

Super-insulated housing for Northern Asia

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Introduction

With over 1.3 billion people and growing, China is actively seeking ways to reduce pollution, promote energy efficiency and use renewable resources. Aiming to improve people's lives while at the same time improving the environment, The Adventist Development and Relief Agency (ADRA) has been introducing a durable and super-insulated style of housing that uses straw bales as a building material (Figure 1). ADRA built the first prototype straw-bale house in Mongolia in 1995 and expanded the programme to China in 1998.

'Straw bales?' you say with surprise. 'Don't they rot or burn?' In fact, straw-bale construction has a proven track record over 100 years. The construction technique was born of necessity on the Nebraska plains of North Central USA, in the late 1800s. The loose sandy soil would not work for soil-block houses and there was little wood, so the new settlers started to build with bales. They found that the houses were exceptionally warm, quiet and strong.

Though straw-bale construction mostly died out just after the turn of the twentieth century, it was revived in

the late twentieth century because of its energy efficiency and environmental friendliness. Now this technique is spreading all over the world. Straw buildings are being built in the US, Canada, France, England, New Zealand, Australia, and China, among others.

China has a long history of building with straw, often in combination with earth for walls and as thatch for roofs. But building with straw bales is a little different. Why are straw-bale houses so well suited for northern China?

- **Super Insulation.** Straw-bale walls (Figure 2) insulate six times as well as brick or concrete walls, saving 60–80% on heating energy depending on outdoor temperature. In northern China, millions of people are housed in substandard or dangerous houses often built of mud and rocks. Such houses usually are very poorly insulated and offer very little protection from cold winter temperatures that average below -25 degrees. This requires dwellers to burn large amount of coal for heat. Poor families can only afford to heat the small area where they

sleep and leave the rest of the house unheated.

- **Reduction of carbon dioxide,** other greenhouse gases and air pollution. The energy-efficient straw-bale houses require families to burn less coal to heat their homes. Coal burning produces carbon dioxide and pollutes the air.
- Straw-bale construction utilizes a waste product (Figure 3). In most of northern China, straw is an agricultural waste. It is often burned in the fields, creating air pollution.
- Straw is a renewable, sustainable resource. Straw grows in one season, as an agricultural by-product, and requires no additional energy input.
- Building with straw preserves land resources. Replacing clay bricks with straw bales reduces the amount of soil required for brick making. China has a scarcity of land resource and brick making destroys the land. The Chinese government has made rules to ban brick use in the near future and is seeking substitute construction materials.

Though ADRA is building high-quality, energy-efficient straw-bale houses, their main project goal is tech-



Figure 1 Typical straw-bale house



Figure 2 Straw bale walls



Figure 3 Straw-bale construction utilizes a waste product



Figure 4 Building with brick and straw

nology transfer. Over the past five years, ADRA's consultants have worked closely with Chinese builders to adapt Western-style straw-bale construction to Chinese conditions. In the US, where the techniques first developed, straw-bale houses are usually load-bearing (where the straw-bale walls support the roof loads by themselves) or wooden post-and-beam with straw-bale infill. In China, the roof loads are too heavy for bales and wood is scarce and expensive. At training in 1999, builders from Tang Yuan County, Heilongjiang, helped develop a building system that makes the most of both bale insulation and brick structure (Figure 4). In ADRA's yearly training, builders from five provinces in northern China have improved and adapted this system for their own local areas. By the end of 2002, Chinese construction workers built 571 residential straw-bale houses and one school.

Like any new technology, the straw-bale construction met scepticism and difficulties when it was initially introduced. But after families lived in this new type of house over a freezing winter, they realized that they were much warmer and more comfortable compared with brick houses. ADRA has worked close with builders and farmers to ensure that the houses are aesthetically and functionally acceptable in rural communities. The interior and exterior of straw-bale houses are plastered and they are indistinguishable from brick houses around them (Figure 5).

This is one of the reasons why farmers embrace straw-bale houses and take pride in the ownership because it is a dream for almost all Chinese farmers to own a brick house that is a symbol of a prosperous life. Those families who did not participate in the project because of their fears showed deep regret. Farmers are happy to see that straw, which once was a nuisance to them, is now turned into a building material that can even become a commodity to generate income.

During our house-to-house visits, residents always told us their new houses were much warmer than brick houses. In 2002, ADRA's national partner in China, the Center for Environmental Sound Technology Transfer (CESTT), conducted a fuel efficiency monitoring programme in one of the pilot sites. The monitoring measured temperatures, and fuel use in both brick and straw-bale houses. The result showed that straw-bale houses are more energy-efficient than brick houses and reduce the consumption of

coal and additional fuel materials (agricultural waste) by considerable amounts. The average consumption of coal is around 33% higher in brick houses. In terms of energy efficiency, straw-bale houses were on average around 68% more efficient than brick houses.

ADRA has worked closely and successfully with local governments implementing this project. They are so happy with the project, many local governments have asked ADRA to drastically increase the scope and pace of the project. All financial and management responsibilities are shared. ADRA provides about a quarter of the building funds, local governments contribute a further quarter, and the new house resident supplies the balance. A typical 60 square metre house costs around US\$3000 in northern China. If families decided to build a larger house, they pay for the extra.

During the coming summer, 23 straw-bale houses and one school will be constructed. ADRA is still seeking funds to help poor communities to build more straw-bale houses. ADRA's ultimate goal is to transfer this technology to China. Chinese workers will be able to design and build Chinese-style straw-bale houses without external technical assistance. So far, we have been able to implement a great part of the project successfully. Hundreds of workers have been trained to build these houses. It is rewarding to see the great interest stimulated by some local partners who are presently making attempts to build straw-bale houses on their own.



Figure 5 Plastered and painted house