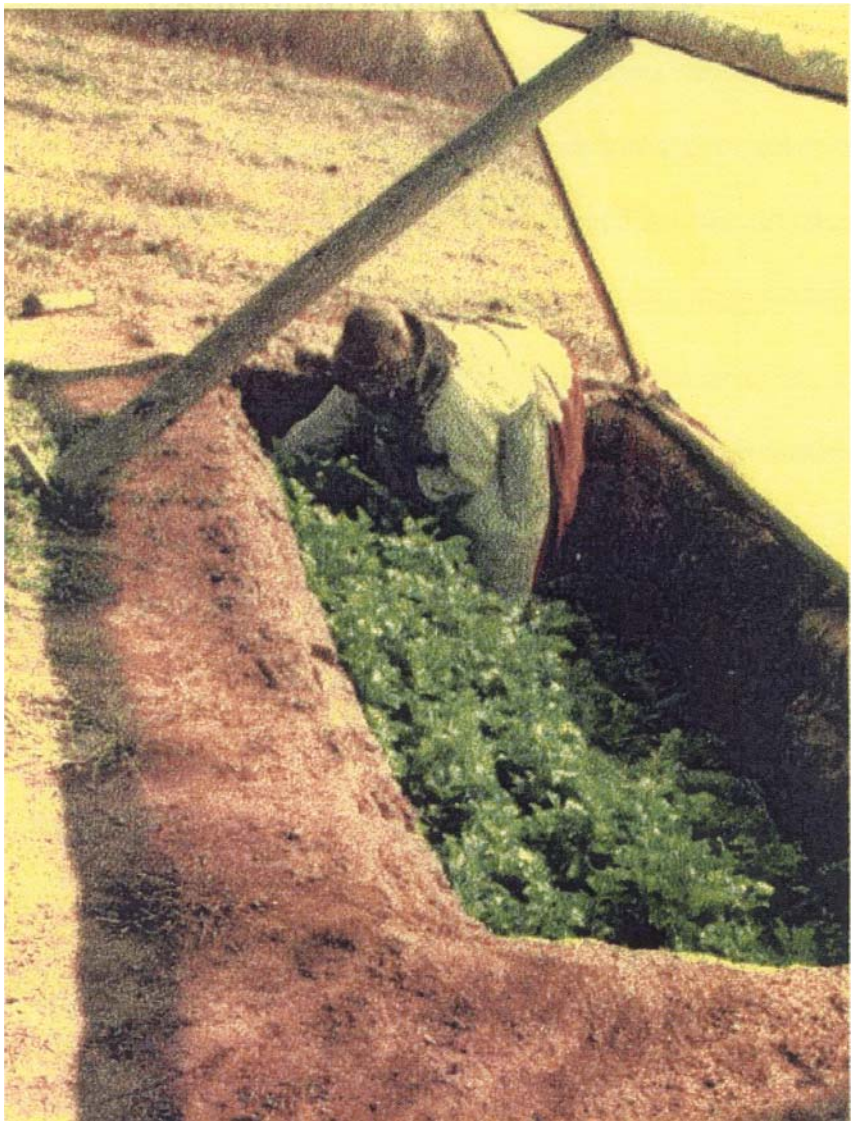
Manual for the Construction and Management of Panqar huyus



Benson Agriculture and Food Institute
Brigham Young University
Provo, UT

MANUAL FOR THE CONSTRUCTION

AND MANAGEMENT OF PANQAR HUYUS

(Semi-underground organic bed)

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For the Benson Agriculture and Food Institute

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PRESENTATION

The Benson Agriculture and Food Institute has developed a new cultivation system as a resource to decrease the rate of malnutrition and increase the consumption of vitamins and minerals in Bolivia. The name of the system is "panqar huyu", which means "flower bed" in Aymara.

Noel Velasco, a student from the Universidad Mayor de San Andrés, participated in a second thesis project from June of 1998 until February of 1999 in Letanías, Viacha, Bolivia. The information compiled from this project is presented as a manual containing detailed instructions on the construction and use of the "panqar huyu" in the above mentioned area. Mr. Velasco received the "Gilbert" Award to continue the implementation of this agricultural production system for the Bolivian Altiplano.

