenever we asked. Graciela Landaeta, architect, was advisor on the spot, in addition to her own research tasks. My main contribution was with the development of the project and analysis of the kitchen designs.

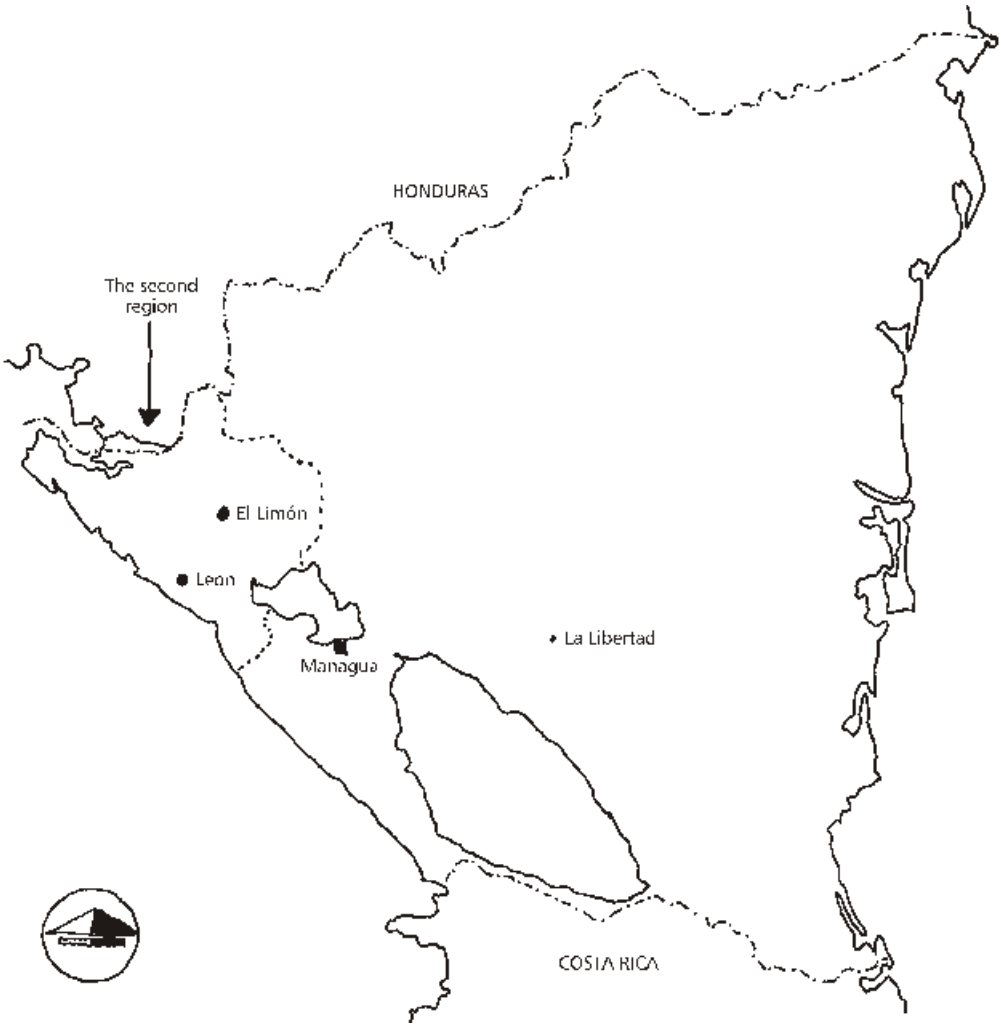
Our first discussions on this project took place in 1987. The project is one step toward development of better stoves and kitchens in many countries of the world.

Lund, March, 1992

Maria Nyström, Principal Researcher

Abbreviations

CIPDC-Nicaraguác	Centro de Investigación, Planificación y Desarrollo Comunal-Nicaraguác
DINOT	Dirección de Investigación y Orientación Tecnológica
INE	Instituto Nicaragüense de Energía
INMINE	Instituto Nicaragüense de Minería
LCHS	Lund Centre for Habitat Studies
SIDA	Swedish International Development Authority
UNI	Universidad Nacional de Ingeniería
UNIFEM	United Nations Development Fund for Women



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Summary

A community development program was initiated in two mining villages in Nicaragua at the beginning of 1990 with SIDA support. One activity was building and improving around 80 dwellings. The implementing organisation CIPDC-Nicaraguác, a local NGO, had little experience with kitchens and stoves, and collaboration was sought with LCHS at Lund University. A proposal for a complementary project on improved kitchens and stoves in one of the two villages was presented to SIDA who agreed to support a pilot phase.

The aims of the project were to build up knowledge and experience in the area of kitchens and stoves on different levels, mainly in the village. The technical support included:

- studying the possible solutions, drafting a proposal for improved stoves appropriate for El Limón, training local people in stove making, and building stoves in the new or improved homes of the housing project
- drafting proposals for two pilot kitchens of different design and building them.

One strategy to fulfil the aims was to involve relevant institutions or groups at local and national level, i e the School of Architecture, DINOT – a research institute working with alternative energy, and a group of village women who became known as "the stove group". The participation of villagers in all the work, including decision making, was fundamental.

The aim of the present report is to describe the project process including the goals, what really happened and what conclusions can be drawn.

The stove related work can be roughly divided into four phases:

1. May 1990 – Measuring fuelwood consumption and the efficiency of some traditional stoves; testing local materials, particularly clays, appropriate for building stoves; and building seven stoves similar to the Indian Nada Chula. This work was led by a consultant stove expert provided by LCHS.

2. June to October 1990 – Monitoring and testing of the new stoves by the project manager, the stove group and the research institute.

3. October 1990 – Evaluation of the stoves, further development of materials, training women in the stove group to build stoves under the supervision of the consultant stove expert.

4. After October 1990 – Further training, monitoring and building of stoves in somewhat larger number. The parties involved were the stove group, the project manager and the research institute.

Proposals for new kitchens were elaborated by an architect from CIPDC-Nicaraguác on the basis of case studies of existing kitchens and discussions with users of both the existing and the new kitchens. Women were encouraged to think about and express their ideas of a good kitchen. Finally four kitchens were built, two new constructions and two renovations of existing kitchens, using different materials

and designs. The two new constructions tried to use very different designs incorporating seldom used local materials/techniques, adobe and bamboo. The kitchens were built by the stove group with the help of a construction manager.

The new stoves and kitchens have created a lot of interest both in and beyond El Limón. The women in the stove group are very satisfied in general, although enthusiasm and consequently participation varied during the project, especially before the results of the work, the first finished kitchen and stove, were seen.

The project continues to spread its ideas and knowledge in and outside the village. Around 60 stoves have been built in El Limón and the interest in getting a stove and willingness to pay for it is steadily increasing. Of the stoves built some have been installed in dwellings that have been improved within the housing project while a majority are installed in households outside the project. From now on stoves will also be built in the new houses that are recently finished and to which the families will move during September.

Up till now there has not been a well functioning payment system, with the result that many have not paid for the stoves. However, now when the interest is growing and the stove builders have more experience they have decided that stoves built in the future must be paid for and that the money shall be the start for a fund for the stove group from which to pay the stove builders, etc.

The project manager and the stove group are also involved in exchange of experience outside the village.

- In September the project manager and three women from the stove group will travel to Guatemala to exchange experiences with a stove project there.
- Through the project manager CIPDC-Nicaraguác is trying to give technical support to a project in a residential area in the city of Le¢n which includes building of 16 new dwellings and where the people are also interested in improving their stoves.
- The kitchen and stove project was recently presented at a seminar arranged by UNIFEM with focus on appropriate technologies and women. The project in El Limón is one of very few within this area in Nicaragua.

From the above mentioned it must be concluded that the project has been successful and that the work done by the women's group and the project manager Herminia Martinez has been decisive for the achievements.

To learn why it worked and what could be done better is an important part of the building up of knowledge for all parties involved including SIDA. An evaluation which could provide important input to future projects is therefore very important. (See also page 9).

Conclusions

Is the project successful?

Is the stove and kitchen project in El Limón successful? It is not yet possible to give a conclusive answer. Little time has passed since the start of the project, and even if there have been achievements, the more long term aims like building competence takes time. This is especially so since the ideas of the project were new to most parties involved and meant changes to old ways of thinking. Lack of traditions to take initiatives and work together also contributes to making the introduction of new ideas in the village difficult. Problems in the national economy have also hindered the project. One clear weakness is also that the kitchen and stove project was not integrated into the housing programme to the extent originally intended.

There have been achievements, even if the improvements and building of capacity still are limited to a smaller number of households and persons. The stove group has played an important role for this as well as the project manager from CIPDC-Nicaraguác Herminia Martinez whose enthusiasm, understanding of the project and good relation to the women has been decisive for the progress of the project. The support given by LCHS, especially in connection with the two visits, has been fundamental for the technical input.

It is hoped that in the long run the knowledge and experience will spread in and outside the village.

The project was extended to the middle of 1991. An evaluation of the project is planned for after June 1991, if possible in conjunction with an evaluation of the whole community development programme in El Limón. The aim of the evaluation is to find out what has worked and why and what could have been done better with focus on the process and the results.

An evaluation should look at:

- how the strategy has worked, i e the cooperation between the different parties, their roles and influence, the division in different periods, the bottom up and local perspective, etc.
- what the new kitchens and stoves have meant for the users.
- if the kitchens and stoves respond to the needs of the users, are they appropriate in materials, durability, price, etc.
- how are the kitchens and stoves used: has the introduction of improved kitchens and stoves influenced cooking patterns, the use of space and time in the kitchen.
- the role as pilot project, i e the possibilities to spread the ideas and experiences outside the village.

