



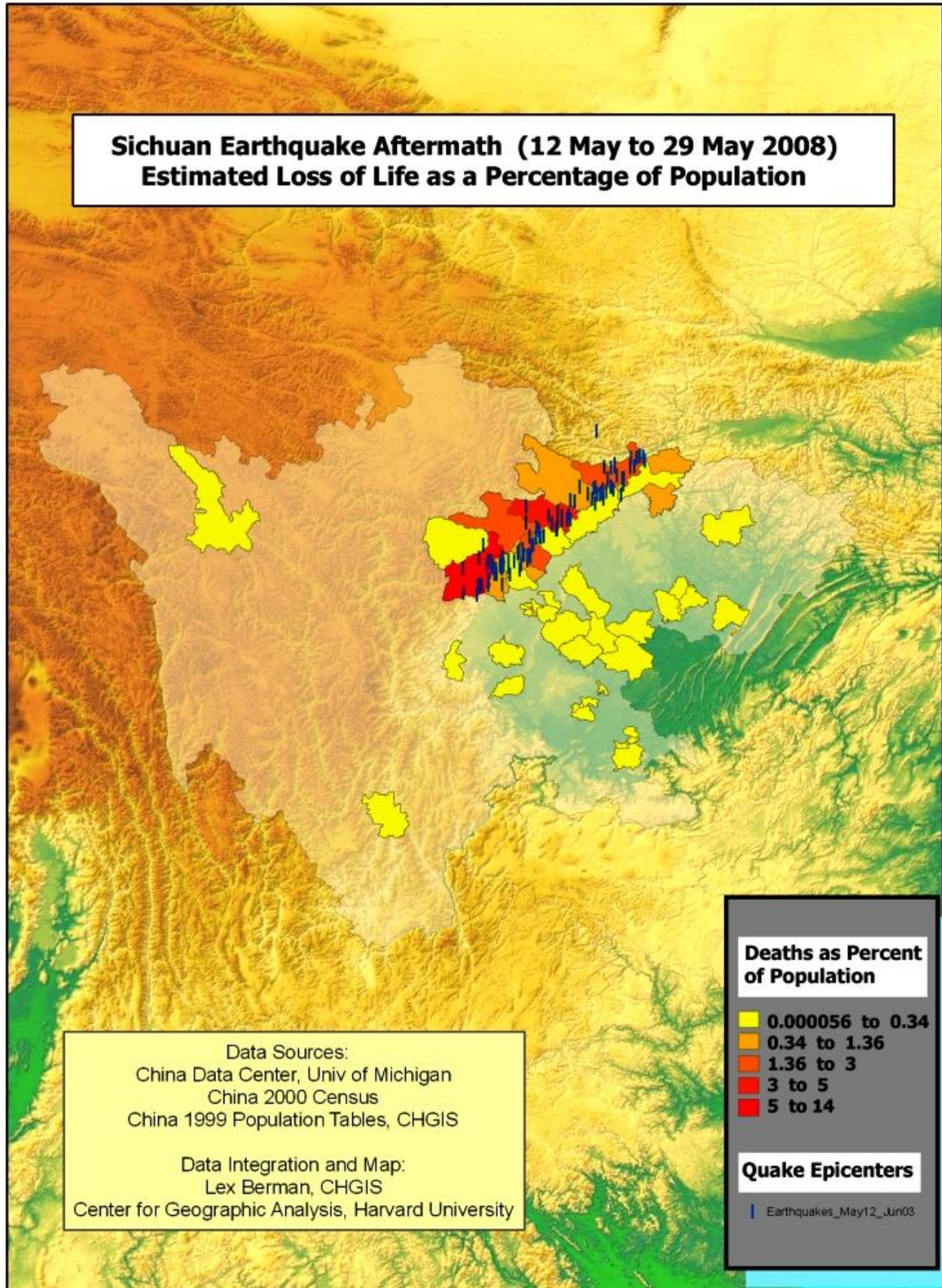
Gardens for Sichuan

By Peggy Bradley and Raanan Katzir

On May 12, 2008, a terrible earthquake shook areas of Sichuan province in China. About 70,000 people were killed and an estimated 4.5 million people were made homeless by the quake. UN FAO estimates that 30 million people in rural areas were affected, and the rehabilitation of agriculture may take three to five years to complete. The damage to the agricultural sector of this region is that to be about 6 billion dollars.