EXPLANATION AND FOREWORD

In 1997, the Benson Agriculture and Food Institute provided Noel R. Velasco of the Universidad Mayor de San Andrés, Department of Agriculture, with the opportunity to prepare his thesis titled, "The Determination of Watering Regiments Through Tensiometers During Four Planting Seasons of Chard Using the Panqar Huyu System."

After the research in Letanías, Ingavi, La Paz, Bolivia, and according to previous arrangements with the Benson Institute, Noel Velasco developed the "Manual for the Construction and Management of Panqar Huyus." The purpose was to benefit communities in Altiplano with the use of this new resource, in order to improve nutrition in the Institute's impact region in La Paz, Bolivia.

However, the Benson Institute wants to make clear that this manual is only a publication of the results from the research that took place. Any use of this manual is the sole responsibility of the person using it.

The Benson Agriculture and Food Institute expresses its gratitude to the students that preceded Mr. Velasco, Cesar Altamirano, Jaime Michel, also from Universidad de San Andrés, and Dr. Larry S. Jeffrey from the Department of Agriculture of Brigham Young University for their important contributions during the development of the model.

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INTRODUCTION

The intensive production of vegetables in moderate and winter climates is a twenty-year-old practice in Bolivia. It has been driven by many institutions working in the Bolivian Altiplano. Because of the climate, it is difficult to extensively cultivate temperate climate species in the open fields. With today's new technology, it is proposed to lower the rate of malnutrition and deficiency of foods rich in vitamins and minerals in this region.

The consumption of adapted vegetables in Bolivia is low, especially in high altitude regions, such as the high plateau region (over 3800 meters above sea level). The consumption deficiencies increase when dealing with vegetables of little use such as chard, radish, turnip, parsley, and others. In the past years, when attempting to overcome such deficiencies, different types of gardens with controlled microclimates have been developed, and different managing techniques have been tested. Nevertheless, the problem still persists. One of the most important reasons for this situation is the introduction of models that do not gather the adequate characteristics, considering the following aspects: available time, knowledge and financial capacity of the farmer, and its use.

The Benson Institute has developed a new cultivation system taking into consideration the points discussed above as part of a strategic effort to improve the quality of life through improved nutrition. The temperate unit has been named "panqar huyu", an Aymara word meaning "flower bed."

This system has proven to be effective in the cultivation of medium and small sized crops due to its low building and maintenance cost. Because of its easy horticultural maintenance, the panqar huyu allows the head of the household to engage in other agricultural activities while the

mother and children handle the cultivation.

What is the panqar huyu and how does it function?

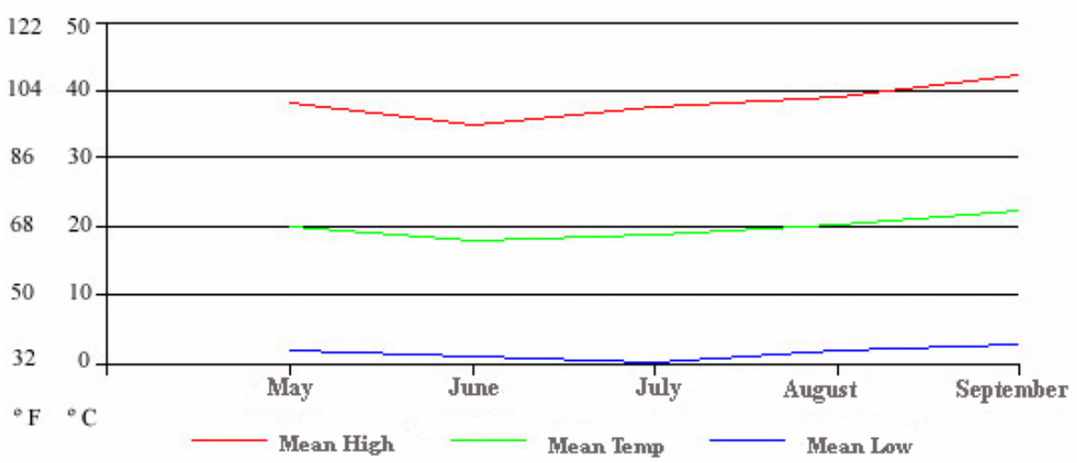
The panqar huyu is a small semi-subterraneous green house. The top assembly consists of a polythene covering commercially known as "Agrofilm", which is partially opened during the day as a lid. The plants germinate and grow inside due to the warm temperature maintained inside because of the specially prepared floor and walls. In this way, the panqar huyu allows the cultivation of species that are normally not produced in the Altiplano. Crops can be harvested multiple times in a year, and the crop cycle can be shortened accordingly. This allows families to produce and consume more vegetables that are rich in nutrients that would otherwise be unavailable to families in the high altitude regions and during certain seasons of the year.