Developing local competence

Important aims of the project were to build up a capacity base on local as well as on regional level through the formation of a stove group in El Limón and the involvement of the executing agency CIPDC-Nicaraguác (Centre for Investigation, Planning and Community Development – Nicaraguác), a local non-governmental organisation, and national institutions like DINOT, a research unit at UNI, the National University of Engineering in Managua.

However, building competence has taken time for all parties involved. For each actor the kitchen and stove project has in some way meant breaking with traditional patterns and outlooks. For example, not all women in the stove group had previous experience in working together or outside the home, and for most of them building was something that men do. The people from the university were very technically oriented and had difficulties in realizing that the reality of the kitchen is not what happens in a laboratory. The architect hired by CIPDC-Nicaraguác, who was responsible for the design and construction of the pilot kitchens, had problems in understanding the ideas and working methods of the project, starting from users' needs and desires rather than the drafting board.

As the project progressed the parties came to manage more and more of the different elements in the area of kitchens and stoves. In addition to active and regular participation in discussions and activities, important reasons for this were the demonstration effect – allowing people to see with their own eyes what could be done and to compare the new with the existing solutions – and the principle that decisions should be taken by the local counterpart, the stove group.

As a result most women in the stove group seem to have understood the ideas of the project. This became evident during a small seminar held at the end of October 1990, when the women presented their experiences. Several of the women know how to build an improved stove and its advantages, and they have learnt about construction through building the pilot kitchens. Through the participation in construction, they have also learned that they can do and learn things that are not traditional for women.

Among the cooperation institutions, collaboration with DINOT has worked well, and the mutual interest in continued cooperation increased as the project advanced. The School of Architecture has not participated at all, probably due to the low priority they place on the project.

Field visits to El Limón were important for DINOT to realize the importance of the user, and that it is the connection between the user and the stove that finally determines how efficient the stove will be. This meant a big change in attitude to the project, as DINOT was not very open to new ideas at the beginning. DINOT has also increased its technical knowledge on testing the efficiency of the stoves and the materials appropriate for stoves.

However, since DINOT made only a few visits to the village, their active participation and training in building stoves was slight. Their limited presence also contributed to creating bad contact with the women in the stove group who feel that they have not learnt much from DINOT.

CIPDC-Nicaraguác's limited interest in the project has influenced both competence building within the organization and the transfer of knowledge to the housing programmes in El Limón and La Libertad. As a result of the limited interest only a few persons in CIPDC-Nicaraguác have gained from the competence building efforts, and only the project manager Herminia Martinez has mastered the ideas and aims of the project.

Transfer of knowledge

The demonstration effect is an important and even decisive factor for the transfer of knowledge, and this has been confirmed by experience during the project.

One example is the construction manager who, when starting the building of the kitchens, had no previous experience in working with women and had never before thought of kitchens and the stoves. After building the first kitchen, he planned to build a similar kitchen equipped with an improved stove for himself. And he had discovered that working with women was not so bad after all.

With time enthusiasm not only increased within the stove group, but there was also increasing interest, especially in the stoves, among people in and around El Limón. The stove group received a lot of visitors who wanted to see the new stoves and kitchens; the women had meetings with families in the housing project to inform them about the project. However, they did not have enough information about building costs, which limited the promotion of the improved stoves and kitchens.

The competence acquired within CIPDC-Nicaraguác can form the base for spreading the experiences. DINOT has increased its knowledge and understanding of what a stove project and the introduction of new stoves imply, which give them better potential to implement and support stove projects in the future.

Women's participation

A basic principle of the project was that the stove group should not only participate in the practical activities, but in the longer term should take an active and leading role in the decision making process.

What has happened in reality? With time the women slowly started to feel themselves part of a group. As one woman said, "Even if we sometimes fight, discuss and do not at all agree, when it comes to it, we are one group". However, participation has been irregular both in time and among the members; mutual aid has not worked satisfactorily, which meant more support was needed from the construction manager. Interest in the project has been closely linked to the achievement of visible results and consequently interest has increased with the progress of the project. When things took more time than planned, like building the adobe kitchen, motivation and participation went down. Not the least at these moments the support and the encouragement of the project manager were important. Some of the more important reasons for the ups and downs are:

- the limited time that the women have for project activities especially since several of them work half time as teachers,
- lack of experience in community work and mutual aid,
- poor understanding of their own problems and possible solutions,
- the unstable political and economic situation, causing insecurity among the population and increasing the project costs.

It has not been too easy to find a balance between encouraging the stove group to take responsibility for the project, when most things are new to the women, and just taking decisions to keep the project moving. One reason is lack of experience in working with and understanding the content of the project, and in working on equal terms. The lack of experience was common to all parties involved, the stove group as well as the executing agency CIPDC-Nicaraguác.

Choice of kitchens and stoves

To ensure that the pilot kitchens and the stoves were, as far as possible, based on local traditions, materials and needs, the users had to influence the design. The idea was also to show alternatives to the existing kitchens and stoves that are economically feasible, not to present one final design.

The women in the stove group have been using their new stoves for almost one year, and they are quite enthusiastic. A growing interest has also been shown by other inhabitants in and around the village after seeing and hearing about the new stoves. Perhaps the most important reason for the acceptance of the stoves is the new design, which:

- has been chosen with the active participation of the women,
- responds to needs felt and expressed by the users,
- was not foreign but rather an improvement of the best existing stoves, and
- has not required major changes in cooking habits and management skills.

The women mention reduction of heat and smoke first, when asked the advantages of the new stove. This also seems to be the most important, as it improves the indoor environment and working conditions in the kitchen. Saving fuelwood was less often spontaneously mentioned, even if all women, when asked, estimated savings up to 50% depending on the type of firewood and the sizes of logs. The women also say that the new stove saves time as the food cooks faster and the stove has space for two pots. Many traditional stoves only have space for one pot.

To take full advantage of the “improved stove”, some changes in behaviour are necessary, especially with maintenance and use of fuel, since the space for firewood (the combustion chamber) is radically smaller than in traditional stoves. To assure a proper use of the stove, it is fundamental that the user is taught and understands how the stove works and how to use it in the best way. Information and follow up are therefore very important.

In the case of the kitchens the suspicions about the materials (bamboo and adobe) and fears that the new kitchens would be too small disappeared as soon as

they were put into use. The change in opinion was general among the women in the stove group when they saw the finished kitchens and started to work in them. They even thought that a small but well designed kitchen with well located functions could be more comfortable.

Again the importance of the demonstration effect is confirmed. Still, fundamental for the success is that the women themselves have participated in the design process and the construction of the kitchens, even if there were communication problems between the architect and the women.

Background

Kitchens and stoves in Nicaragua

Few organisations in Nicaragua work with improved wood stoves, and there are relatively few experiences despite the fact that approximately 70% of the households cook with firewood, most on open fires.

Guatemala is perhaps the country in Central America that has come furthest. A wide range of organizations and institutions carry out applied research on stoves for rural or urban areas. Most of them also have their own projects.

Most of the attempted stove projects in Nicaragua have failed. Two of the more important causes are lack of follow up and taking stove models from other countries without adapting them to local needs, traditions, materials and kitchens. Like in many stove projects, stoves were taken out of context, both cultural and physical.

Organisations currently working with improved woodstoves in Nicaragua include Save the Children, which has been building the traditional Lorena stove (from Guatemala) for several years, and DINOT which focuses on development of appropriate stoves for urban or semi-urban areas. The stoves are used and tested by households in the outskirts of Managua.

Efforts to initiate stove projects have also been made on national level through the Nicaraguan Institute of Energy (INE). A national woodstove seminar was held at the end of 1989 and led to the formation of a national commission for woodstoves. So far the group has not fulfilled its objectives.

If stoves have received limited attention, the kitchen has been completely neglected by both the users and the architects. Few dwellings include a cooking area appropriate for the fuels and stoves used, or that fulfils the functions and needs of a kitchen. Instead many kitchens are badly ventilated, dark, hot, smelly and smoky. Too avoid some of these problems, especially the smoke, many families who build their own kitchens prefer to have them separate from the rest of the house.

Why a project to improve kitchens and stoves in El Limón?

The Swedish government through SIDA has supported programmes to develop the mining sector in Nicaragua since 1981. However, little had been done about the living conditions of the miners.

On the basis of requests made by INMINE (the Nicaraguan Institute of Mining) and one of the mineworkers' unions, SIDA asked CIPDC-Nicaraguác, to draft a proposal for a project with a focus on community development in two villages. The

proposal for a three year project “Social Investments in the mining sector in El Limón and La Libertad” meant cooperation between CIPDC-Nicaraguác and INMINE, with the former as the executing agency. SIDA agreed to support a first phase to take place during 1990.

Important aims of the social development program were to:

- improve the living conditions in the two villages
- promote individual decision making
- develop and strengthen local institutions
- promote community development through self help and mutual aid
- strengthen and build up the executing agency CIPDC-Nicaraguác.

A housing project including the building and/or improvement of 60 dwellings in El Limón and 20 in La Libertad was to be the main activity during the first year.

As CIPDC-Nicaraguác did not have experience in the area of kitchens and stoves, collaboration was sought with LCHS, resulting in a proposal for a complementary project in El Limón to improve the kitchens and stoves, within the context of the housing project.

The first step towards a proposal was an appraisal study done at the end of 1989. The study was carried out by LCHS in cooperation with CIPDC-Nicaraguác and included a field visit to El Limón. (See the report published by LCHS: *Tortillas must be baked on flames*). The aim was to document the existing situation of kitchens and stoves, and to identify needs and the people’s interest in such a project.

The proposal was presented to SIDA, and in the beginning of 1990 a project agreement was signed with CIPDC-Nicaraguác in cooperation with LCHS[1].