The FAO assessment reports that over 30 million people in rural communities have lost most of their assets. "In addition to the human tragedy caused by the disaster - mainly the loss of family members - many rural communities in Sichuan province have lost their means to produce food and create income," said Rajendra Aryal, FAO Senior Regional Emergency Coordinator. "People in the villages have demonstrated great resilience and have expressed their strong willingness to return back to their fields and resume farming and food production. It will probably take three to five years to rebuild the agricultural sector in Sichuan," Aryal added.

**Sichuan Earthquake Aftermath (12 May to 29 May 2008)
Estimated Loss of Life as a Percentage of Population**



Data Sources:
China Data Center, Univ of Michigan
China 2000 Census
China 1999 Population Tables, CHGIS

Data Integration and Map:
Lex Berman, CHGIS
Center for Geographic Analysis, Harvard University

Deaths as Percent of Population

- 0.000056 to 0.34
- 0.34 to 1.36
- 1.36 to 3
- 3 to 5
- 5 to 14

Quake Epicenters

| Earthquakes_May12_Jun03

Agricultural impacts

Most of the wheat harvest was lost and that wheat that had already been harvested was lost with the collapse of grain storages. Thousands of greenhouses collapsed causing severe loss of vegetable crops. Rice crops were damaged with losses estimated at 20 to 50% of the regional crop. Over three million pigs were killed with some villages losing 70% of their livestock.

Current shortages of pesticides and fertilizers are jeopardizing future food production. “Urgent provision of fertilizers, pesticides, farm tools and machinery, livestock and reclaiming damaged fields will be the main challenge for the next six months,” Aryal said.

The medium and long-term relief efforts will have to focus on the rehabilitation of water reservoirs, dams, animal shelters, the training of farmers in cash crop production and disaster preparedness. Also, the Bureau of Agriculture in each county needs support to rehabilitate damaged infrastructure, office equipment, seed inspection and testing facilities, warehouses and technical extension services.

The Chinese authorities asked FAO to coordinate the agricultural rehabilitation efforts in Sichuan province.

Recommendations

Based on the desire for people of the region to return to their homes and begin the process to restoration, and on current critical issues about food supply, a project should be started to help the local population grow their own food.

The purpose is to help affected families take immediate initiative to help themselves growing vegetables, pigs and staple crops and not become dependent upon foreign food supplies: to, as fast as possible, become self sufficient in their basic daily food.

Levels of Production:

1. Simplified Hydroponics (SH) of family units where mostly women and children grow near home vegetables and raise some small animals for themselves and some income. These gardens can be outdoors in the summer months, but will need indoor protection at first sign of frost.
2. Microgardens runs by few families where groups grow vegetables and pigs on small fields of 200-2000 m².
3. Establishing small and simple greenhouses as lean-tos for the new dwellings. This protected system makes it possible to both provide heat for the new shelter and to grow food year round.

The foods can be grown organically or with pesticides and fertilizers. Both options should be available to the local populations. To support this effort, local Ministry of Agriculture, emergency organizations, local and international NGOs can all participate in reconstruction efforts.

Simplified Hydroponic Gardens

Simplified Hydroponic gardens have been supported in many countries by UN FAO projects and others. There are, within the FAO organization, many experts who have been working with the technology for long term projects. These include projects in Colombia, Senegal, Cuba and Venezuela.

Simplified hydroponics differs from traditional soil based agriculture in that the nutrients to the plants are provided through the plants water supply. This can be either an organic tea or inorganic nutrients. Because the plants no longer depend upon nutrients from soil they can be grown in soilless cultures either organic such as coco fiber or inorganic such as perlite, or volcanic rock.

An advantage of soilless culture is plants grow faster, and can be grown in containers to help protect the plants from some pests and damage. In disaster situations, training begins with families being trained and starting with a seedling grower to grow the seeds for the full garden. The training takes three days and the seedling growers will be ready to transplant in about three weeks from the start.

Simplified hydroponics is recommended as a method to begin growing plants, either in the refugee areas or in the areas where the affected families relocate. With simplified hydroponics they can produce lettuce, radish and a few vegetables in 30 days and a full garden providing two kilos of fresh vegetables a day in 90 days.

