

# Capacity Building for Sustainable Construction in Rural Northeast China

## Case Study Report

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This report summarises the findings of the mission dated on 15 – 19 December 2008 to Heilongjiang, China for the APFED case study on the 2008 APFED Award winning project entitled Capacity Building for Sustainable Construction in Rural Northeast China.

### 1. Background

The project has taken place in Heilongjiang Province, China where the area is categorised as a coldest (or very cold) zone in China<sup>i</sup>. [basic info on weather] The project aims at the improvement of energy efficiency of buildings by using locally available straw bales as insulation materials. National Government of China has shown its concern over the continuous coal consumption and brick production as they contribute to air pollution and land degradation of the country. The National Government has now promulgated to ban the brick production by 2010. Accordingly, the straw-bale building is expected to address such environmental issues as it reduces the use of heating system, which depends heavily on coal, and the use of red brick, which is a main material for the skeleton and walls of the building.

More than 600 buildings have been built under this project with the financial and technical support from ADRA China, gaining a reputation for its simple building technology and the contribution to the reduction of coal usage for heating.

In Heilongjiang, 70 % of existing buildings are recognised as energy efficient; however, 2 million more houses need to be rebuilt to meet the standards of energy conservation and earthquake resistance.

Although in the beginning of the project, no one was interested in building a SB house and

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<sup>i</sup> Chinese Standard (1996) Thermal Design Code, Energy Conservation Design Standard for new Heating Residential Buildings, JGJ 26-95, Chinese Construction Industry Publisher, Beijing

doubted its features, several meetings held by the county government finally persuaded one family, and others followed. A SB house tour after completion of the first building drew public attention.

## **2. Key actors**

ADRA is a leading organisation of the project, providing training and transferring technique and knowledge. One of the remarkable features of this project is an active involvement of government agencies. Due to multiple environmental impacts such as air pollution, heavy energy consumption and carbon emissions that China has faced, both national and regional governments are highly interested in innovative initiatives that contribute to solving the mentioned issues.

Heilongjiang Government has been financing the straw-bale (SB) house project in response to the national policy of the restriction of coal use; a whole production of coals will be banned by 2010. Mr. Xing Ce, a government official of Tangyuan County in northeast Heilongjiang, is performing as a key coordinator of the SB project across China. Likewise, the government officials of the county have received the training provided by ADRA and supported the extension of project activities.

Residents are also key stakeholders who take part in the construction from baling straws to plastering walls. House owners are certified as straw-bale workers after receiving required training sessions.

Beijing Association for Sustainable Development, a local NGO, shows an interest in the improvement of energy saving facility in the SB house.

## **IMPACTS**

### **3. Straw-bale House**

#### Heating and cooling system

The SB house boasts its high insulation and contributes to the reduction in coal use. Generally, coal is used for heating and cooking in the province. A cooking stove and a kiln are connected to a pipe that transfers steam / heat to a room heater or underside of a bed room floor, of which the heating structure is similar to Ondol developed in Korea.

Some houses owned by a lower income family have no heating system, and the house can be kept at a moderate temperature above 9 – 10 or above 20 °C in sunny days only with a cooking stove. Therefore, even in the houses with a heating system, the kiln is used for only

a few hours in the night time or no need in a warm day. For example, in a house accommodated with no heating system, one hour cooking can keep the room 18 degree Celsius and humidity of 38 % in December when the outside temperature is around -10 to -20 degree Celsius.

In summer time, the straw-baled wall functions as heat prevention. The room temperature keeps 18 – 19 degree Celsius when the outside temperature is approximately 28 – 32 degree Celsius high.

An average of 100 – 800 kg of coal is consumed per family during the winter period for six months. The coal consumption is reduced by half in a SB house; for example, a family that used to buy 5 – 6 tonnes of coal annually now use 3 tonnes per year.

### Building

The SB construction is rather simple, and community people can obtain the technique and knowledge in the training and be involved in the construction of their own house. Construction that requires professional skills such as plumbing works is applied by experts. A ventilation scheme with windows on the upper and lower wall for aeration control is also adopted. Since the first SB house was built in 2000, major maintenance has not been required for SB buildings. Some residents show concern over cracks on the wall.

Expanded Polystyrene (EPS) is preferred for roof insulation. Straw bales used as insulation of walls are supplied locally and sustainable. It is believed that packed straws are comparable to other strong materials.

In the light of material supply, while red brick production is eventually seized, new types of material such as concrete-made brick is being developed.

### Straws

Rice and wheat are most commonly used for SB houses along with others including grain, barley and buckwheat. They have to be kept under 17 % of dryness; therefore, straws need to be maintained properly to keep the appropriate quality, and the construction could only take place in summer in the cold area. The benefits of using straws are that they can be locally produced in a sustainable manner and farmers can use the residual of their own crops in addition to the heat insulation feature.

Supplying a straw baling machine is a major barrier for replicating in other communities. ADRA owned two bailers, which were manufactured in Harbin and given to a local partner at the time of project completion. Wu Chang Government possesses 10 to 20 reed bailers used for reed business in the region, but the bailers manufactured in Harbin turned to be suitable for SB construction. Currently, Tangyuan Government plans to set up a straw bale factory and seek for the creation of a new market for packed straw bales for SB houses.