Physically, the panqar huyu works as an energy reservoir. The solar rays penetrate the agrofilm covering, since it has good permeability to short waves, but is less permeable to the longer waves emitted from inside. Therefore, the sun light "warms up" the interior and the heat builds up in the floor and walls. The floor accumulates heat during the day and slowly transmits it to the rest of the interior during the night. This effect increases when there is humidity in the floor, because water has a high capacity of storing energy due to its specific heat. The walls of the panqar huyu act as a thermal mass that regulate nocturnal and diurnal temperatures better than thin walls.

During the winter, the highest mean temperature is 38° C (100° F), the lowest mean temperature is 1.5° C (34.7° F), and the monthly mean temperature during this period is 19.9° C (67.8° F). The relative humidity oscillates between 20% in the afternoons and 90% in the night time.

This provides favorable conditions for most medium to small size crops even in the coldest seasons of the year. However, in order to avoid extreme variations in temperatures, the covering should be opened 30 to 40 cm during the day and then completely closed during the evenings. Not following these instructions will cause the temperature to rise to 49° C (120° F), which could cause hydric stress in the plants and thus reduce their yield. On the other hand, it is also necessary to avoid opening the cover too much since the dryness of the outside can produce stress inside.

Table 1. Interior temperatures of the panqar huyu during the Altiplano winter



How to build the panqar huyu

The panqar huyu is designed for easy and fast construction with no need for advanced building knowledge. It is very versatile, as far as the building materials go, since the necessary materials can come from those already available in the community. It can also be adapted according

to different building methods used by the farmer. This allows for the practical experience from the participant to combine with the technical instructions from the extension representative.

All of the labor for construction will come from the family. The sheep dung used as fertilizer is available to most farmers, and the gravel is found in streams. Therefore, the purchasing of building materials (Table 2) is the only necessary financial expense. This allows for the unit to be within the reach of any farmer.

Table 2. Building materials for a panqar huyu (approximate costs in Bolivian Pesos)

MATERIAL	CHARACTERISTICS	QUANTITY	UNIT	COST
Wood strips	3.3 m (10.8 ft) long, 2" (0.05 m) wide, square sections	3	piece	565
Polythene	Thickness: 250 micros	7	m^2	595
Nails	2" (5 cm) in length	25	kg	56
Nails	1.5" (3.8 cm) in length	25	kg	56
Rubber	1" (2.5 cm) wide to be used as washers	150	m	30
Sheep dung	Sifted and not fresh	39	m^3	—
Gravel	2" (5 cm) in diameter	39	m^3	—
TOTAL				**1332**