Strategy and aims

The long term goal is to contribute to the development of competence within the area of kitchens and stoves on different levels in Nicaragua, although mainly the village El Limón. This will also make it possible for the knowledge and ideas of the project to spread both in and beyond the village.

Other general aims were as follows.

- To improve the working conditions in the kitchen through improved ventilation and reduction of heat and smoke.
- To increase fuel efficiency.
- Through the building of pilot kitchens to show alternatives to the traditional kitchen, in design, materials and use of space, to the people in the village and especially the target group (the 60 families in the housing project).

Specific aims were to:

- To propose one or more improved stoves appropriate for the village.

1 LCHS’s participation in The Kitchen and Stove project was supported through a contract between SIDA and the Stockholm Environment Intsitute.

- To train local people to build the stoves.
- To build improved stoves in the houses of families in the target group who were interested and agreed with the conditions.
- To build two pilot kitchens using different materials and designs.

Four important prerequisites to fulfil with the aims were set up:

- The local approach: i e; materials used should as far as possible be local; the new designs for stoves and kitchens should be based on local traditions, habits, needs and opinions expressed; and local people should build the stoves, promote them and take the decisions.
- Collaboration with institutions working with similar issues on national level, in this case the School of Architecture and DINOT
- The bottom-up approach, i e that the people in El Limón form a stove group to be the local counterpart, which should be actively involved in the planning and implementation of the project, including defining the strategy and work-plan.
- Regular contact and exchange of information between LCHS and the project including two visits by LCHS.

Objectives of the report

The objective of this report is to describe the project process: what was planned, what happened and what conclusions can be drawn.

Actors

The cooperation between groups and organisations working on different levels and representing different aspects has been fundamental for the work of the project. A short description of the different participants and their roles in the project follows. For names and addresses see Appendix A.

CIPDC-Nicaraguác – the implementer

The Nicaraguan non-governmental organization CIPDC-Nicaraguác was established in 1989 to promote integrated development in urban and rural areas, above all in the second region (León and Chinandega) of Nicaragua. One major area of action is building projects based on popular participation.

CIPDC-Nicaraguác was responsible for the implementation of the stove and kitchen project including:

- design and building of pilot kitchens
- organization of people
- supervision
- coordination of groups and institutions involved
- dissemination of the kitchens and stoves
- technical and social follow up
- training of stove builders and promoters.

The project group has mainly consisted of a project manager, Herminia Martinez and, for shorter periods, an architect hired by CIPDC-Nicaraguác, Carolina Madriz.

LCHS – the technical adviser

LCHS (Lund Centre for Habitat Studies) is a research body within the School of Architecture at Lund University, Sweden. LCHS mainly acts in two domains, i e household energy related to housing design, and construction related to climate and resource saving methods.

The role of LCHS in the project has been to give technical advice and to build up local competence within CIPDC-Nicaraguác and the village. LCHS has contributed:

- to the design, production and spread of the stoves, by providing a stove expert, Auke Koopmans,

- to the studies of existing kitchens, and the design and building of pilot kitchens,
- to monitoring of the project activities,
- to administration of project finances and communication between SIDA and the project.

DINOT and other cooperation partners

To promote the exchange of knowledge with institutions working in the area and to build competence on national level, long term collaboration was planned with the School of Architecture and DINOT, a research unit at the University of Engineering that does applied research in renewable energy.

Contact had already been made with DINOT during the appraisal study, and it was agreed that as part of the collaboration DINOT would give technical support to CIPDC-Nicaraguác.

When initiating the kitchen and stove project contact had already been established between the School of Architecture and CIPDC-Nicaraguác; the school would participate in the development of the pilot kitchens.

By chance the project came into contact with Mr Ron Rivera who has started a ceramic workshop in Managua. Ron has mainly helped with the identification of good clay for chimneys and then trying to produce them.

The stove group in El Limón – the local counterpart

A stove group was formed in El Limón at the beginning of 1990 with the support of CIPDC-Nicaraguác. In the start the group consisted of 10 women, a majority of them teachers, who had expressed interest in stoves and kitchens and were willing to act as promoters, not only for stoves and kitchens but also for other activities like tree planting. At least one person already had some experience in stove building.

El Limón

The village

El Limón is a semi-urban village with slightly more than 3,000 inhabitants, located 50 km north-east of the city of Le¢n (see map on page 4). The climate is semi arid with a dry period from November until the rain starts sometime in May. Normal temperatures are between 28 and 38°C.

One of the country's most important gold mines is located here, and the mine constitutes not only one of few working opportunities but also the most important. The history of the village which circles the mine is both short and special. The English started exploiting the mines at the end of the 19th century and in the 1950s the Americans took over. With the revolution in 1979, the mine was nationalized, and today it is run by one of INMINE's companies. However, due to growing economic problems both on national level and within the mine, there are discussions about the mine's future.

The workers have always been very dependent on the mining company. This dependence continues and is expressed in a lack of individual initiatives to improve living conditions. If a door falls down, you wait for the mine to hang it up again. A part of this special relation is the traditional responsibility of the mining company to provide electricity, water and housing to its workers.

The dwellings which to a big extent are owned by the mining company are in general not well maintained. They can roughly be divided into three types: barracks, row houses and individual houses. The problems of crowding are biggest in the barracks which are very small (approximately 25 square meters), while the living spaces are bigger in the individual houses.

The household energy situation

In El Limón as in most Nicaraguan homes, cooking is the most energy consuming activity of the household. The most common fuel used is firewood but several families complement it with an electric hot-plate for quick small meals, and some better-off families use kerosene as their main fuel.

The impression is that a majority of the households collect their firewood on a small scale from nearby forests, while some hire or borrow a truck once a month, or less often, to collect larger quantities of firewood. There are also households which buy firewood from sellers passing the houses with carts. Particularly in female headed households, a big part of the fuelwood seems to be bought.

Almost all households in the village are connected to the electricity grid. Electricity, which by tradition is provided by the mine, is mainly used for lighting and electric appliances.

Transport of firewood

The energy is in general used inefficiently, mainly due to bad equipment (stoves, etc), lack of information/knowledge and traditional habits. One example of the latter is that firewood is seldom cut into smaller pieces. Instead many put logs of one meter into the fire and do not remove burning logs after cooking to use later.

Traditional kitchens and stoves

Kitchens

Kitchens are generally given low priority when it comes to household investment. They are badly maintained and most often in a worse condition than the dwelling. The design and building materials are frequently simpler; roofs of corrugated iron sheets without ceilings, wood or pole walls and cement or earth floors.

Many kitchens are built separate from the main dwelling, and families who themselves have chosen to do this say the main reason was to avoid smoke coming into the house.

A barrack with a low smoky kitchen to the right

The kitchens of the barracks in particular are small in relation to all their functions. Low roofs, few and badly located window and door openings create bad ventilation. In combination with the use of open fires, this results in the smoke staying in the kitchen and in high temperatures when cooking. Closed kitchens are dark, and the user needs electric light even during the day. Rain frequently enters the kitchen mainly through the roof.

Stoves

The traditional stove in El Limón is the open fire made in different ways. The most common is made in the form of a U using one or a combination of the following materials: bricks, tiles, concrete blocks, or clay. The pot is put directly on the stove, or on metal bars or a metal sheet when the pot is small in relation to the combustion chamber.

The stove is usually built on a base made of half an oil barrel or a box of wood filled with stones, sand, soil and/or ashes.

Several families use simple metal stoves for charcoal or firewood that are made by the mining company, while some have a closed wood stove equipped with a chimney. However, few of the latter seem to work satisfactorily because of bad design, bad position in relation to airflows, or lack of cleaning.

There are families that complement the open fire with an electric hot-plate and/or more rarely a gas stove. Households that mainly use a kerosene stove for cooking are exceptions.

A tortilla is baked on a traditional stove with U-form

A metal stove made in the mine company's worshop. A temperatute of 50°C around the stove when cooking in this kitchen is not rare

Stoves

At the start of the project

The most important – a group of women interested in the project had been formed in El Limón and a first contact had been made between them and the other future participants in the project, CIPDC-Nicaraguác and DINOT.

According to the results of the appraisal study, it had been agreed (see report *Tortillas must be baked on flames*) that CIPDC-Nicaraguác would identify local human and material resources relevant for the project. It had also been agreed that the organisation would follow up the contact taken with DINOT.

By May and the first visit of LCHS, part of the preliminary tasks had been carried out: the formation of the stove group and the contact with DINOT. The latter had resulted in two workshops with the stove group about the importance and advantages of improved wood stoves. Two improved stoves of the CETA model (a prefabricated two pot-hole stove from Guatemala) had been built by DINOT in the houses of two members of the stove group. However, the lack of baseline data on fuelwood consumption, stove efficiency and cooking practices made it difficult to analyse and compare the CETA stove with traditional stoves.

From clay to pilot stove

The interest and participation of the stove group increased little by little during this period which included identification of appropriate clays and collection of baseline data, but it was not until the first stove was put in use that the women really became enthusiastic and doubts disappeared.

The purpose of the first visit by LCHS with the stove expert was to initiate the technical and strategic aspects of the stove project within CIPDC-Nicaraguác and in El Limón, including developing stove prototypes and an implementation strategy. The plan was to build stoves during the visit using proven materials and train selected persons so that additional stoves could be built before the second visit.

However, discussions held with the project manager on arrival and the first field visit to El Limón showed there was need of further work to identify and test materials appropriate for stoves. The two stoves built by DINOT gave further support to this as these appeared to be very expensive to construct (approximately US$36 per stove). To make these stoves accessible for the target users large subsidies would be needed[2].