### Cost

The cost of building a SB house is around 20,000 – 60,000 yuan (2,923 – 8,769 USD)<sup>ii</sup> of which the regional government and ADRA finance approximately 30 % each, and the rest is borne by an owner. Most families, with the average income of 5,000 yuan (730 USD) per year, are affordable to purchase the house by cash. In order to expand the opportunity of introducing the SB house in a poorer family, Tangyuan Government intends to collaborate with local banks for loans with a reasonable interest of approximately 0.005 % per month.

At the beginning of the project, the cost price was 200 yuan/ton, which raised by 700 yuan/ton. An interviewed family in a conventional house consumes 1.2 tons of coal during winter (in 6 months from mid-October to mid-April), 840 yuan is required mainly for heating annually. In addition, the same family pays 50 yuan for electricity per month or 600 yuan per year. If the same family lives in a SB house, purchase of coal can be reduced by 420 yuan. Saved money can be used for fuel and fertiliser for farming.

The construction cost of SB building is also competitive to or less expensive than the one of conventional houses. In the community of Tangwang Township, farmers / owners could save 10 – 15 % of construction cost comparing with normal houses. People in Tangwang have straws from their rice field, and thus do not need to pay for the straws and transportation cost. Since the cost saving of the SB houses depends on the straw price and transportation as the other construction materials that SB house uses are the same with those of brick houses, farmers find advantage of building SB house.

### Straw-bale School

A new SB school building was built in a primary school in Tangwang Township in 2004. The construction took approximately five months from early June to October, involving 40 people including teachers. The building consists of 6 class rooms and dormitory for grade 1 and 2 students in the 11,000 m<sup>2</sup> area. The cost of 500,000 yuan was financed by ADRA (300,000)

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<sup>ii</sup> Exchange rate: 1 CNY = 0.146 USD as of 6 January 2009

and Tangyuan County (200,000). After completion, government officials visited the school for inspection, but no statistic data were collected. The heating cost reduced by half comparing with the original building that stands in the opposite side of the ground. Similarly, the period of using the heating system is one month shorter (5 months) in the SB building.

#### **4. Impacts**

##### Land degradation

National Government has shown concern over the land degradation due to the production of brick and coal. Annually, 867 km<sup>2</sup> (1.3 M mu)<sup>iii</sup> of land is depleted for brick making. This is considerably serious for Heilongjiang that provides crops such as rice, beans, corns and potatoes to adjacent 8 provinces. Land protection through the reduction in coal use, therefore, can directly save the land for agriculture and its economy.

##### Health impact

The use of coal also affects air quality in the room. Indoor coal combustion causes health issues, especially respiratory diseases. The period of using coal in the room decreased in the SB house, and such health issues also decreased.

##### Social impact

A number of residential buildings remain primitive, with thatch roof and mud and straw walls, and do not have piped water and stable electricity supply. Government officials also expect the improvement of housing quality, taking this construction opportunity. At the individual level, saved money from reducing heating expenses can be applied to the investment for agricultural activities.

Further, there would be an employment opportunity in the local community. Along with the creation of straw-bale house market, builders, technicians, workers at a straw-bale factory, and people who take care of straws need to be hired at a local level.

National energy efficiency and environmental protection policy as well as environmental education have helped to raise an awareness of saving the land.

#### **5. Policy relation**

National energy efficiency and environmental protection policy such as Standard for Energy Efficiency and Environmental Design of Residential Buildings and environmental education

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<sup>iii</sup> 1 mu (亩) = 667 m<sup>2</sup>

has worked synergistically in increasing awareness of saving the land. [related national and regional policies / laws, Heilongjiang guideline, National policy on quality of village housing]

## **6. Future plan and challenges**

Tangyuan County has scheduled to build 1,000 SB houses the following year by replacing thatch-mud houses. In the county, there exist 35,870 mud and grass houses, of which 11,809 are planned to be rebuilt to SB houses. Currently, those houses do not satisfy seismic qualification and are considered as dangerous.

The Heilongjiang government intends to set up a straw-baling factory with the budget support from the provincial government in 2009. In addition to the creation of the market for packed straws, the introduction of loan service by local banks is also planned.

The brick production will be gradually eliminated, and a government official recognises the loss of employment in this section as a positive conflict. However, there seems no treatment for the workers to be applied. Taking into account that people have largely relied on brick for housing, a great number of workers will be forced to abandon their livelihood.

Another expected concern is that as the SB house construction spreads in a large scale, not well-trained builders may be involved in the process. In such an occasion, disguised use of materials and low quality construction can happen. There needs to provide thorough training and education to all the stakeholders.

While the housing quality will improve together with the rebuilt of old houses, there are still issues of waste management and drinking water supply in Tangyuan County. According to the county government, the waste in the county consists of organic (15 %) and construction waste (75 %). It is assumed that an increasing amount of demolition waste is expected in the next years.

## **7. Observation**

In closing, hearing voices directly from local government officials in different levels and areas, project implementers, house owners and supporting NGOs, it came to light that all the stakeholders truly believe in the straw-bale house. Not only have those who have attended the training sessions provided by ADRA but also who reside the house all assure the insulation of buildings. In addition, government officials are especially keen to the reduction of coal use, which degrades the land of Heilongjiang where 25 % of agricultural

products in the eight provinces of the north China are cultivated.

All the stakeholders involved in the project seem to fully buy in the idea of straw-bale buildings. In fact, no one has found major secondary issues after the construction activities so far except that some owners argued about cracks on the wall during the interview.

The project is in the stage of information dissemination and capacity development of local communities. In order to proceed with the next step and replicate the activities, other issues in the community such as drinking water supply and proper waste management need to be further integrated in the initiative.