Shelter and food

There are several issues involved in rebuilding homes including new forms of architecture to be stronger in an earthquake and more energy efficient. This offers an opportunity to improve housing for the peoples affected.

A lean-to type greenhouse can be a temporary shelter through this first winter, and or a food producing area to help provide fresh vegetables through this first terrible winter.

Required sun space

For a garden to be successful, it needs to face the southern exposure, and have access to full sun during the day. This means from at least 10 in the morning to about 4 in the afternoon, sunspace without shading. While some of the vegetables need some shade, most require a portion of full shade each day. If this amount of sun is not available, the plants are likely to suffer.

Winter sun space is more complicated because the sun rises lower in the southern sky. So trees or other obstructions that are not evident in the summer show themselves in winter. So it is important to start with a site sun map that allows for both summer and winter exposure on the southern side of the new dwelling. This is also important for solar collectors for solar heating and cooling.

Vegetables to grow

Every family will have their own preferences for foods they would like to grow. Most vegetables have been successfully grown in hydroponics, and in greenhouse culture.

A recommended space for family vegetables is 18 square meters. This amount of space can produce about 1.4 kilos of vegetables a day.

This growing space can be combined with a passive solar addition to a home to be an energy efficient method of heating and cooling the home. The hydroponic growers can be filled with solar collectors such as gravel and water. A solar cooker can also be included to create a living space that helps produce family foods.

For the Sichuan garden the following plants are chosen as likely favorites for several families: ginger, scallions, bok choy, Sichuan chili pepper, garlic, cucumber, celery, salad greens, and tomato. An example greenhouse with water and plant nutrients required as inputs is shown in Figure 3.

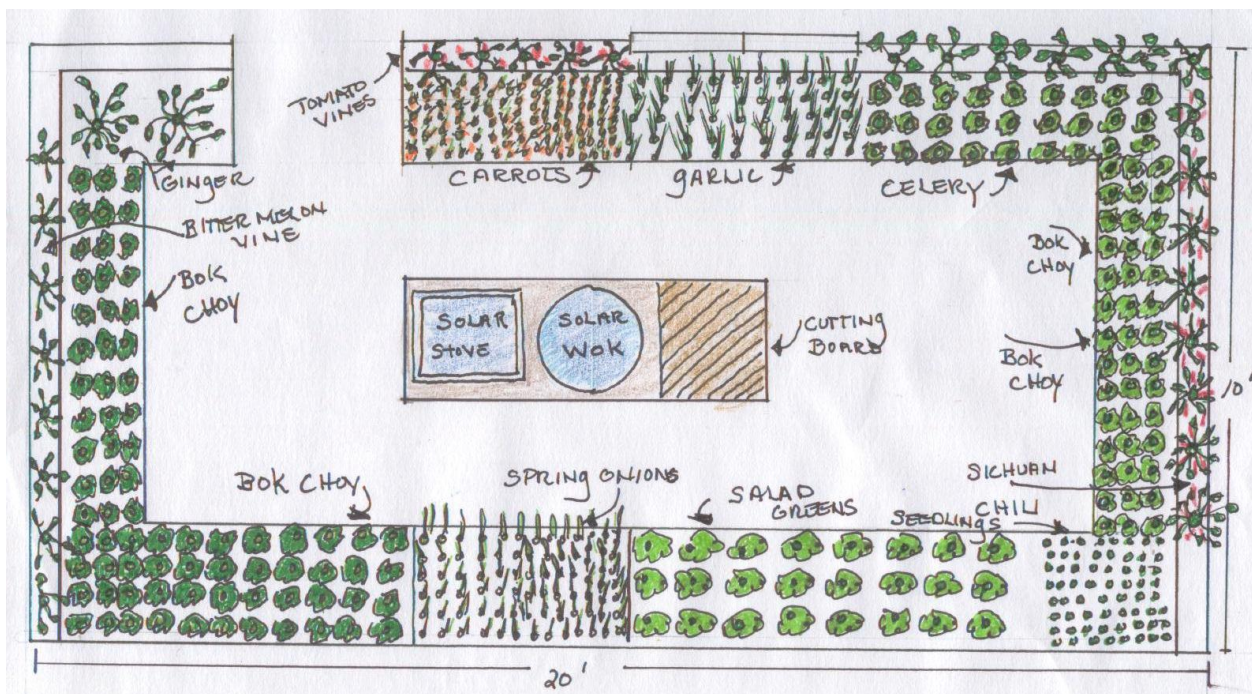


Figure 3. A potential greenhouse interior plan for daily vegetables in Sichuan region. This interior plan is expected to produce both shelter heat and about two kilos of produce a day.

