



The Evolution of Agriculture in the face of climate change

Educational Resource File 2 (Supplementary educational material to be used in conjunction with the ACCC documentary)

This educational resource accompanies the Adapting to Climate Change in China documentary and provides further background on some of the adaptation strategies being employed by communities in northern China. The purpose of this supplementary material is to promote wider discussion and to foster cross-cultural understanding of some of the key issues raised within the film.

The Evolution of Agriculture in the face of climate change

While global action on climate change has been ongoing now for several decades, understanding on what these changes mean for nature and human life is still growing all the time. Scientists have studied weather patterns and climate variability over a number of years but what is becoming of more importance now is how these changes are impacting on vulnerable rural communities and the methods they are using to cope.

Climate change threatens access to basic human needs, including food and water, and also gives challenges to people's livelihoods. Without the capability of becoming self-sufficient or generating an income through agriculture and other rural livelihoods, communities are sometimes left with little choice but to move, usually to cities and urban areas. We are already seeing this in the southern mountainous communities of Ningxia,

an area featured in the documentary, where conditions have gradually become intolerable and the trend is to migrate. This can cause swelling cities, rapid urbanisation and the associated challenges for development planners. In other communities, where locals have chosen to stay and adapt, progress is being made which could bring benefits on both an economic and environmental level.

Meeting China's climate challenge through new partnerships

One of the achievements of the ACCC project has been to bring together a wide range of stakeholders to work on the challenges presented by climate change from academics, scientists and meteorological experts to decision-makers, governmental departments and local people.

In Inner Mongolia, ACCC researchers have begun working with local herdsmen to hear their experiences and knowledge. The coupling of these on-the-ground observations with scientific monitoring and climate modelling is helping researchers to develop their understanding of the impact of climate change. These communities are living through climate change and are already initiating their own adaptation measures and change; much of which could be helpful for others facing similar climate impacts. ACCC is feeding this information into its research to help policy makers in China and elsewhere in the world better prepare for the future. This style of working couples scientific-led research with real-life experience for a top down-bottom up approach.

Question to Consider: What type of new partnerships might meet the challenges in your area or region?

Grass Gridding

(Documentary: 07:10-07:50)

One of ACCC's pilot provinces is Ningxia, where researchers have been seeking to understand how local people are adapting and can adapt to the changing climate. The desert communities of Zhongwei City, northwest China, and the challenges they are facing are depicted in the documentary.

The Tenggeli Desert is located in the West Wind Gap of Ningxia, one of the three biggest wind gaps in China. In recent decades, the landscape surrounding the desert has become increasingly dry and arid and is losing its capacity to sustain vegetation. This wasn't always the case. Rich grassland once covered large areas of China but natural changes in climate such as increased drought as well as human activities such as over grazing, mining and over cultivation has reduced soil moisture and removed nutrients vital for growth.

When soil can no longer sustain vegetation and the land becomes dry and barren, wind erosion allows the desert to further gain ground of more fertile areas. This reduces food production and directly impacts on farmers' livelihoods. Sandstorms are a major threat to agriculture in Ningxia. One of the challenges facing the locals here is to prevent the desert from encroaching further inland and damaging ecosystems. To tackle the situation, the local government has

encouraged the implementation of an afforestation strategy which has a dual purpose: to allow the eco-system time to recover and increase the fertility of the soil and to reduce the velocity of the wind and retain drifting sand. ACCC has been looking at the performance of this technique as an adaptation measure.

The process involves pressing straw or weed grids on the dunes to anchor the sand. The grids hold the ground together well enough to grow some drought-tolerant species of grass in the straw. Within two to three years, the grids naturally decompose and turn into fertiliser which provides the right nutrients and conditions to grow larger desert plants. These provide the additional benefit of forming a windbreaker to reduce wind erosion and reduce the rate at which the desert is able to move.

The technique was initially devised to prevent sand from blowing across railroad tracks which slowed down passenger and commercial rail travel. The system is now primarily used as a way of tackling desertification and protecting local eco-systems. After two generations of efforts, indications suggest the Tenggeli Desert has been pushed 30km northward.

Originally, grass grids were made of different shapes and sizes ranging from 40cm through to 1.5m in length. After exhaustive testing over the decades,

grids of between 80cm and 1m have proven to be more effective at fixing the sand dunes in place.

