China; - floods, droughts and climate change

Research proposal   12 April 2011

Preface

China with its mighty Yangtze and Yellow Rivers share with Australia with its less mighty Murray and Darling Rivers a common problem; - food bowls suffering from an historic flood and drought cycle, now aggravated by climate change and loss of top soil.

Warm air can hold more water, so rain falls less often but with greater intensity when it does rain. There is a growing sense of dismay and frustration as people watch the failures of climate change negotiations, Copenhagen, Cancun, Bangkok. Yet there is a solution, by changing the agricultural system. Plants are already absorbing large amounts of atmospheric carbon - some thirty times man made emissions yet the majority of the carbon absorbed re-enters the atmosphere as it decomposes.

By modifying agriculture this flow of carbon can be captured in the soil. Organic waste is placed into lined trenches, which are regularly filled with water, inoculated with mycorrhizal fungi and worm eggs giving controlled decomposition with reduced emissions of green house gases. This is known as the wicking bed system as water wicks up from the trenches to the root zone to provide an efficient irrigation system.

Agricultural organic waste is insufficient to provide the tens of billions of tonnes required to balance human carbon emissions. Some otherwise productive or marginal land must be dedicated to growing fast growing species selected for optimizing carbon absorption. Forest and urban organic waste provide other streams. With correct choice of deep rooted species this provides a system of nutrient mining.

The farmers receive direct benefits, the subsurface trenches provide a highly efficient irrigation system with no water lost by leaking into the subsoil, surface evaporation is virtually eliminate so all the water goes into plant production, the soil structure and nutrient levels are improved leading to higher and more stable food production.

The community benefit, external application of fertilizers is reduced; - nitrogen is energy intensive and phosphorous is becoming in short supply. Nutrient run off into the water table and river systems are reduced and urban waste, sewage and forest waste can be beneficially recycle reducing pollution and fire risks.

The benefits are overwhelming, but there are costs which are too high to be borne by food production alone. It is simply not reasonable for farmers to meet all the costs of reducing green houses gases on a large enough scale. On a global scale the costs are almost trivial in comparison with the damage caused by climate change or other means of green house reduction schemes. Farmers must, in some way, be paid for their new role of green house gas abatement.

The climate change debate is almost an Alice in Wonderland story. The battle between the developed and developing countries is so intense that no one seems to have time to step back from the battle and reflect on this alternative solution which is staring them in the face.

The realities are simple, developing countries with a large population who do not have access to the benefits of modern technology; particularly basics like electricity, have no option but to expand their economies. This will inevitably mean building more power stations, and with the lack of an alternative, that means coal. Attempts by the developed countries to reduce their emissions have been patchy; any reductions that have been achieved are small, now where near enough to combat climate change or to offset the increase in emission from the developing countries.

Changing our agricultural system to absorb carbon appears to be the most viable way to resolve the climate change battle. But just because an idea is right does not mean that it automatically accepted. The challenge is to gain acceptance of this agricultural revolution.

China is the key. China is the largest emitter of carbon, and has done more to abate carbon than other countries; it leads the world in many green technologies such as electric cars and solar panels. It ability to manage major projects to become a super power leave many in awe. If China were to adopt this technology other countries are sure to follow.

But first there must be verification by a recognized Chinese research institution. Here we lay out such a research program.

Proposed research program

Aims

The **first** aim is to verify and quantify the immediate technical benefits of

1) Reduced water use
2) Increased productivity
3) More effective use of nutrient
4) Reduced pollution of the water table and rivers
5) The ability to absorb significant volumes of atmospheric carbon

The **second** aim is to estimate the costs involved in achieving the global reduction in green houses gases which are measured in tens of billions of tonnes of atmospheric carbon.

The **third** aim is to examine the logistics in achieving this change and develop a broad plan for adoption.

Methodology

Water use. Measuring the water usage in the wicking bed system is easy; it is simply a question of measuring the amount of water to regularly top up the beds. This data can then be used to develop crop factors as a basis for comparison with traditional irrigation systems.

