

PRESSURE COOKER TRAINING

This article is related to only one activity of a renewable energy staff training programme, realised in coordination with Welthungerhilfe (German Agro Action, GAA) in Ayni, a small town in the centre of the Zeravshan Valley, about 150km north of Dushanbe, the capital of Tajikistan.

The Zeravshan Valley runs along the borders with Uzbekistan and Kyrgyzstan and climbs from 1,500m altitude in the West, to about 2,500m in the East, with some villages located over 3000m altitude where winter temperatures fall to as low as minus 40 degrees Celsius. While I was advising on house thermal insulation and explaining the options for renewable energy solutions, inevitably one gets involved in the cooking process as this is directly linked to the house heating system in the winter. In many of the houses in the Himalayan regions, the cooking stove is the only heating source. During the summer however, cooking takes place outdoors because the inside cooking stove emits too much heat. In this valley, bread is invariably made in outside ovens using about 30% of the annual household firewood and cow dung consumption.



Due to centuries long collection of biomass for cooking and space heating by a growing population, in combination with the grazing by goats and growing herds, the mountainous landscape has turned into a stone desert. Only for small patches of privately owned land with irrigation some branch and tree harvesting is realized.

Traditional cooking and bread baking methods in the Zeravshan Valley are with only 20% firewood efficiency very poor in terms of biomass consumption. This is the case in other areas of the country as well and several development projects are focussing on improving the stoves and cooking methods, and eventually manage vegetation, watershed and control erosion.

Because houses are poorly insulated (in particular the ceilings/roofs and windows), the cooking stove is stoked for many hours to provide some warmth in the winter, consuming massive amounts of firewood, dried cow dung (*tapack*) and coal.¹ Only the richer people are able to afford purchasing about one ton of coal per bedroom per winter, while the poorer people (the majority) are dependent on firewood and cow dung cakes for cooking and space heating. Low-income families scavenge biomass, spending at least 10% of their day time, and sleep during winter together in one 3m x 4m room, sometimes with six persons.

Sleeping is on carpets and thin mattresses, but floors in poor people's houses are seldom thermally insulated.



¹ Coal burning results in much hotter and continuous fire, requires thicker metal (4mm) or cast iron stoves, but the traditional wide chimneys (10-12 cm in diameter) cause massive energy losses through the chimney.

About three-quarters of the heat from the cast iron (Soviet relic) cooking stoves goes out of the chimney; the remainder is used for space heating, cooking and water heating. Several improvements are being introduced to reduce the massive heat waste of the cooking stoves such as improved stove design (air intake, insulation), heat exchanger cum bread oven on the chimney pipe and modified chimney pipes (photo right: the low opening can be closed, creating an oven).



Other methods to reduce biomass consumption are now being proposed such as improved thermal insulation (roof, windows, floor, walls, roll curtains), stove-linked back boiler, parabolic solar cooker, solar water heater, pressure cooker, ARTI Sarai steam cooker and hay box (heat-retention box), to name a few.

Because of the intimate relation between long cooking times and minimal house heating at high altitudes, good thermal insulation is a pre-condition to changing the design and use of the cooking stove.

Pressure Cooker in High Altitude Areas

Shortening the cooking process is an option for fuel saving which will also save fuel during the summer period. The pressure cooker is particularly useful for cooking above the 1000m altitude.

As a component of the renewable energy training for Welthungerhilfe staff, I held a short training session on the pressure cooker in Ayni village located at 1500m above sea level. The purpose of the training session was to demonstrate the energy saving aspect of the pressure cooker by comparing the same dish (soup) cooked according to the traditional method and using the pressure cooker and a hay box (heat-retention box).



The cook prepares equal portions of the ingredients in the two pots.

The pressure cooker is essential in the higher altitudes, because it creates a higher boiling temperature due to the steam pressure inside the cooking pot. The higher the altitude, the lower will be the atmospheric pressure and the related natural boiling temperature and hence, the longer it will take for food to cook, and more efficient becomes the pressure cooker. Several types of pressure cookers can have about 100kPa pressure increase over local atmospheric pressure, but models vary greatly. The required boiling time for softening the food is between 1/4th and 1/5th of the normal boiling time, depending on the altitude.