The use of unproven materials in the construction of the new stoves, and the new designs, made a longer testing period necessary, and meant a change of the

2 The stoves are made of cement mixed with sand or ground bricks, metal and concrete pipes for the chimney.

original strategy. It was decided that the stoves built in May should be tested from June until the second visit in October, and that no additional stoves should be built to avoid losing the population's confidence in the project. The decision was facilitated by the delay of the housing project by half a year, as the target groups are the same for the two projects.

Except for testing local materials the first part of the visit was spent collecting baseline data on fuelwood consumption and testing the efficiency of existing stoves. A survey on fuelwood consumption including both poor and less poor families was carried out. (See the table below). The results must be treated with caution as the study was limited. The average consumption found was 1.2 kg per capita and day, which is radically lower than estimates made by the Nicaraguan Institute for Energy (INE)[3].

Fuelwood consumption in eight households in El Limón (May 1990)

Household	*No. of persons and age*					*Fuelwood consumption*					*Average in kg/day/*		
Name	*Total*	*child <14*	*F >15*	*M 15–59*	*M >59*	*person equiv.*[a]	*day 1*	*day 2*	*day 3*	*day 4*	*house-hold*	*ca-pita*	*pers. equiv.*
Yolanda	12	3	5	4	0	9.5	13.4	10.7			12.05	1.00	1.27
Aurora	9	1	4	4	0	7.7	11.5	14.4	12.0	13.0	12.73	1.41	1.65
Maria Jesús	12	6	3	3	0	8.4	12.3	11.6	7.8		10.57	0.88	1.26
Magdalena	12	3	5	4	0	9.5	14.5	18.0	8.4	21.5	15.60	1.30	1.64
Maria Luisa	4	0	3	1	0	3.4	7.4	8.4	6.4	13.9	9.03	2.12	2.05
Alejandra	10	4	4	2	0	7.2	4.3	17.9	10.5	4.6	9.32	0.93	1.30
Hilma	5	0	5	0	0	4.0	5.4	6.9	5.1	4.2	5.40	1.08	1.35
Total	64	17	29	18	0	49.7	68.8	87.9	50.2	57.2	10.67	1.20	1.50

a *The number of person equivalents (p.e.) are calculated since persons of different sexes and ages do not eat the same quantities of food, which influences the consumption of firewood:*
– children 14 years and under – 0.5 p.e
– women 15 years and over – 0.8 p.e.
– man between 15 and 59 years – 1.0 p.e.
– man over 59 years – 0.8 p.e.

Some water boiling tests were carried out to get an idea of the efficiency of the three most common types of stove in the village[4]. The test is normally done on cold stoves, but as it is difficult to find a cold stove in El Limón due to the long cooking periods, the tests were made on stoves in use. The results (see appendix B) are somewhat difficult to interpret. The test was done on stoves equipped with a baffle rather than the traditional village stoves. However, the testing and/or calculation method is not crucial as it is only used to compare stoves in El Limón, and the same method is used for all stoves.

In deciding which stove model to introduce, the stove expert proposed a design similar to the Nada Chula. The choice was based on observations and conversations with women in the village made during the appraisal study and the consultant's

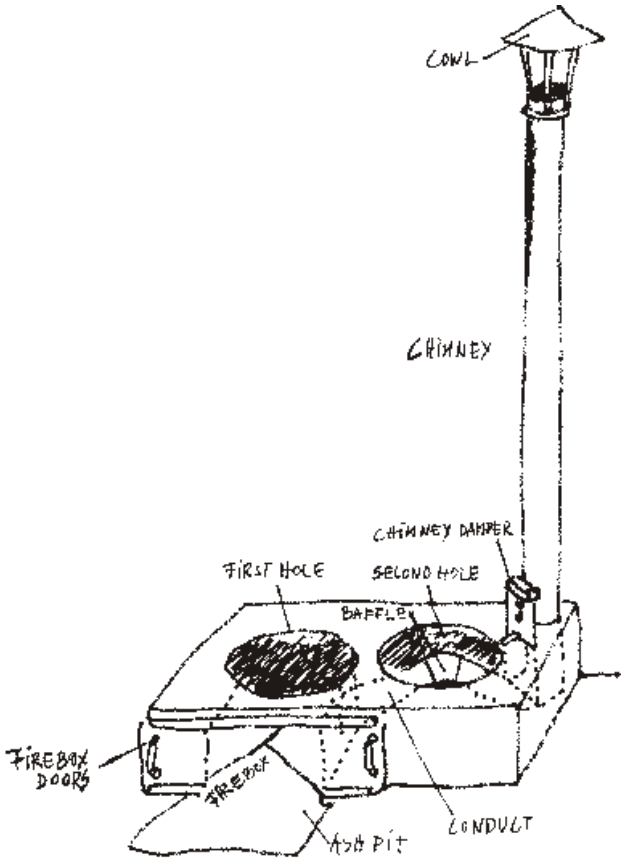
3 2.5 kg per capita and day for Nicaragua and 1.85 per capita and day for the city of León.

4 A two-pot metal stove consisting of a metal box without chimney and grate, a single pot protected three stone stove without chimney and grate, and a two pot brick/mud stove.

A family's daily consumption of firewood is measured

own observations. Two types of stove would be built; one made almost exclusively of clay and one of clay and bricks (see pictures below).

As the aim was to use local materials the first step was to test the suitability of available clays. Many of these clays showed high shrinkage or contained large amounts of stone and other foreign matter, which would result in problems with cracking stoves. Three types were selected of which two came from the El Limón



The Nada Chula stove from India

area and one from Larreynaga village, a distance of about 45 km. This latter clay was known to be good for making stoves.

Most of the clay types selected had low plasticity, and it was decided to mix them with horse dung which is easily available and improves the workability of the clay.

Altogether seven stoves were constructed in May, one at the village office of CIPDC-Nicaraguác to serve as a demonstration stove, and the others in the homes of stove group members. Six stoves were built of bricks and clay, while one was made entirely of clay. All seven were equipped with two pot holes, metal bars to strengthen the weak points, a baffle between the first and the second pot-hole and a concrete pipe chimney. The sizes of the two pot-holes were made to fit the pots most often used by the household as indicated by the user. Most households has several pots of different sizes and materials and it should be mentioned that there is no real standardization of pots or cooking vessels in Nicaragua.

The pot holes of the demonstration stove are adapted to the size of the pots by the stove consultant with assistance of the project manager

The finished demonstraton stove is tested for the first time

Clay is prepared by women in the stove group and the project manager

New stoves built in El Limón

Name	*Type of materials used*	*Type of stove*
Maria Luisa	bricks, tile clay (Victoria)	2-pot chimney stove
Maria Jesús	bricks, river clay	2-pot chimney stove
Magdalena	bricks, clay (Larreynaga)	2-pot chimney stove
Yolanda	bricks, clay (Larreynaga)	2-pot chimney stove
Aurora	bricks, river clay	2-pot chimney stove
Amanda	clay (Larreynaga)	Chula 2-pot chimney stove
Hilma	bricks, cement and pumice	CETA 2-pot chimney stove
Silvia	cement and pumice	CETA 2-pot chimney stove

The stove group began to participate slowly in the different activities, even though they were uncertain in the beginning. According to the strategy worked out together with the stove group members, the stove was provided free if the user prepared the base, used the stove regularly, maintained it, made observations and monitored the stove's materials, construction and use, and promised not leave the group if there were problems (like cracks) with the stove.

By the end of the May the stove group consisted of seven women. One woman had left the group already in April as she did not like the CETA stoves built, one woman who had been given a CETA stove was not interested in participating, while one left the group because she did not agree with the conditions to get a stove.

The project had also contacted a farm family living on the outskirts of the village that had experience in earth construction and working with clay for making stoves. Several visits were made by the project manager, LCHS and women from the stove group. The family said they did not have time to participate in the project, but it was decided to keep contact.

The work plan to October developed by all the parties, included:

- testing the eight stoves built,
- regular monitoring of the stoves,
- measuring fuelwood consumption of new stoves.

In addition CIPDC-Nicaraguác would take immediate action to complete the chimneys for all stoves built during the visit as, due to time constraints, only the first pipe had been installed.

For the continuation of the project the stove group among themselves chose a coordinator, Amanda, while another stove group member, Maria Luisa, was chosen to be responsible for giving and supervising the technical follow up of the stoves built in cooperation with the project manager.

Efforts were made to sign a formal cooperation agreement with DINOT on the stove component, and the work plan for the period to October 1990 was agreed by the end of the visit.

Testing period for pilot stoves

The decision to test the stoves built during four months turned out to be a well chosen strategy as it made it possible to identify which clays were appropriate for building stoves and to get more information about users' needs and the main problems related to the use of the stove. It also meant time for the stove group to understand the aims of the project and to develop and strengthen even though the participation and enthusiasm varied during this period.

Most of the work to be carried out during this period was completed as intended with the exception of the fuelwood measurements. These could not be done as DINOT staff, who should have been trained to do this work, were not available due to logistic problems.

The other activities e.g. the efficiency measurements and monitoring the condition of the stoves were carried out by CIPDC-Nicaraguác in cooperation with DINOT, Amanda and Maria Luisa, the coordinator respectively the technical supervisor from the stove group.

It is clear that the different stove types did not show great variation in fuel efficiency as all but two were in the same range, between 22% to 26% (see appendix C). However, it should be noted that the number of tests was rather low and that large variations in test results were found. This is also evident from the high values for the standard deviation.

Comparing the efficiency data with the results of the traditional stoves, it is evident that the new stoves are about 50% more fuel efficient (improved from about 15% to 22.5%). With other words they use about one third less fuel than the traditional stove. Some of the users claimed savings up to 50% in fuelwood with the new stove and with chopping fuelwood into smaller pieces. Unfortunately, this has not yet been confirmed by fuelwood consumption measurements.

To observe the use of the stoves and get users' comments, households were visited by representatives of DINOT, CIPDC-Nicaraguác and the stove group, and also by the stove group coordinator alone.