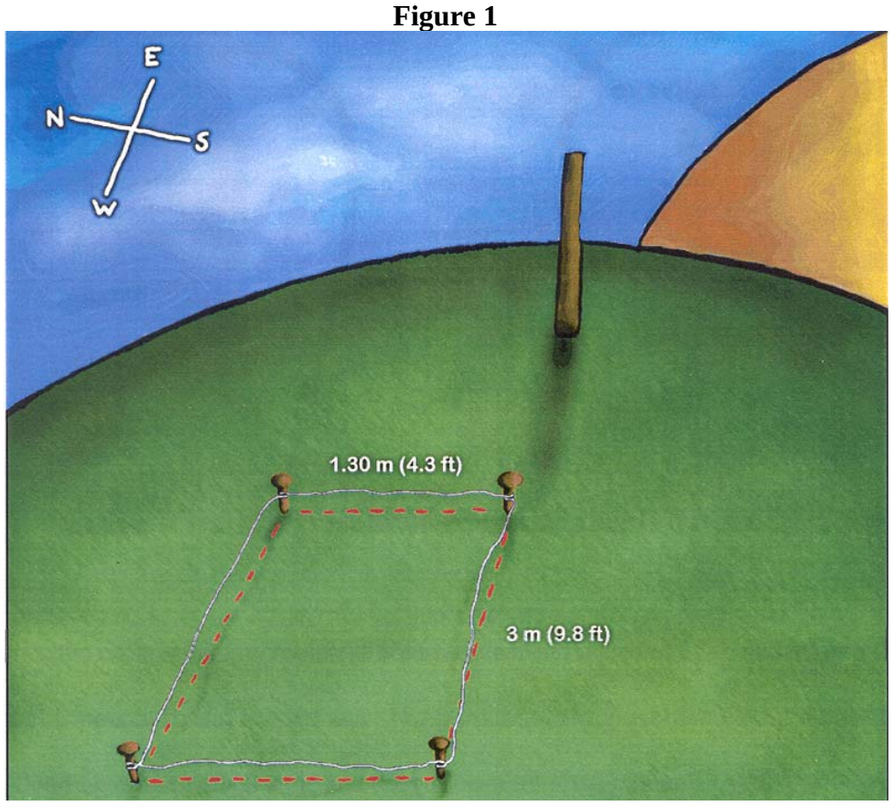
* When strips are not available, small dull branches 2 inches (5 cm) in diameter, which are locally known as "callapos", can be used. The cost of these and the pins that would substitute the large nails in the corners are $3.33 and $0.89 USD, respectively. Therefore, the cost with this option would be $11.86 USD. (Exchange rate of 6 Bolivianos / $1 USD)

The building process can last up to four days. First, an appropriate place should be chosen, preferably an elevated area in order to avoid flooding during the rainy season and excess capillary ascension. If the panqar huyu is constructed laterally, it should be facing towards the north (southern hemisphere) in order to receive more sunlight throughout the year. The floor of the upper section

should be unimpeded (not too clayed or sandy). It is critical for the water source or well to be nearby (at least 30 m or 98 ft) in order to allow an appropriate water supply throughout the year. It is important that the animals do not have access to the garden.

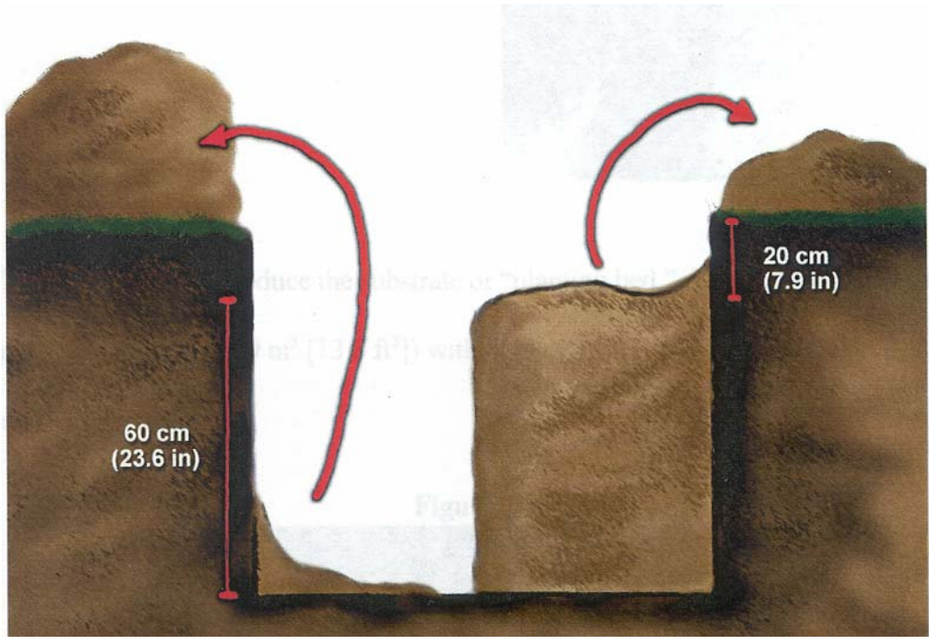
The selected excavation area should be marked by stakes and cords. The longer side should face east-west. A simple method is to place a wooden stick vertically during the morning or evening hours. The shadow produced will indicate the approximate orientation of the axis (Figure 1).