Altitude in meters	Sea level	1000 m	1500 m	2250 m	3000 m	Pressure cooker A
Altitude in feet	Sea level	3000 ft	5000 ft	7500 ft	10.000 ft	3000 ft + (15 psi = 107kPa)
Boiling temp. degr. Celsius	100 °C	96.6 °C	95 °C	92.2 °C	90 °C	118 °C ~ 120 °C
Boiling temp. degr. Fahrenheit	212 °F	206 °F	203 °F	198 °F	194 °F	244 °F ~ 248 °F
Estimation boiling time needed	100%	105 %	110 %	125 %	150 %	25 %-20% (approximately)

Cooking time savings, and with that the fuel savings, will increase with increased altitude.

Cooking Activities

- (1) The meat and vegetables (carrots, potatoes, tomatoes and onions) were cleaned and divided equally between the pressure cooker and cooking pot.

The vegetables were not chopped into small pieces, but were cut following the traditional method of keeping the potatoes whole and the vegetables chunky.

- (2) The amount of water (for the soup) in the pressure cooker was just above the vegetables, while the amount of water in the common cooking pot was well above the vegetables.

In addition, because the traditional cooking method requires two hours of simmering after being brought to boil, an additional two cups of water were added to the open pot during the cooking process.

The vegetables in the two pots were prepared according to the traditional method in order to demonstrate the difference in energy use between the two methods. When the vegetables were also chopped smaller for faster cooking in the pressure cooker, the trainees would not have clearly understood the difference.

Chopping the vegetables small in the traditional cooking pot would have tenderized them earlier, but the traditional dish included the meat. The long cooking process also guaranteed adequately the stewing of the meat. Besides, if one is traditionally used to big chunks of meat and vegetables, you would not appreciate mini cubes in the soup.



The traditional wood fired stoves are unsuitable for comparative testing

Comparative Demonstration

In order to compare the two cooking methods, a new double pit gas stove was used, giving the same gas flame under the pressure cooker and the other cooking pot. Doing this test on one or two traditional mud stoves would not be possible as these would not have two similar cooking points, and the flame could not be accurately controlled (picture above).

In the larger village of Ayni many people used bottled gas for cooking and time saving would imply less cooking gas, motivating them to calculate the financial differences and benefit of the pressure cooker.

- (3) The two pots were placed on a double pit gas stove, assuring that the flame under the pots was about equal. (picture right: fine tuning the two gas flames)

Although the pressure cooker has a larger mass in terms of the amount of metal, it came to the boiling point faster than the cooking pot because of the lesser amount of water.

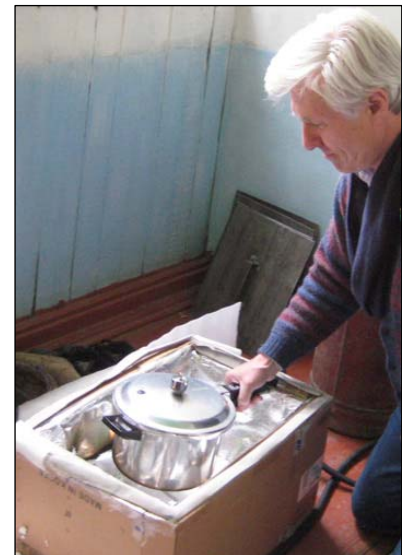


- (4) The pressure cooker came on pressure in 17 minutes, while the pot with the glass lid took 25 minutes to reach boiling point. Once the pressure cooker came to full pressure, it was taken off the stove and placed in a heat-retention box.

The temporary hay box (heat retention) was made from a cardboard box lined with three layers of metalized foil, each having a Polyethylene (PE) backing of 3mm. The highly reflective aluminium surfaces of the foils were placed towards the heat source. These will reflect radiation heat, provided there is a 5-7mm air space on the shiny side.