Most stoves were found to be in a good condition (see Appendix C). However, two of the stoves made with clay from a river near the village (Mayakunda) began cracking right after construction, and although constant repairs were made, cracks kept developing. It was decided to scrap the stoves and construct new ones using clay from Larreynaga. On another stove, made with clay from El Limón, the seat part around the first pot broke away. After repair, the joint flaked away because the bond between the old and new parts was not good. This might have been caused by the clay (high silt content), but probably the reason was that the stove was still hot and not clean at the time of repair, but this could not be confirmed.

Most of the women were very satisfied with their new stoves. Still, big variations in use and maintenance could be noted as the new stove means a change from traditional ways of using stove and fuel. In one stove the baffle below the second pot seat was completely broken by wrong use. In the old traditional two pot stoves there is no baffle, which allows users to push the burning logs directly under the second pot. With a baffle this is not possible; forcing in logs breaks the baffle. The habit of using long logs (one meter long is not unusual) contributes to the problem

Example of inappropriate use of the improved stove. This woman had never seen this kind of stove before and used it like her old stove which had pot-holes that did not fit the pots. She has put a metal bar across the top of the pot-hole to support the pan. But this allows the heat and smoke to escape. The pot should sit in the pot-hole and seal it.

as can be seen in the picture below, where flames come out in front of the stove opening. It can also be noted that the woman has put a metal bar down in the first pot-hole, which makes the flames come out and the fire less efficient.

Examples of other problems were: the users did not repair the stove at all or used ashes which destroys the stove; they did not remove ashes from the tunnel between the first and second pot-hole so the smoke was blocked; and few women used the second pot-hole correctly.

One user, Aurora, who had her stove rebuilt because of problems with the clay wanted to add a third pot-hole, because the original two pot-holes were placed too close together to use two big pots at the same time.

The participation, interest and enthusiasm of the stove group and its members varied during this period. The coordinator of the stove group in particular showed little interest. Some of the reasons were directly related to the project, like the disappointment with the stoves and the lack of experience to do other things than the traditional domestic tasks. The national situation, increasing economic problems and the unstable political situation also affected the village. The teachers felt their salaries and jobs to be threatened.

To promote the women's interest in the project and strengthen the stove group, a visit was made to a cooperative that makes pottery, and several meetings and discussions were held with the group.

Evaluation and new workplan

The evaluation not only gave a basis for defining the future workplan. It was also important for the future cooperation as the experiences from the evaluation helped everyone understand and agree about what things, such as the importance of the user, were fundamental.

Compared to the first visit, the visit in October focussed less on the technical aspects but instead concentrated on evaluation, planning, discussions, and meetings with the participants.

The visit started with an evaluation of the work achieved, including the design and materials of the stoves, to develop guidelines for the future. Other activities carried out included construction of other stove types, training of stove installers, evaluation of raw material.

All parties involved in the project participated in the evaluation. Discussions with the stove group included socio-economic topics like acceptability of the stove, advantages and disadvantages, functions, costs and ability of people to pay for the stove. Technical aspects like the life time of a stove, ease of manufacturing and repairs, adaptability to different sizes of cooking pots and availability of stove construction materials were discussed with all participants.

The unanimous conclusion was that the improved stoves were better than traditional ones, particularly in saving fuel and in being less hot and smoky, which improved the working conditions in the kitchen considerably. No bigger differences between the brick-clay and the CETA stove were mentioned except that the CETA stove, made of cement and pumice, became very hot after some time. Several of the users found the brick-clay stove's flexibility in the placing of pot-holes and the adaptability to different sizes of cooking pots to be an advantage.

A general comment made by the users was that the distance between the pot-holes should be increased because the present design made it difficult to fit two large cooking pots in the pot holes at the same time.

No conclusions could be drawn about the lifetime of the stoves as they were still quite new at this time (installed less than a half year previously). However, it was feared that problems might occur with the bridge over the fuelled opening and between the pot-holes in the brick-clay stove, and separation of the top cover from the walls might pose a problem for the CETA stove.

In general it was thought that the lifetime of the stove with proper use and regular maintenance would be more than two years, and it can be assumed that the CETA stove will have a longer lifetime as high grade and more expensive materials were used. Still, the high cost of the CETA stove (almost four times as high as the brick-clay stove) will make it unacceptable if the user has to pay for it.

Approximate cost of the different stove types (in US $)

Cost component	*CETA stove*	*2-pot stove*	*Chula 2-pot stove*
Clay[6]	3.00	3.00	5.00
Cement	4.00		
Brick		0.50	
Metal reinforcements	5.00	1.00	1.00
Chimney pipes	3.00	3.00	3.00
Other costs including labour	21.00	2.50	4.00
Total	36.00[7]	10.00	13.00

6 Include transport costs of the clay from Larreynaga to El Limón provided that clay is transported in relatively large quantities.

7 The US$36 does not include the base of the stove (estimated cost US$10). According to DINOT the price can be reduced to about US$28 if the stoves are built on a large scale.

In the new brick-clay stove logs of a maximum diameter of 8–10 cm only can be used because of the size of the fire box. Several women in the stove group thought at first it would be a problem to cut the firewood into smaller pieces. However,

they soon realized the advantage of using smaller pieces, and one user reported that fuelwood lasted twice as long with the new stove.

The brick-clay stove was found by the stove group to be the most appropriate stove to be promoted in and around El Limón. The stove works well, saves fuelwood, is made of local materials and can be built at relatively low cost by locally trained stove installers. The CETA stove was also considered to be a good and durable stove, but the cost was seen as a big drawback.

The stove group thought that people, in particular those who buy fuelwood, would be willing to pay for a good stove as the stove would pay itself back within a reasonable period of time[5]. Most of the women thought that villagers would be prepared to pay the whole cost to avoid doing something themselves. For that reason the women considered US$10 to be a reasonable selling price, although in some cases exceptions would have to be made to make the stove affordable to the very low income group. However, the price includes labour (preparation of clay, stove construction, etc) and since one of the aims is to promote participation of the people, it was decided to offer a lower price to those helping with stove construction. A price of US$5 was suggested.

Even though the stove group thought US$10 was a fair price, LCHS and CIPDC-Nicaraguác found the price to be quite high taking into account the lack of tradition to pay for things and the difficult economic situation.

The technical evaluation of the stoves showed that those constructed with clay from Larreynaga were far superior to those made from other clays which had greater shrinkage. Although the Larreynaga clay is easily obtainable it can be expected that the distance from El Limón will pose problems with above all transport. For that reason work was undertaken to mix river clay with varying amounts of sand to decrease shrinkage which is the main reason for cracks. A stove was made out of this mixture and although cracks appeared after a day, they were reasonably small and could be repaired. How the mix will behave in the long term is not known. The stove had a rough surface from the sand, and the stove group thought this did not look as good. A clay similar to the one in Larreynaga was found 30 km from the village. It tested well and two stoves were built (see Appendix C for clay testing).

During the visit in May only one stove model had been introduced albeit made in different ways and using different materials. During the second visit some other types were built, basically for demonstration purposes, to show alternatives in the location of the opening to the firebox and the chimney, and the number of potholes.

At the same time the opportunity was taken to retrain Maria Luisa, the technical supervisor, as there was doubt about her capability to construct stoves on her own. Training was also given to the project manager and the farmer woman, Yolanda, with whom contact had been taken in May, who at this stage showed increasing interest in learning to build stoves and to participate in the project. At the end of the visit these persons were thought to be able to construct stoves, even if there were still doubts about the technical supervisor, while others from the stove group had

5 Possibly within a few months, reckoning with a cartload of fuelwood weighing about 300 kg and costing approximately US$9–10 and fuelwood savings of 25–30%.

A stove is built by the project manager and the farmer woman, Yolanda

received a basic training enabling them to build a stove with the guidance of a trained stove installer.
It was decided to employ one person full time as stove installer for a trial period of three months – November until January). The stove group found Maria Luisa to be the most appropriate person as she had been participating full time in the building of stoves and was unemployed.

There had not been much contact between the stove and kitchen project and the housing programme. The most important activity to address this situation was a seminar at the end of the second visit with all project participants and staff from CIPDC-Nicaraguác. During the seminar the project was presented including the activities carried out and the results. The user's opinions were presented by women from the stove group.

As the cooperation between DINOT and CIPDC-Nicaraguác had been useful and mutually beneficial, it was decided that the cooperation would continue with DINOT in stove and kitchen activities. The role of DINOT should be to support and assist in studies of local materials and testing. The cooperation would be voluntary with support from CIPDC-Nicaraguác in transport and lodging.

Promoting the improved stoves

After the evaluation activities concentrated on building stoves and carrying out promotional activities among the families in the housing project.

Some further training with the project manager, the women from the stove group and the farm wife, initiated this period. Maria Luisa, the employed stove installer, did not seem to be very interested in building stoves continuously. One reason was her disappointment at the group's limited participation in the building of her new kitchen. The building of stoves was taken over by Yolanda and Amanda, the stove group coordinator, who after the second visit had become much more involved and interested in the project.

A lot needed to be done not only to promote the stoves but also to integrate the stove project in the housing project. Still, the promotion work started slowly,

partly because the project manager and women felt need of more training. Although the families of the housing project were informed about the improved stove and how to get one, stoves could not be installed until all dwellings were finished in September, as the whole programme was further delayed by three months. The stove building has therefore been concentrated to dwellings that have been improved in the housing project. However, the contact and cooperation increased with the housing project, especially through the social promoter.

The chimney – from cement to ceramics?

The chimneys installed are made of cement drain pipes as they are economically accessible for the villagers and relatively functional. Still, efforts are being made to use ceramic pipes produced locally as these are more easy to install and maintain.