Figure 1



The excavation is rectangularly shaped, measuring 1.30 m in width by 3 m in length and 0.80 m deep (4.3 ft x 9.8 ft x 2.6 ft). The first 20 cm (7.9 in) of soil, which correspond to the horizon of agriculture practices, is the best quality for horticulture. This is why it is set apart. The deeper soil is accumulated in the other side and used to build the borders or berm used to support the lid. The stability and endurance of the panqar huyu depends on the care given during the excavation process so as to not wear away the borders (Figure 2).

Figure 2



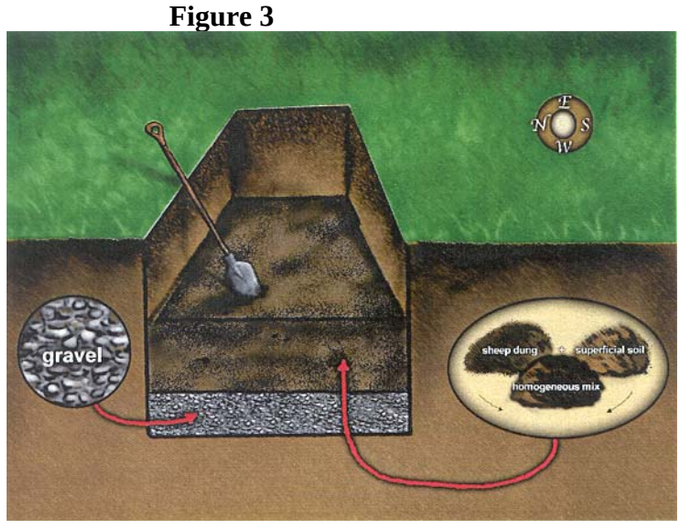
Once the excavation is complete, the surface is then leveled out. Then 0.39 m^3 (13.8 ft^3) of small gravel is poured in and leveled out. The purpose of the gravel is to drain the excess water, avoiding flooding of the radical zone and the suffocation of the plants.

Excavation: 3.12 m^3 (110.2 ft^3

Gravel layer: 10 cm (3.9 in)

The next step is to introduce the substrate or "planting bed." This is a mixture of non-fresh sheep dung in equal parts (0.39 m^3 [13.8 ft^3]) with 0.39 m^3 (13.8 ft^3) of superficial soil, which was set apart earlier (Figure 3).

Figure 3



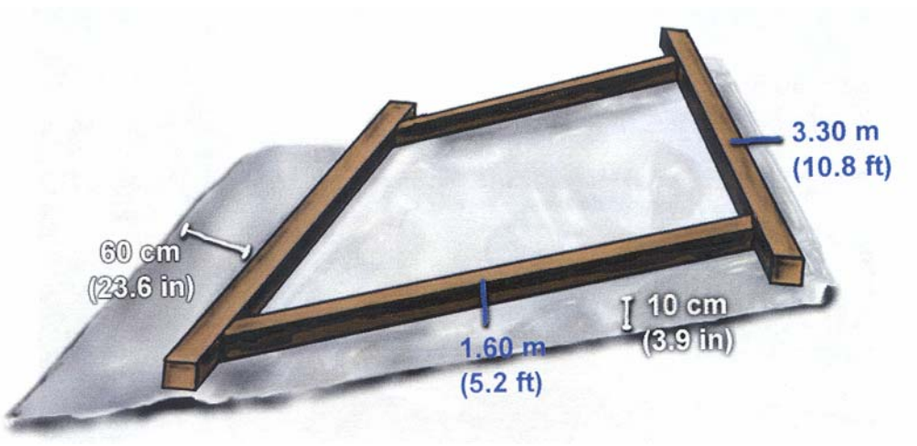
The best way to quickly obtain a good mixture is to pile up the fertilizer next to the superficial soil, mix the contingent parts, and place the mixture progressively in the excavation.

When the planting bed is leveled out, a deep initial watering is done (plenty of water). The final result will be a homogeneous soil with good chemical fertilization (due to the sheep fertilizer that is rich in nutrients) and optimum physical properties, which allow good water retention and air circulation.

The small dimensions of this "greenhouse" allow for the entire surface, which is prepared as other planting beds, to be cultivated. Generally, it is not necessary to establish rows for the cultivation of most small to medium crops.