This metalized insulation foil is commonly used for pipe insulation, under laminate floors and for house insulation. It is becoming widely available.



Heat-retention cookers are commonly made from insulation materials such as Expanded Polystyrene, EPS ($\lambda=0.04$ W/m.K), loose wool ($\lambda=0.05$ W/m.K), straw ($\lambda=0.08$ W/m.K) or even less insulating materials. However, the highly reflective metalized foils are far more effective and require less space.

For a total heat resistance of $R=3.0$ m.K/W, a material thickness of 12 cm EPS is needed or 24 cm loose straw, making it a voluminous box. Each reflective foil with 3mm PE backing has an R value of about 0.8 m.K/W. Hence, only four foils are needed to reach $R=3.2$ m.K/W, being only 2cm in thickness.

- (5) After placing the pressure cooker in the heat-retention box, it was covered with small broken pieces of EPS packing material, followed by a layer of bubble foil. By this time (25 minutes), the traditional cooking pot had started to boil and the gas flame under this pot was lowered slightly to simmering.



- (6) After two hours, during which two cups of water had been added (evaporation), the traditional dish was ready. The pressure cooker was taken out of the heat-retention box. The pressure cooker had retained some of its pressure, meaning it had actually continued to cook the ingredients at a higher temperature than the traditional cooking pot.²

- (7) Comparing the two soups, all the Welthungerhilfe project staff agreed that the soup cooked in the pressure cooker tasted better and the carrots were softer. One female staff commented: *“Now I do not need to get home two hours before lunch in order to start cooking, I can make the soup in the morning and it is still warm at lunch.”*

- (8) The pressure cooker used only 17 minutes of gas while the traditional pot took 25 minutes (high flame to come to the boil) and 120 minutes (simmering time = half gas); in total 85 minutes full gas. This meant that the pressure cooker used only **20%** of the gas (or other cooking fuel such as firewood) as compared to the traditional cooking method. The low gas position was assumed to use half the amount of gas.

The exercise demonstrated that the combination of the pressure cooker and heat-retention box results in considerable savings of cooking fuel. Actually one-fifth of the amount of fuel. The high saving is partly due to the inefficient cooking method of the traditional dish requiring long cooking times. This correlates with houses being poorly insulated and requiring constant heating during the winter. The exercise was

² The higher starting temperature of the pressure cooker when entering the heat-retention box (115 °C), and its total mass, assisted in maintaining a higher temperature than that of the traditional cooking pot (95 °C).

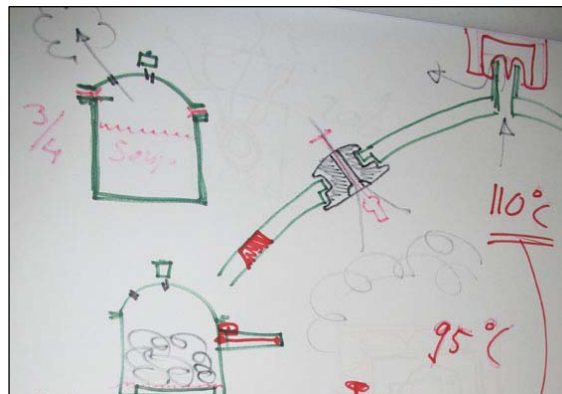
concluded with another two short training sessions on (a) the technology of the pressure cooker and its use, and (b) the technical design of the heat retention box.

The Welthungerhilfe programme uses the Afghan model pressure cooker now because it is available in the capital Dushanbe and it can be used on any kind of stove (gas, electricity, open fire, solar cooker). The project staff needed to prepare a special pressure cooker recipe book in Tajik language. For changing of cooking behaviour, the introduction of a recipe book will reduce some resistance against new technologies.

Safety Requirements

Using the pressure cooker without knowing how it works can lead to dangerous situations, especially when the fire under the pot cannot be accurately tempered (traditional fire wood stove). With vigorous boiling, steam and foam will develop inside the pressure cooker.