The first chimneys installed were made from cement drain pipes. These pipes posed installation problems as holes for the smoke had to be cut and chimney caps made, resulting in a lot of waste. They were also quite expensive[6]. Metal chimney pipes, often used in other countries, were even more expensive since all metal is imported[7]. Other alternatives to chimneys were considered and it was decided to try ceramic pipes, as these could possibly be made by local people at low cost.

During the visit in May contact was taken with an innovative potter in Managua, Mr Ron Rivera, who has extensive experience in the introduction of new products, training and production technology.

At the request of the project in October, he made several pipes using a simple extrusion process. At the end of the month some of these pipes were available, but there were still some problems with the clay. Although the manufacturing costs were higher than for cement pipes, it is expected that the unit price will decrease with large scale production and be comparable or even cheaper than the cement pipes which have to be transported from Le¢n (55 km from the village).

The advantage of these ceramic pipes is that a chimney can be easily installed without having to cut and cement chimney caps. The cleaning of the chimney will be easier

A ceramic pipe is made by Ron Rivera and his assistant

6 For a four inch pipe with a length of 75 cm the price is about one US dollar excluding transport costs. Chimney heights are in average 2.5 m.

7 A three inch diameter pipe with a length of 2.44 meters and a wall thickness of 0.5 respectively 1.5 would cost about US$7.5 and US$25 respectively (excluding labour).

since the chimney cap can be removed and reinstalled after cleaning.

The development of ceramic chimneys was postponed because of lack of money. Therefore all the new stoves are installed with a concrete chimney. The insulation between the chimney and the roof is also concrete.

The chimney is not equipped with a damper as it was thought by all, including the stove group, that this would not be used since it was too unfamiliar. The CETA stoves built by DINOT have dampers, but the women do not use them.

Kitchens

From studies to proposals?

Studies made of existing kitchens showed that the main problems were lighting, ventilation, location, height and inappropriate building materials. The proposals to new kitchens which in the end became four instead of two took into account these problems as well as the aim to have different designs and use local materials.

The aim of building the pilot kitchens was to demonstrate how indoor climate and organization of space in the kitchen could be improved at low cost through better design and building materials.

The appraisal study in 1989 had indicated that there were several problems and deficiencies in the traditional kitchens. To learn more about existing kitchens and get a baseline for proposals for modifications, detailed studies were made of ten kitchens owned by members of the stove group, some of whom lived in the barracks and some in separate dwellings. The condition and size of the kitchens varied quite a lot, and one of the women did not have a kitchen at all but cooked on an open fire outside.

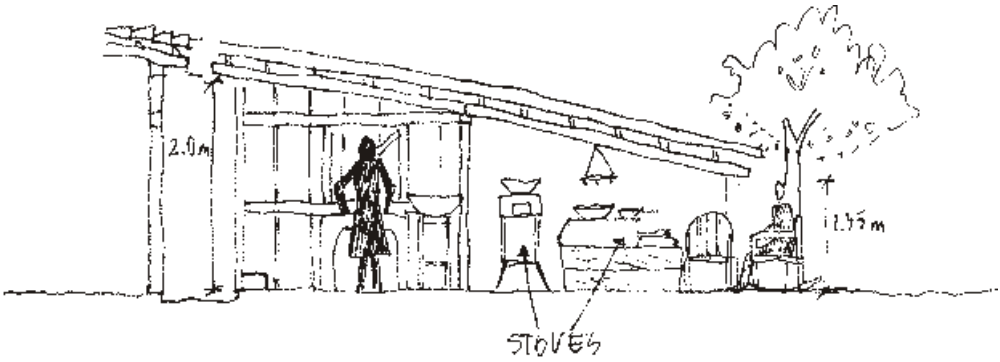
The case studies focussed on:

- design,
- location of different functions,
- equipment in the kitchen.

Later on, studies were made in some kitchens of use of space and time in connection to kitchen work to make it possible to compare the situation in the old and the new kitchen. A socio-economic study was done in a small number of households.

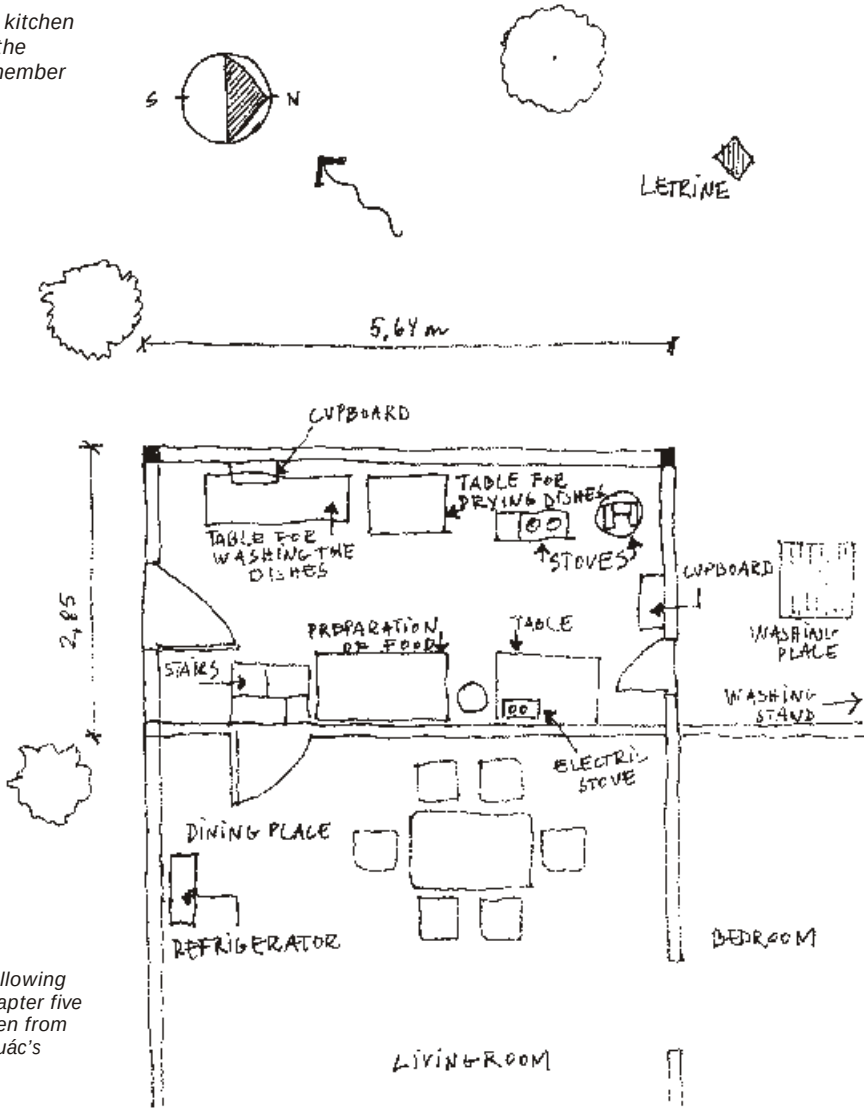
The results confirmed that the kitchen is deficient in terms of its functions and the type of fuel and stove used. The most common and severe problems were:

- low ceiling height, in one extreme case between 1.36 and 1.68.
- bad ventilation, mainly due to bad design with lack of enough well located door and/or window openings. This contributes to heat and smoke in the kitchen which seeps into the rest of the dwelling. The lack of openings makes the kitchen dark and requires electric light during the day.
- use of building materials that are inappropriate, like corrugated iron sheets for roofs, which contributes to raising the temperature in the kitchen.
- bad location of functions, resulting in a use of space that is not very comfortable or efficient.



The ceiling height is partly very low in one of the two kitchens to be improved.

Plan of an old kitchen belonging to the stove group member Magdalena.



This and the following drawings in chapter five and six are taken from CIPDC-Nicaraguác's report Informe Final Proyecto de Fogones, January 1991.

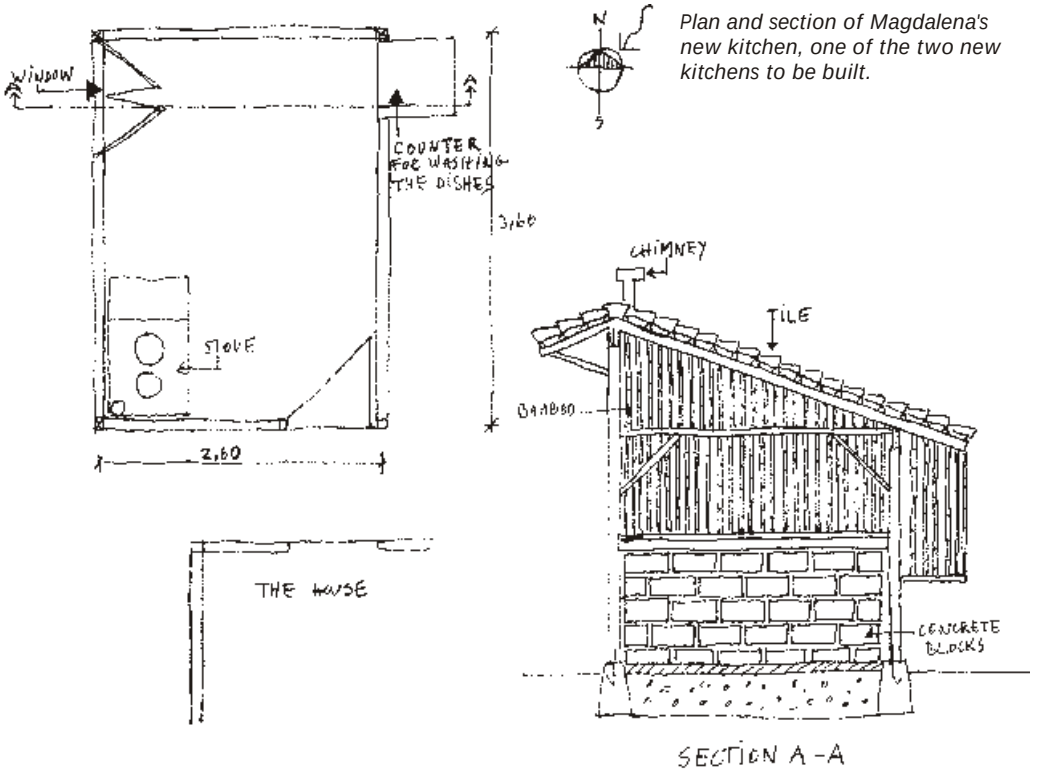
- bad location of the kitchen in relation to the house and the latrine with the result that smoke and heat seeps into the rest of the house and the latrine smell reaches the kitchen.