A good size of this year round growing space is 3 by 6 m. The glazed area of this space is likely to be 200 square feet of glazed space requiring 200 gallons of water as the heat sink storage space. These 750 liter containers should be on the south facing wall, exposed to the daytime sun. Twenty five gallon storage containers should be enough and the best shape is in cube shaped five gallon black plastic containers.

The water containers should be black plastic and located against the interior southern facing wall. They are used to collect rainwater and supply a heat sink for the excess solar energy. The 750 liters is a minimum, and 2000 liters probably a maximum for these containers.

If the greenhouse is properly designed and maintained, it can collect 220,000 BTU per day, as much as in 21 kilos of oak firewood, 220 cubic feet of natural gas, or 5.68 liters of fuel oil. This energy requirement is estimated as a daily cost savings of \$7.50 a day.

Producing food

The solar greenhouse can be built of locally available materials at relatively low cost. In a UN FAO supported project in El Alto Bolivia, home based greenhouses and community greenhouses and made of Adobe, earth sheltered and use pole roof construction with a roof of double sheets of greenhouse plastic. This type of construction is relatively low cost.

According to a founding organization **CASOL (Cooperativa Agrícola de Comercialización Solidaridad)** , "Thanks to their greenhouses, local residents have quadrupled the production of vegetables that otherwise grow only in summer on the Altiplano. Lettuce, spinach, zucchini, tomatoes, cucumbers, and celery now fortify the family diet."

To also be a solar collector for providing heat, the greenhouse space needs to be designed so that the winter sunlight is collected on the rear water tanks, so the front table grower must be lower to the ground and grow shorter vegetables. The back grower above the black water tank can grow anything so larger plants are reserved for that area. As shown in Figure 4, the greenhouse includes several growing areas, a composter and a solar cooker. The composter is necessary to provide some warmth and CO₂ for the plants.



Figure 4. A greenhouse made of locally available materials in El Alto, Bolivia provides for both family foods and commercial crops. Add on greenhouses to homes also provide heat energy for the dwelling.

Table 1 Expected daily wet vegetable output from the solar greenhouse

Vegetables	Area in Square Meters	Grams per Day	Calories	Proteins (g)	Fats (g)	Carbohydrates (g)
Carrot	0.8	125	54	1.30	0.24	13
Bitter melon	0.5	100	34	0.84	0.19	8
Celery	0.8	150	24	1.3	0.26	4.4
Cucumber	2.0	125	18	0.8	0.14	3
Garlic	1.2	25	37	1.60	0.125	8
Spring Onion	2.0	50	16	0.9	0.1	4
Ginger	0.30	25	20	.44	0.18	4.26
Peppers	0.4	75	30	1.4	0.33	6.6

Salad greens	1.2	150	21	2.2	0.36	3.5
Bok Choy	1.6	500	65	7.5	1	11
Tomato	0.2	125	22	1.08	0.25	5
Total:	7.5	1.450	341	19.36	3.17	71

As seen in Table 1 the expected daily output in vegetables is about 1.45 kilos a day. These numbers are generally correct based on experiments and literature. The actual output can be more or less depending upon management, species grown and greenhouse management. This amount of vegetables can be estimated at costing about \$7.00 a day in the US.

Solar Cooker

The solar greenhouse should also include a solar stove. There is a wide variety to choose from, and two or more in the greenhouse can assist in daily food preparation. The solar stove can include a solar food dehydrator, and a small space under the support for a wood fire if needed on very cold days. The wood fire option requires venting of smoke out of the greenhouse.

With the solar greenhouse heating the home and the solar stove used for some of the cooking, the need for firewood should be reduced for the family. Rotary International has taken a lead on this work throughout the world, and supports a production stove manufactured at Mazahua Mission, Mexico. A similar manufacturing facility can be set up in the affected area of Sichuan.