When the pressure pot is filled to the rim, the foam and bubbling food may clog the pressure control steam vent. This will excessively raise the pressure and temperature, and without a proper safety valve, the pot may explode.



- A pressure cooker works on steam development and therefore water is an essential ingredient.
- Pressure cookers having an increased height top lid are slightly safer than pressure cookers with a flat top, because foam less easily blocks the steam vent.
- A pressure cooker should not be used for frying.³
- Aluminium cooking pots should **not** be cleaned on the inside with soda or a metallic sponge; otherwise, aluminium will enter into the food, having a negative health aspect (Alzheimer's).

Pressure cookers are on the market in different price classes and qualities. In Afghanistan (4 litre, USD 25), low cost aluminium pressure cookers are available, and these are now being introduced by Welthungerhilfe, as a result of the training exercise. Considering the amount of gas saved through a pressure cooker, the cost of the cooker is recuperated within a single summer season.

The cook being very happy
with the quality of the soup,
the amount of time saved,
and the amount of gas saved;
in that order.

Retention-Heat Box

It was suggested to make an insulated stand and cotton cloth-covered heat-retention bag (big tea cosy) with several reflective foils to reduce its volume when stored away. A local women's workshop can be set up in producing and marketing the best designs.



Follow-up on Training Session

Although the staff training session had demonstrated clearly the effect of the two new technologies, statistical data could be collected during further demonstration sessions in the villages and with other food products. This single demonstration, using only 1/5th of the amount of gas, using the two techniques of pressure cooker and heat-retention cooker was highly convincing of the potential benefits. This, however,

³ Frying, stir frying and deep frying are common cooking techniques in high altitude areas because the cooking temperature reaches above the 100°C, speeding up the cooking process. Many pressure cooker related accidents are caused by using the pan as a frying pan or without water. Only a single accident in a village will discourage all villagers from using pressure cookers.

needed to be translated to village based cooking demonstrations, eventually including the use of wood, dung and coal fires. From every demonstration session a good time and fuel record should be kept. The best designs for the heat-retention boxes or cosies can be evaluated at the same time.

The following recommendations resulted from the training session:

- Have such cooking demonstrations in the villages, with tasting the dishes for comparison.
- Explain the operation of the pressure cooker with its advantages and disadvantages.
- Develop a cookbook with easy, tasty recipes using the pressure cooker (in progress).
- Make the pressure cooker available through local shop outlets in the villages, selling it only with an instruction manual and cookbook (in progress).
- Make the heat-retention box also available through local shop outlets and include an instruction manual for the types of food that can be cooked with the aid of the box (or cosy).
- Explain the relation between traditional long cooking times and house insulation.

Behavioural change related to cooking and traditional dishes is difficult. The notion that “new cooking methods do not taste good” is not always correct and often merely an expression of resistance to change. Resistance to change sometimes has a rational basis - it is up to the development agency to understand what this rational basis is, and devise methods to overcome this resistance. Enthusiasm of local communicators and leading community members about new working methods (lower cost, more efficiency) will help to introduce these methods and achieve energy saving.

In the case of the cooking methods, and when the long cooking periods for making stews are linked to house heating, thermal insulation of the house is often a priority, before something can be done on the stove design or cooking methods.

Thermal insulation of many houses, especially of roofs and windows, is often very poor.

Changing the stove or the cooking method, will have an immediately effect on the room heating during winter.

Energy saving in cold climates, needs to be a combination of reviewing the insulation of the house and than the stove design.

Changing the stove design, almost always implies changing the way of cooking.



Household energy management is influenced by the local climate conditions and house design. The supply of the energy depends on natural resources. With the increasing scarcity of these natural resources, the cost of obtaining that energy increases, either in finances or collection time. Economizing on cooking energy becomes an important factor in the household finances and its time management. In cold climates the two elements of cooking and thermal insulation of the house are intimately linked.

Sjoerd Nienhuys,
Senior Renewable Energy Advisor
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