Once the planting beds are prepared the lids or coverings are then assembled. The wood strips are cut into two pieces of 3.30 m (10.8 ft) and two pieces of 1.60 m (5.2 ft) in order to construct the wooden frame where the polyethylene will be attached. The four wooden strips are then connected at the ends with five nails 2.5 inches (6.35 cm) in length (Figure 4).

Figure 4



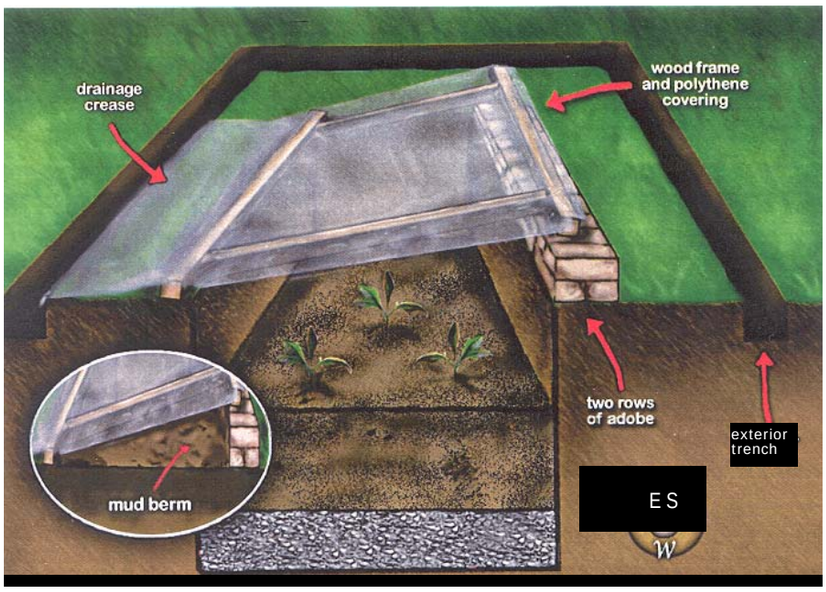
Another option is to use sticks of two inches in diameter, called *callapos* by the local inhabitants. However, due to the natural irregularity of the callapos, the frame will not produce good tension for the agrofilm. Nevertheless, this alternative can be used successfully when cut wooden strips are not available.

The agrofilm is cut in pieces of 3.5 m (11.5 ft) length and 2.0 m (6.6 ft) wide and later installed tightly onto the frame. A simple method for installation, even with just one person, is by securing the agrofilm with a nail inserted in a rubber washer at one side of the frame, stretching and nailing at the opposite side every 10 cm (3.9 in) until perfectly tied. There should be a crease in the agrofilm on the north side of the covering in order to allow the accumulated water to exit freely. Once the agrofilm is completely nailed to the frame, a wooden strip of 1.51 m (5 ft) in length is coupled to the middle of the frame (parallel to the shorter sides). This provides a tension effect that permits improved material durability.

Construction of the covering

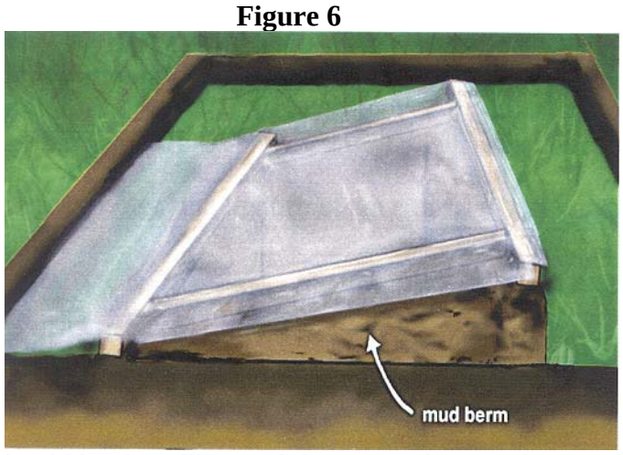
There are two possible options to couple the lids of the panqar huyu, depending on the availability of adobe. The first is to use adobe bricks that are placed only in the southern border of the excavation, two tiers high. The covering is then installed on top to form an inclination towards the north allowing the rain water to drain towards the drainage ditch. The south, east, and west borders will be filled with a clay mud mixture creating a berm which provides an almost hermetic seal. The north side will not have a berm because it will be the side where the rain water will exit towards the exterior drainage through the crease of the agrofilm (Figure 5).