Water

Daily water requirements for hydroponic culture varies according to environmental conditions, age of plant and type of substrate used, but it can be generally predicted that each square meter will require about four liters of water each day, so this greenhouse garden will likely use about 64 liters of water every day. Assuming water storage of 2000 liters in the greenhouse, the storage should be enough for a month of greenhouse production.

Water can be conserved in the greenhouse if irrigation of the plants is below the surface of the substrate and if the substrate is chosen to reduce surface evaporation. If the daily transpired water can be partially recaptured in nighttime condensation, the water use might be reduced even more.

Certainly the surface of the solar greenhouse can be designed to collect rainwater off this surface to help supply fresh drinking water. If the exterior surface does not use any paint or other chemical modification, the runoff water can be used for plants or human consumption.

Plant nutrients

The plant nutrients can be provided by organic or inorganic sources. The actual requirements of nutrients should be about 3 to 4 grams of minerals. If this is supplied in inorganic fertilizers it should be about 15 grams of material and if supplied in organic should be about 150 to 300 grams of material. The amount and cost of plant nutrients will vary but should be just a few cents a day for inorganic and at no cost or expensive if organic.

Costs of Greenhouse Construction

The solar greenhouse project in Bolivia has so far produced 170 structures in the El Alto project. The greenhouses are partially buried in the earth, made with adobe and constructed with a double plastic roof. The inexpensive construction allows for near year round production of vegetables at a very high altitude. Pit solar greenhouses are a known form of greenhouse construction that can be extremely low or extremely high cost.

The Bolivia Greenhouses are now proven technology, able with withstand snow loads in the winter and still produce vegetables. For Sichuan, a leanto greenhouse modification will allow the greenhouse to also function as a means of winter heat for the attached dwelling that can be built as soon as resources are available.

The El Alto greenhouse project may face water problems with the eventual melt of the nearby glaciers. Any greenhouse structure should include a rainwater harvesting system to secure daily needs for water. The greenhouse design uses large tanks for the 500 gallons but more rainwater storage may be necessary for year round water security.

Reconstruction

Efforts of all can help the people of this region regain their independence and livelihood as rapidly as possible. Beginning training in simplified hydroponics and providing the necessary products to begin their gardens would be a first step in helping the families with a fresh start.

Proposal

To support the foundation of these production units could be done within the framework of the local Ministry of Agriculture or a local emergency organization settled after the disaster occurred or local NGOs.

To run such a project a supportive governmental policy is needed. A governmental priority has to be set including financing.

The main components of such a project are:

1. To establish a regional pool of inputs as seeds, fertilizers, pesticides and basic cultivation tools.
2. To establish a regional pool of small tractors and attached mechanical tools.

3. A pool of building materials to construct greenhouses as wood, iron plastics ,drip irrigation equipment
4. An agricultural extension system serves as a human resource to actually carry out the project

The objectives of the agricultural extension system are:

1. Establishing contact with the producers
2. Disseminate agro technical professional knowledge
3. To disseminate technical knowledge about greenhouses construction.
4. To inform about access to inputs necessary for production activities
5. To organize production units of micro gardens
6. To carry out agricultural extension activities as lecturing, publications, demonstration, excursions, and field days.
7. To evoke promotion through radio, television and press.
8. To support mentally and morally the producers

Under the special local circumstances, there is a need to adopt activities to the exist reality on the spot. Activities should be applied according to local human willingness and possibilities. To adapt production characteristics to the current people knowledge and technical level but gradually to promote the increase of knowledge and technical level.

There is a permanent need to recruit inputs, financing and manpower to serve as agricultural extension agents. The agricultural extension is the predominant factor of the project success. The human resources of extension could derive from the student sectors of universities, advance farmers from remote regions and Ministry of Agriculture staff who will devote special priority to such project.

When such a project will extend, it will be necessary to extend publicity among many local societies, so it will become a wide range regional or provincial project. After the initial steps of the project, the producers will start to take initiatives. This project can start on a small scale and grow to wide frame project.

To prepare a solar greenhouse for Sichuan, experimental models should be built in the area to determine costs of site preparation, construction and daily operation. Plant production can also be tracked and costs of nutrients and water can be evaluated. A model greenhouse adapted to the area climate conditions and available materials should be designed and built.