To get more ideas of what a new kitchen could look like, visits were made to a new settlement and a small village north of El Limón where bamboo is a common building material. A visit was also made to a family living on the outskirts of the village that has built a kitchen of adobe, sun-dried soil blocks.

The original idea was to build two pilot kitchens using different materials and designs and locate them to serve as models. However, the stove group proposed that four kitchens should be built instead, two new constructions and two improvements of already existing kitchens, for members of the group who did not have a kitchen or whose kitchen needed improvement.

The proposals for the four kitchens were developed by a hired architect in cooperation with the future owners and the project manager. They were discussed with other architects working for CIPDC-Nicaraguác and an architect employed by LCHS and based in Nicaragua. Designs were also sent to LCHS for analysis and revision.

There had to be major revisions in the first proposals as they did not vary much in design or materials used, in spite of the clearly stated objectives, and they did not completely correspond to the users' needs and wants. The architect had not completely understood the reasons for building the pilot kitchens, or that the women themselves had opinions, ideas and knowledge that must be incorporated in the designs.

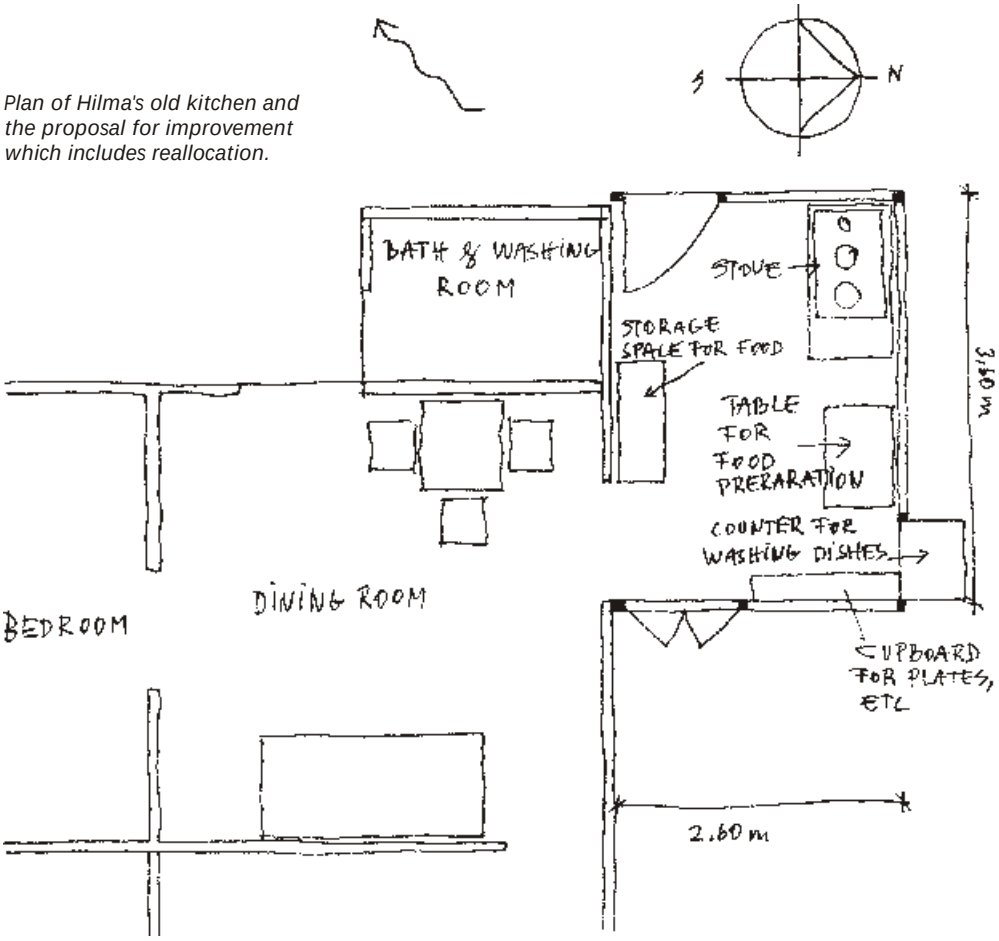


Plan and section of Magdalena's new kitchen, one of the two new kitchens to be built.

To improve the indoor environment the following design criteria were established

- The roof should be much higher than in the traditional kitchen (three meters at its highest point).
- There should be more door and window openings, placed for good cross ventilation.
- Building materials appropriate for the climate should be used: roofing tiles instead of corrugated iron sheets, bamboo and sun dried soil blocks (adobe).
- The two new constructions would be built separate from the dwelling to avoid smoke seeping into the dwelling, while in the case of the improvements one kitchen was going to be moved farther away from the latrine.

According to the design the walls of the new constructions should be made according to traditional design, “the miniskirt model”, with the upper part of bamboo and the lower part of concrete blocks produced by the women themselves. The tile roof should repose on a structure made of mainly wood but also some bamboo. The location of the window, washing place and the door were chosen to achieve cross ventilation in one part of the kitchen while the other part where the stove is placed is more protected.



Plan of Hilma's old kitchen and the proposal for improvement which includes reallocation.

The reasons for choosing the above mentioned materials were several. Not only do they help to improving the indoor climate, bamboo and adobe are local materials that can be obtained at a low cost. The use of adobe with its tight and massive walls and the light bamboo which permits ventilation will make it possible to compare the influence of crossventilation on indoor climate and the behaviour on the stove. Concrete blocks give a better protection against rain and improve the safety of the kitchen.

As it was thought that better utilization of space would allow the reduction of area, and it was important to keep down costs, the kitchen area was fixed at approximately 10 m^2, smaller than many traditional kitchens, which can be seen from the pictures above showing Magdalena's old kitchen and the new proposal.

Most of the old materials were used to improve the two existing kitchens, even if the roofs had to be partly or completely changed. For the family with a roof of corrugated iron sheets, a inner ceiling of bamboo reduced the temperature in the kitchen.

Building pilot kitchens

The four kitchens were built by the stove group with support of a construction manager. The women's participation in the building varied a lot due to personal interest and other factors like lack of experience or interest in "men's work". The very limited participation during some periods became a test for the stove group as such.

The stove group and CIPDC-Nicaraguác decided that the pilot kitchens should be built by the future owners and the other women in the group with the support of a construction manager, "maestro de obra". He had no previous experience either in working with women or in building kitchens and was therefore quite sceptical when starting the construction.

The building phase started with the new kitchen with an upper wall of bamboo. However, not least Magdalena, the owner of this kitchen, was suspicious about us-

Magdalena nails bamboo to build the upper walls of her new kitchen with assistance of the architect Carolina.

ing of bamboo even if she was fully aware and accepted the idea of the pilot kitchens and the conditions, i e that the construction and design was to be decided in cooperation with the others. Her enthusiastic mother postponed a trip to the USA to see the bamboo kitchen finished.

As in the case of the stoves, with the advance of the construction the enthusiasm grew among all the women, including the owner. Still, there was one problem, the size. Both the family and the other women in the group were very disappointed to find the kitchen so small. It turned out that they had misunderstood both the plans and the architect and thought that the kitchen area would be size nine by nine meters instead of nine square meters.

Despite the enthusiasm shown, participation in the construction was quite irregular and uneven among the women, so several meetings were held with the group and the project manager to discuss the problem and find solutions. Still, most work was done by the owner, the technical responsible for the stoves, her son, and the construction manager. The latter not only got more interested in the project with time, but little by little changed his attitude towards the women. When finishing the first kitchen the manager wanted to build himself the same type of kitchen to be equipped with a brick and clay stove.

The construction manager and Maria Luisa from the stove group working on Magdalena's new kitchen. The old kitchen peeps out to the left.

For the building of the second new kitchen the women were trained to make soil blocks and to build by the man in the farmer family who had built their kitchen of adobe, as neither the construction manager nor most people in El Limón knew this building technique. However, the women's lack of time, problems finding appropriate clay and the time consuming production of the blocks reduced not only the enthusiasm of the stove group but also the participation in the construction which was quite low. The owner of the kitchen, the employed stove installer, was very disappointed, especially as she had been very active when building the first kitchen. As a result she almost abandoned the stove building to finish her own kitchen.

The first kitchen improvement, to a big extent used the materials from the old kitchen which made this the cheapest construction. The second kitchen appeared

to be in a worse condition and therefore needed a much bigger investment in new materials for both walls (bamboo and blocks) and roof (tile).

The partly very irregular and not well organized participation, which increased costs as the building process took longer time than planned, had several reasons of which some of the most important were:

- that the women had limited time for the project, especially those working as teachers who at the same time were among the most motivated,
- the women's limited time was further reduced by the rain period,
- little experience in construction,
- problems to move the materials to the place of building when it was needed and the women had time,
- lack of experience and understanding of working together and of mutual aid,
- initially little understanding of their problems and the possible solutions.