One of the biggest advantages of the grass gridding system is that it is an effective, low-cost adaptation measure. The government funds the cost of the seedling and straw and local people undertake the labour. The technique is also environmentally friendly and the materials are locally-accessible. However, the project has its constraints including long-term financial support, heavy workloads for those involved and insufficient knowledge and training of those employed to create the sand barriers. One of the objectives of the efforts is to increase the participation of local residents in the afforestation scheme but without economic incentives and subsidies, less people are willing to adopt the technology.

China's experiences tackling desertification could have value much further afield, particularly in countries in Sub-Saharan Africa where land degradation is adversely affecting production and desertification has become a major concern. Workshop visits have taken place to northern China's anti-desertification projects to share knowledge and skills. The Chinese government has also funded courses to train African desert control technicians in effective desert management.

Wind-breaking forest

(Documentary: 07:10-07:50)

The second phase of the work in Tenggeli, shown in the documentary, **is to cultivate rows of plants in the decomposed grass grids as a means of achieving a windbreaker to reduce wind erosion.**

ACCC is looking at the effectiveness of such techniques.

The technique is traditionally used in arid or semi-arid areas and is regarded as an effective means of slowing the pace of desertification. The vegetative barrier is made up of plants which are suitable for desert conditions including drought and sandstorms. The rows of plants gradually reduce the speed of the wind while also allowing drifting sand to pile up rather than be blown across fertile areas. As well as fixing local sand, the wind-breaking forests, also known as high vertical living barriers, have the capacity to anchor sand blown in from elsewhere.

In the desert, the precipitation rate is as low as 180mm per year however the evaporation rate is considerably higher at 3,000mm. The trees selected need to be drought-resistant and able to establish strong roots within the sand to provide resilience against the wind. Date trees and other fruit tree species have proved particularly good at adapting to the environment and are able to grow, blossom and bear fruit

despite the low humidity level. This provides the farmers with a source of income every three to five years but the primary purpose of the afforestation plan is an ecological one to help the land recover and restore biodiversity

Planting takes place every spring and tree maintenance is an essential part of the work to ensure the forest has adequate density. Project leaders appoint designated maintenance workers to tend to the plants to avoid further human and livestock damage. The freshly planted rows can bring desertification benefits within the first year of growth and provide carbon sequestration benefits.

The Tenggeli Desert covers a total area of 106,666 hectares. Local farmers have already treated a huge expanse of the desert with a combination of tree-planting and grass-gridding. This style of intervention has had positive effects on the environment. Some accounts show that the air humidity has increased by 15-20%, the frost-

free period has been extended by 15 days each year and the wind speed is considerably lower. Locals are now seeing fewer sandstorms and increased rainfall in some areas because of the increase in vegetative cover but there are some concerns that such extensive tree-planting places an additional burden on scarce water resources. Residents attribute this to the notable anti-desertification efforts happening in Ningxia. While the technique provides a short-term solution to sand movement, these benefits could be outweighed if the consumption of water is excessive. For this reason, emphasis has been placed on identifying tree species suitable to a barren environment such as Aborvitae and Chinese pine. Project leaders have recommended introducing tree species which originate from a sandy/desert environment and are able to withstand extreme temperatures and low precipitation rates. What's more, Ningxia is trying to build up public cooperation to ensure a "water-saving society".

Trickle irrigation

(Documentary 07:10-07:50)

Desert plants and trees have developed effective techniques for storing and preserving water but no variety can survive without it. Different varieties cope better in drought conditions than others and some species will require more water during different seasons.

To save water, locals use a process known as trickle irrigation which originates from Israel. This technique allows water to slowly drip to the roots or soil surface through a network of pipes and valves, thus reducing the likelihood of evaporation. Plants receive all the water they need to survive but no more than absolutely necessary.

Using the groundwater supply, irrigation takes place once every 10 days for 12 hours. The dropper emits three litres of water every hour bringing the total up to 30 litres in a 10-hour period. This amount every 10 days is enough for one tree to survive.

Without the water-saving irrigation, trees would require 100 cubic meters of water every year. With trickle irrigation, they require just 30 cubic meters. However, there are disadvantages of the technology. Trickle irrigation involves an initial set-up investment and comparatively high-costs in maintenance. One of the reasons it is used more frequently in high value crop production is because of the higher costs involved.