Figure 5



If good quality adobe is not available, the second option would be preferable. The covering is installed over the panqar huyu without the use of adobe bricks, propping up the entire edge, without an inclination, against the mud mixture. The panqar huyu should be opened on the following day and touched-up with mud mixture on the sides. The durability of the walls depends a great deal on this process, since the walls keep water from seeping in through the sides (Figure 6).

Figure 6



Small trenches should be dug all around the panqar huyu to keep erosion from affecting the walls and the rain water out. The trenches should be 50 cm (19.7 in) from the sides, and should be 15 cm wide and 15 cm (6 in x 6 in) deep.

Once the construction is complete, the field should be irrigated once again according to the field capacity (the maximum moisture retained by the soil before saturation), and then wait a few days before planting.

Daily operation of the panqar huyu

The process of daily operations is simple. In the case of directly planted crops (carrots, radish, etc.), the panqar huyu can remain closed for three to seven days in order to obtain an earlier germination, since high temperatures accelerate the process. At the conclusion of this period, the panqar huyu should be partly opened between the hours of 9:00 am and 4:00-5:00 pm, and remain completely closed at night. The hinge of the opening should be on the north side. Therefore, the opening in the south side should be 30 cm (11.8 in) for the vegetable crops requiring less heat and

40 cm (15.7 in) for those requiring more. The covering can remain partly opened by resting it securely on two stakes nailed into the ground at 15 cm (6 in) from the southern border. The unit should remain closed at night. It is also important to continually weed the planting beds to keep the weeds from stealing nutrients, water, and light from the crops.

How is the panqar huyu cultivated?

The work of cultivating the panqar huyu is simple and requires little time. The mother and children can take care of this, thus allowing the father to spend his time in other activities.

Different horticultural crops have been cultivated using the panqar huyu system, even during the winter. Some of them are described in the following table:

Table 3. Harvest time of different crops in the panqar huyu

CROP	**TIME BEFORE THE HARVEST OR FIRST CUTS**
Chard	65-75 days before weekly or biweekly cuts
Celery	45 days until weekly cuts
Onions	3 ½ months after transplant
Lettuce	1 month after transplant
Parsley	40 days to begin weekly cuts
Carrots	4 ½ to 5 months

Chard: This crop gives very good results, even during the winter. With this system, the planting can be done anytime of the year. Planting can begin with the external seed beds, inside the

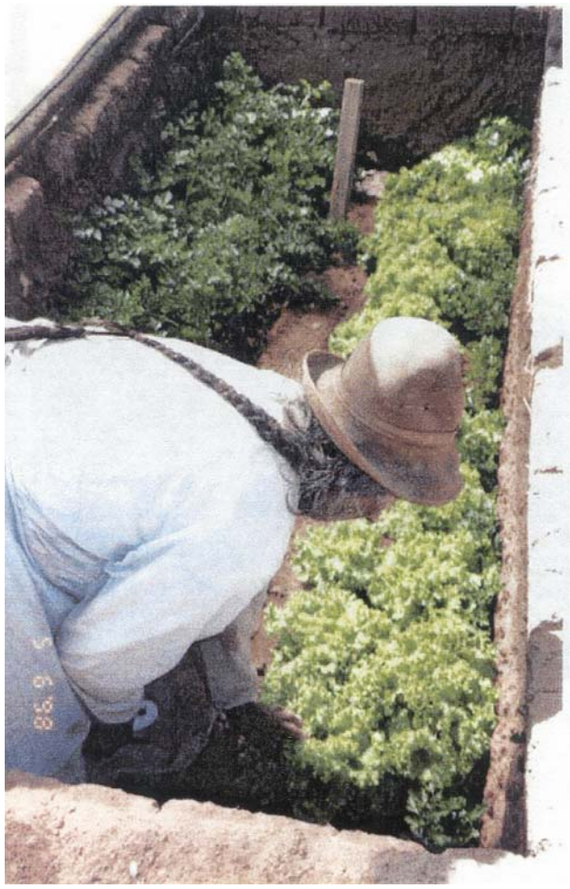
panqar huyu, in a 30 cm x 30 cm (11.8 in x 11.8 in) surface. After a week, the plantlet will begin to emerge, and after four to five weeks the chard can be transplanted indefinitely to the panqar huyu. They should then be transplanted at distances of 40 cm (15.7 in) between rows and 30 cm (11.8 in) between plants. Harvest cuts for consumption can even be made after the fourth week of the last transplant without fear of damaging the plant. Even though chard is a strong crop, the transplanting process is very critical. It should be done at dawn or around sundown in humid ground, covering the lid with straw when there is too much sun. The yield is high even during the winter. Every 15 days, 1.33 kg/m^2 (0.27 lbs/ft^2) of fresh greens can be harvested. This would make 5 kg (11 lbs) from a completely harvested unit.