The costs of the new kitchens (see table below and appendix E) turned out quite high in relation to income when taking into account that people already have problems to survive on their salaries due to low wages and the high inflation. The first new construction (US$ 937) in October 1990 corresponded to around 6–7 months of salary for a teacher while the cheapest improvement meant three months salary. One way to reduce the costs radically (with 30–50%) according to calculations made by CIPDC-Nicaraguác, is to build without paid labour. The objective is that main part of the cost of the kitchens will be paid back by the beneficiary families. Still, the conditions had not been defined when initiating the construction phase.

Building costs of the kitchens (in US$)

Component	*Type of construction*			
	new	*new*	*improved*	*improved*
building materials	516	489	221	268
transport	155	147	66	80
labour	265	265	265	265
Total	936	901	552	613

The costs can be compared to the cost of the dwellings, approximately $ 2,300, that are built within the housing project through mutual aid. The mentioned dwellings have walls of concrete blocks and asbestos roof and the size is around 50 m^2.

Use of space and indoor environment

As in the case of the stoves it was not until the first kitchen was finished and put into use that the women including the future owner became completely positive to the new design. The indoor environment was considerably improved with the new kitchens, but to get a comfortable and functional kitchen, also the design and location of equipment must be improved, which studies confirmed.

As hinted above the new kitchen with bamboo walls was found too small by the stove group including the user family who therefore at first did not want to demol-

ish the old kitchen. When starting to use the new kitchen both the family and the other women realized that the area needed to a big extent depends on how it is used. With a better location of functions in the new kitchen compared to the traditional ones which often give an impression of being badly used and organized, there was enough space for the needed working areas and the kitchen became more comfortable to work in.

To give the stove group and others an idea of what it can look like when the space is used in a more efficient and comfortable way it was decided to make the first new kitchen a complete experimental kitchen, i e something should also be done to improve the interior design. This included a better location of functions and appropriate heights of the different working areas. For example, to make the

The illustration shows the main movement patterns of the kitchen work during one day in Magdalena's new kitchen.

tortilla baking more comfortable and time saving it was decided to place a small table at a suitable height by the fire. To save space the walls could have shelves to store kitchen utensils like plates. This has not yet been done because of both lack of funding and bad planning.

The need to improve the interior design of traditional kitchens as well as the newly built kitchen was confirmed by case studies made shortly after the first kitchen was finished. The studies, which focussed on the use of space and time in connection with the kitchen work, included two kitchens; one newly built and one traditional that was going to be improved within the project. The frequent movements between the stove, the tables and the counter where the dishes are washed are to a big extent due to badly designed and placed furniture. It should also be noted that the new kitchen (as well as the old one) is not equipped with running water. Water for washing dishes, etc, is stored in a barrel, while ceramic vessels are used for drinking water. The family with the new bamboo kitchen for example started to use the counter for washing dishes as well as for preparing food since its height was more comfortable than the table previously used for this purpose.

The women think that the ventilation has improved the indoor climate, and that the kitchen has become the freshest and nicest place of the dwelling. Besides, there is no need for electric light during the day in the new bamboo kitchen as the daylight enters not only through the window and door but also through the walls. The adobe kitchen has more problems with light. All reported that they spend more time in the kitchens talking, visiting and sometimes eating as the new kitchens are relatively light and cool.

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Appendix

Appendix A

Names and addresses of persons and institutions involved in the kitchen and stove project in El Limón

CIPDC-Nicaraguác

Address:	Apdo 364, León, Nicaragua
Telephone	(+505) 311 5787
Project manager:	Herminia Martinez
Architect:	Carolina Madriz

DINOT

Address:	Apdo SN-30, DINOT UNI, Managua
Telephone:	(+505) 2 41457
Telefax:	(+505) 2 662683
Director:	Rafael Acevedo
Project coordinator:	Rosario Sotelo

Members of the stove group in El Limón

Amanda Morales
Maria Luisa Morales
Magdalena Hernandez
Maria Jesús de Torres
Alejandra Molina
Hilma Perez
Yolanda Vallejos
Aurora de Arnuero
Yolanda Colindres

Appendix B

Water boiling test (WBT) with existing stoves in El Limón

Owner's name	*Maria Luisa*	*Magdalena*	*Aurora*
Type of stove	*1 pot U shape*	*2 pot Metal*	*2 pot mud/metal*
Date of test	*16-05-90*	*18-05-90*	*19-05-90*
Percent Heat Utilized (PHU) in HP [a]	0.183	0.151	0.116
Percent Heat utilized (PHU) in LP [b]	0.138	0.145	0.167
Total PHU (HP+LP)	0.161	0.148	0.142

a HP = High Power
b LP = Low Power

Appendix C

Efficiency and condition of the new stoves built in El Limón

Name of owner	*Type of stove*	*Materials used*	*Efficiency ave. in %*	*STD*	*no. of tests*	*Condition*	*Remarks*
Maria Luisa	2-pot chimney	Br+TC	15.4	1.3	4	Chipped around ph	1
Maria Jesús	2-pot chimney	Br+RC	23.9	5.5	4	Badly cracked	2
Magdalena	2-pot chimney	Br+LR	24.1	9.2	4	Good	3
Yolanda	2-pot chimney	Br+LC	26.4	7.2	4	Good	
Aurora	2-pot chimney	Br+RC	22.7	1.5	3	Badly cracked	2
Amanda	Chula 2-pot chimney	LC	22.3	1.1	2	Good	
Hilma	CETA 2-pot chimney	Br+CP	26.2	6.0	4	Good	
Silvia	CETA 2-pot chimney	CP	15.3	0.0	1	Good	

TC = Tile clay.
RC = River clay.
LC = Larreynaga clay.
CP = Cement and pumice.

1 Around first pot hole parts broke away and this was repaired.
2 Stove broken away and new one built using Larreynaga clay.
3 Baffle broken due to wrong use and use of large fuelwood logs.

Appendix D

Guidelines for identifying appropriate raw materials for brick-clay stoves

A few simple guidelines are presented which can be helpful to decide whether a clay will be useful or not and how it can be made suitable for the construction of brick-clay stoves.

Brick-clay stoves, sometimes called mud stoves, are common in many areas. However, today efforts are made in quite a few countries to change to ceramic insert stoves where the interior of the stove is made from fired clay (ceramic) while the outside is still made from mud.

The mud used to construct stoves often consists of a mixture of clay, sand, dung, straw, chaff, etc. Before a clay or soil is used it should be tested to check whether it is suitable for construction of stoves.

In general a clay is used as the main material and, depending on its composition and properties, other materials might have to be added. Clay consists of different sizes of particles and in general three types are recognized according to particle size: below 2 micron (clay), from 2–20 micron (silt) and above 20 micron (sand). Each of the these three particle sizes has an influence on the behaviour and feel of the clay. In general it can be said that:

- with too much clay particles the material will shrink a lot and often in an uneven way resulting in cracks and warping. When rubbed between the fingers it will feel smooth, greasy and sticky.
- with too much sand the material will not stick together and the strength will be low. When rubbed between the fingers it will feel gritty and coarse.
- with too much silt the mix will not form a cohesive mass and parts will easily break away when heated during cooking. Rubbed between fingers it feels like powder.

To check how much particles a soil contains do as follows. Take a little bit (a handful) of soil in the hand, add water to make stiff mud and mix it properly. Thereafter you make a flat round cake (about 1 cm thick and with 3–5 cm diameter) in the palm of the hand and slowly close the hand pressing the cake. The cake should get a shiny look after closing the hand. If not, add a little more water and try again. If the shiny looks disappears while opening the hand the soil probably contains a lot of sand or silt. If the shine remains, the soil contains a lot of clay particles.

Another test is to make a thin worm of clay (like a pencil), pick it up at one end between two fingers and hold the “worm” horizontal. If it breaks it means that is contains a lot of sand or silt, while if it bends but does not break it contains a lot of clay. Another method is to wrap the worm around a finger. If no cracks appear it contains clay. Depending on how many cracks appear a very rough estimate can be made on the amount of sand and/or silt.

A quick test to check how soil will behave in a stove is to make a ball of moist clay (about chicken egg size) and fire it in hot coals for about half an hour. If the ball is completely broken or parts (chips) can easily be broken away by rubbing, do not use the clay. Good soils will show only small cracks and parts do not easily break away when rubbed.

A clay suitable for brick/mud stoves like the types constructed in El Limón should contain a lot of sand particles and a little bit of clay particles. For stoves like the Lorena (seen in places in Nicaragua) about 20–30% of a good clay (pure clay) is used which is mixed with about 70–80% of sand. Such mixtures should be tested before being used and this is done as follows.

Make test blocks or bricks measuring about 10 by 12.5 by 30 cm. Use a clay and sand mixture with the right moisture content which can be checked by making a well pressed ball (about 5 cm diameter) out of the mix. Throw this ball up about one meter and catch it in your hand without cushioning it. The ball should stay intact. If it breaks the mix is too dry and if it flattens and comes apart the mix is too wet. The blocks should be well pounded so that they are quite hard. Let the blocks dry before testing their strength as shown below.

However, even in this case this will not be a guarantee that the stove will be strong and durable, but these guidelines give some indications. Only the behaviour of a stove in use can give the final answer if a clay/sand mix is good for making stoves.

Appendix E

The building costs of the four kitchens and the materials used

Type	*Budget*	*Real cost*	*Main building materials*
1. New construction	1,249	937	Roof: structure of wood and bamboo, tile Walls: concrete blocks & bamboo Floor: concrete Door and windows: bamboo
2. New construction	1,394	900	soil blocks, concrete, bamboo, tile and wood
3. Reconstruction	658	551	concrete blocks, wood, zinc
4. Improvement	923	613	tile, bamboo, wood