The work in Ningxia uses other water-saving measures to enhance crop quality and protect the water supply including plastic mulch irrigation. Plastic mulch reduces the evaporation of water from the soil by reducing sunlight exposure and the temperature of the soil. This means that less water is needed during the trickle irrigation process. However, this procedure also involves a cost for the plastic film and labour.

Question to consider: What kind of technologies and measures are being used to help farmers adapt in your area or country?

Protecting livelihoods In Focus



To broaden the agricultural possibilities available for locals, the government in Ningxia has invested in greenhouses in the desert area.

Farmers are able to take advantage of the ample sunshine to grow a wider variety of vegetables and other sellable food products to generate an income. To support the venture, the Government has also developed good infrastructure in the form of roads, electricity and water supply to enable farmers to plant food and sell it for profit.

The output within the greenhouses is way beyond that of open farmland and could be as much as 20,000 Yuan (3,266 USD) per greenhouse per year. Farmers own the greenhouses and grow cucumber, mung beans, chilli, tomato and fruits such as peach and almond in the off-season. The produce is organic which has high market value and the quality is high because the drought environment is insect-free. This means it can be sold on the supermarket shelf.

The same process of trickle irrigation is used within the greenhouses to save water and reduce the cost and locals take care to ensure the farming process is environmentally-friendly.

The Ningxia region is particularly suitable for greenhouse production because it has more sunshine than most other parts of China. In this region alone, sunshine exposure is 2,250-3,100 hours per year (eight hours a day on

average). Local farmers can earn 10 times more than when they relied solely on the weather for harvest because of the constant source of solar energy and water. The scheme is helping local communities adapt to difficult climate conditions but is also lifting them out of poverty.

Case Study

Documentary (07:55-08:21)

Yang Fei is chairman of Zhongwei Modern Desert Agriculture Co Ltd. He came to the West Wind Gap area of Tenggeli Desert in 2009 and invested in more than 650 hectares of plant-cultivation park.

The businessman is currently cultivating a 50-meter stretch of wind-breaking forest at the front of the desert using live grass grids to grow date trees. As part of the growing process, the company uses manure fertiliser from local cattle to make the sandy landscape more fertile and give the date trees a better chance of survival.

The desert enjoys rich ground water reserved and the unpolluted environment produces high quality produce - up to the national organic standard - and is marked up with organic certification.

For those who have cultivated the land in this way, the effort and patience has paid off. Each 666 square meters of

desertland has the potential to raise 4,000 to 10,000 Yuan (653USD to 1,633USD) when the trees bear fruits every three years. In addition, if locals plant alfalfa - a plant used to feed cattle - they can receive 2,500 Yuan (408 USD) per heap.

As well as bringing economic benefits, the trees also perform an environmental function and serve as a screen on the edge of the desert to lessen the speed of the wind. This in turn prevents sand from being blown towards the cities. The wind-breaking forest can bring positive changes to the ecosystem with fewer sandstorms in recent years and clearer rainwater.

In addition to the grass grids and wind-breaking forest, Mr Fei's company also grows produce within the desert greenhouses including pepper, tomato, aubergine, carrot and muskmelon which generates income on a permanent basis.

"After our years of efforts, the desert is no longer dreadful. We turn waste into wealth, making the desert a place that can bring us financial and ecological benefits," he said.

"I believe if I stick to the road I am walking on, there would be more success to come. Spot your direction; walk towards it; never look back."

The Future

The responses to desertification in Ningxia have delivered positive results and are achieving a wider social purpose by helping local people to escape poverty. The green houses, in particular, have brought private sector investment and have broadened the availability of funding as well as created employment opportunities and enterprise. Meanwhile, there is research to suggest grass gridding and afforestation is having a beneficial impact on climate conditions although further study is needed to assess the extent of this progress.

Locals plan in the short-term to treat a further 20,000 hectares of sand land over the next five years and preserve the remaining area for tourist resources. By enhancing the environment in this way, the hope is that climate conditions will become more hospitable and agriculture can continue to thrive in the area.



BIBLIOGRAPHY

This Resource File has been developed by the INTASAVE Partnership for the Adapting to Climate Change in China project, based on the transcripts of on-the-ground interviews, undertaken for the ACCC documentary. Other sources used to develop this Resource File include:

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