Chard production

Celery: It demonstrated good adaptation to this microclimate with vigorous growth. The gradual harvests can begin around two months after planting in weekly or daily selective cuts. This vegetable is used widely in meal preparations. The leaves are consumed in uncooked salads since its taste is more desirable than the unsheltered celery and its thick petioles are consumed in soups. The production increases as harvest cuts are made.

Onions: In order to facilitate the crop and to make best use of the cultivation surface of each module, terebinth onions will be transplanted, also called "cebollines." These have a length of 10-15 cm (4-6 in) and can be acquired in the rural market or planted in the seed beds inside the panqar huyu. After the permanent transplant to the panqar huyu, the harvest time of this crop is reduced to less than four months.

Lettuce: Just like celery, it is used in salads. Its cultivation under this system has produced satisfactory results in yield, quality, and harvest time. The recommended species is the "Grand Rapid" lettuce. This species has plenty of folic mass and very good organoleptic quality. The cultivation process begins by planting seeds in the seed bed; after three or four weeks they are permanently transplanted to the panqar huyu with a separation of 25-30 cm (9.8-11.8 in) between rows, and 20-25 cm (7.8-9.8 in) between plants, in other words, 48 lettuce plants if the panqar huyu is full. The harvest takes place one month after the transplant. This is a very appreciated crop because of its home use and because it is the preferred fresh-consumption crop in the market. Research by Martínez and Sanchez (1998) show a production of 362 g (0.79 lbs) per plant, which translates into 22 kg (48.5 lbs) per harvest.



Lettuce harvest

Parsley: It is used daily as a supplement in soups. The consumed quantity is not high, but its leaves are rich in vitamin C (ascorbic acid) and fulfill part of the daily recommended values. The foliage can be harvested daily after the second month.

Carrots: Its production under this system provides good quality and its cultivation period is less than that of traditional production. Its root is the most important 13-carotene source (due to its high vitamin A content).

Carrots during the winter

Maintenance

There are two main factors that contribute to the deterioration of the panqar huyu. The first is the pressure created by water accumulated in the covering. The polythene is flexible and resistant to such force, but it begins to develop concavity. It stretches until it damages the unions with the nails in the frame. It is necessary to reinforce the agrofilm every year after the rain season (November to March) with nails, stretching in every direction. This would also be a good time to repair any holes with silicon. A well-maintained polythene film can last up to three years, it can then be replaced with a new film without any problems. The second factor would be the eventual erosion suffered by the walls, especially when the unit is poorly maintained and when the exterior drainage trenches have not been made, since these can withstand a hydrostatic load. Any cracks or slips

should be repaired with clayey mud mixed with straw or adobe bricks, which can be affixed in the damaged area as a partition wall. The berm that allows for the sealing of the lid should also be repaired with the same mixture. It is also important to regularly clean the drainage trench to avoid sediments to accumulate and cause the water to run over, since excess infiltration affects the walls. If the panqar huyu is well-maintained, it can be useful for longer than one agrofilm life cycle.

Families who have adopted this new technique have learned of the value of vegetable consumption and the simple, economical production of this system. Some have even suggested new uses by cultivating additional crops, constructing additional units, and gradually turning into alteration agents who train farmers around them. Families who have observed their neighbors use this system have shown interest in employing the system for their home use. Therefore, this process of transferring and disseminating technology is open to projects with ambitious goals to reach multiple families.