But compared with what? High tech irrigation systems such as pulsed subsurface irrigation using soil moisture sensors and computer control can achieve similar water use efficiencies but at much greater cost. In practice large scale agriculture still largely uses flood irrigation which is intrinsically less efficient. However one of the major losses of water is poor irrigation scheduling. The comparison should therefore be the water saving that could be readily achieved in large scale agriculture as currently practiced.

Nutrient use. One of the major benefits of the system is that there is no loss of externally applied nutrients and the decomposition process is adding a steady stream of nutrients. However decomposition can cause problems of its own, specifically there is typically an initial large drain on nitrogen which has to be compensated for. Also some organic waste streams, such as plant roots of certain species can exude growth inhibitors. Until such organic wastes have decomposed they may be a need to compensate for these inhibitors. Experiments need to be conducted to establish the optimum nutrient balance.

Productivity. The general experience with the system is a significant increase in productivity. However there have been cases when germination and productivity are reduced. This is almost certainly due to the early stages of decomposition and its effect on nutrient balance. The final comparison with conventional methods should be based on productivity after the nutrient requirements have been optimized.

Reduced pollution of the ground water. In normal conditions there should be virtually no nutrient leaching past the root zone. However nutrient run off is often caused by heavy flooding. To give a balanced understanding large scale open beds need to be monitored in times of heavy flooding.

Absorption of atmospheric carbon. This is likely to be a highly controversial issue. The Kyoto protocol did not give proper consideration to soil carbon directly but it did adopt the concept of permanent soil carbon which is based on the false thinking of carbon as a static problem. In reality soil carbon is dynamic with carbon continuously entering and leaving the soil (from decomposition). It is logical to accept the reality of a dynamic situation and measure the amount of carbon added to the soil with each application of organic material and the amount leaving the soil from decomposition to give the net balance over time.

This can be done by measuring soil carbon directly and the rate of emission of gases (for example by a small tent). The rate of decomposition is a critical concept. The aim should be to develop a method of extrapolating emission of carbon over long periods of time.

Measurement of the rate of decomposition is critical. A key part of the argument for this process is that decomposition using fungi in a moist subsurface layer is far slower that normally occurs with bacterial decomposition on the surface or in an oxygen rich environment.

Individual measurements of soil carbon on the millions of farms over the large areas necessary to absorb the tens of billions of tones of atmospheric carbon (millions of square kilometers) would present a major cost and logistical problem. It is hoped a simple method of classifying the carbon content of the various organic wastes added to the soil, and typical rates of decomposition would avoid the need for this expensive monitoring.

The farmer simply has to record the amount and type of organic material added to the soil. This can then be entered into a simple computer program could predict the carbon sequestered over time. The development of this software would be an important part of this project.

Experimental requirements

Several types of experiments are required.

Laboratory trials. A great deal of valuable information can be collected from simple wicking bed boxes. This enables a wide range of experiments and operating conditions to be analyzed under controlled conditions.

Field trails. Field trials are essential to fully test the practicality of the system. Again many of the trials can be conducted under research style conditions to give useful information. However a critical it is crucial to see how practical commercial farmers react to the system and how well they adapt to the new technology. Farmers tend to think in a much more holistic way than research scientist and experience has shown they can make a major contribution to the development of new farming systems.

It must be remembered that many of the techniques of no till farming, direct seeding etc were developed by famers to solve the real problems of drought and were initially rejected by the research community until after the practical benefits were undeniable.

Species selection. There is a need for research into mycorrhizal fungi. These are readily available commercially in Australia but there does not seem a great deal of information on what types are most suited to different climatic conditions and crop types.

Similarly with plant types for carbon capture (plants deliberately grown to provide large volumes of organic material). It is clear in Queensland that species such as Easter Acacia and Bolivian Beech (local name possibly *Anadenanthera colubrina).*

No doubt there are suitable fast growing plants native to China, possibly even bamboo.

There is significant opportunity to refine the system over time, the first priority must however be to demonstrate the system is viable.

Organic streams. The target is to capture tens of billions of tones of carbon (on a global scale). This will almost certainly required nonfarm streams of organic material (urban, forestry and reclamation of unproductive land). There is a need to quantify the potential amount of organic material and the costs of distributing this to farms for embedding into the soil.

Please see

Innovation_in_soil_carbon.pdf at

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