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LEADING EDGE

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Giving farming costs the chop in China

By Gary Alcorn

Australian farmers have plenty of agronomic and engineering challenges, but sowing into soil frozen solid at 100 mm depth is not usually on their list.

Add to this difficulty, restrictions such as tractors producing less than 20 hp, having to serial (sic) plant between rows of existing green crop, and very traditional farmers working very small blocks (less than 1000m^2).

These parameters set the scene for an unusual agricultural engineering challenge where the brief is to introduce and 'sell' permanent raised beds (PRB) to an isolated irrigated farming community sandwiched between the Tibetan Plateau and the Gobi Desert.

For the geographically minded, UQ-based research scientist Dr Allen (Jack) McHugh established research and demonstration plots in Gansu province in north-western China where annual rainfall is less than 150 mm and most of the irrigation water comes from mountain snow melt.

He started his four-year ACIAR project, *Promotion of conservation agriculture using permanent raised beds in the Hexi Corridor, Gansu, China* back in 2005.

"Farmers, industry and expanding urban areas are placing heavy demands on available surface water and dramatically lowering water tables.

"Recent reductions in snow fall over the last few decades have seen considerable reduction in ground water recharge, surface water and environmental flows," he said.

Rather than educate users in improved water use efficiency techniques, "local policy makers have implemented water restrictions, lowered allocations and increased water pumping costs," Jack said.

Although the availability of surface water is restricted it is very low cost, if not free, so those farmers not on the irrigation scheme are dependent on pumping from wells and bores and are often disadvantaged.

Sound familiar? Substitute rain for snow and you could have the Australian situation. Indeed some lessons learnt there could apply to most of our irrigation industry.

In Year 1 he was charged with developing and testing conservation agricultural machinery, including a five-row planter mounted on 20 hp tractors to mechanise PRB management in wheat/maize systems.

Other targets were to set up irrigation monitoring systems and develop an extension program to deliver the zero-till PRB system in the Hexi Corridor.

He offers this insight as background to local social and farming cultures along the Old Silk Road in the Hexi Corridor.

The soils are very deep, well drained and low nutrient loess derived from wind blown particles and contain around 30 per cent clay.

The corridor is about 60 km wide at 1500–2000 metres above sea level, extremely dry with 4000 metres high snow covered mountain ranges to the south and an arid desert to the north.

Traditional farming practice often demands two crops are planted into the same permanent raised beds in a five-row

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This Chinese generation II prototype zero till planter was developed from Australian and overseas bed planters by Dr Jack McHugh and interpreted by local engineers in the Hexi Corridor of NW China. Implement cost, mass, and depth control where key concerns.

(three wheat–two maize) configuration (intercropping) because of the very short cropping season. But traditional rotations of five-row wheat on 65 cm beds followed by two row maize in the following season is the norm.

"Spring wheat is planted on March 20 (or as soon as the top 10 cm of soil is unfrozen), or maize about April 20 in a standard rotation cropping program. By September/October temperatures are close to a mild Toowoomba winter, then from December to March it is very cold often well below freezing," he said.

In the intercropping situations maize is sown between the wheat rows (April 20) which are then hand-harvested in July before the maize becomes dominant and then harvested in September.

In April 2006 Dr Jeff Tullberg of CTF Solutions assessed current planter design and recommended a comprehensive rejig, which incorporated bed forming and planting in one pass, bed surface depth control, improved seed metering and better seed/fertiliser separation at the delivery point.

As with all treatments, zero-till controlled traffic with flood irrigation, freshly raised beds and PRB, depth control, high moisture content and frozen soil often caused planting stoppages and poor establishment.

Capacity for simple adjustment to enable sowing in different field configuration was another recommendation, as well as reliable residue management which was a major factor when upgrading planters to Generation II models.

After installing an array of electronic instruments to monitor weather, salinity, soil moisture and temperature and 48 full-stop wetting front detectors, the team was ready to use Sirmod and other proven software to monitor soil, water and crop performance.

With the average farm size around 1000 m^2, wheeltracks (doubling as irrigation furrows) in PRB become a significant non-production area – up to 30 per cent of the surface area with 65 cm bed width.

Evaluate Australian systems

"We wanted to evaluate proven Australian conservation and zero tillage systems in their context of using existing small tractors with minimal additional costs. Possible cost savings such as fuel, seed, fertiliser and labour were major considerations, but saving water under the new farming systems was paramount.

"Fertiliser rates were up to 5-6 times rates in western nations and 40 per cent of input costs. Seeding rates were also much higher because of poor seed metering on the planters and local wheat varieties which don't tiller," Jack said.

Traditional irrigation scheduling was based on fixed volumes delivered to farms at four prescribed times for wheat, by extensive concrete lined irrigation channels. This prescribed water delivery to basin-irrigated farms led to considerable over-watering and leaching of nutrients into the groundwater system.

"Chinese farmers were convinced more fertiliser was always better so we had a major entrenched attitude challenge to convince them yields would not be affected by fine tuning inputs.

"That's why we established large demonstration plots across the corridor, conducted training and information sessions and brought a team of local extension officers and researchers to Australia to see how lower, better managed inputs could achieve comparable yields.

"Traditional prescriptive farming customs where A+B+C is folklore in the corridor. In Australia we have an abundance of local agronomists, advisors and extension staff. But in China, the extension system is convoluted and often non-existent and if active, is mostly targeted at mechanisation development," he said.

Another social challenge is the drift of young people to the cities for better paid work. Even today men drive the tractors and women do the manual field work, including harvesting, and quite often, these people are the grandparents in the families doing this intensive work.

A successful zero-tillage system would help alleviate the chronic labour shortage and make farming easier for the aging rural population.

This project will run until 2009. So far the input savings and yield results using the Generation II planter are encouraging (see box story) and have identified related areas requiring more research, particularly better wheat varieties.

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PRBS DO REDUCE COSTS

In the 2006 cropping season, eight comparative fields were established, four configurations in two replicates (PRB, FRB, zero till CTF and Conventional). The new bed-former, and planter caused poor emergence (65 per cent) under the new farming methods compared to conventional at 85 per cent.

There was no significant difference between wheat yield of conventional practice and PRB even though planted area was 30 per cent less and plant emergence was 20 per cent lower under PRB in the first season.

Water balance data demonstrated a 40 per cent irrigation water saving using PRB in the 2007 season after a 22 per cent saving in the previous season.

PRB yield in the second season, after minor planter modifications and farm managers adjusting to the new farming system, exceeded conventional farming by nine per cent.

Stubble cover on the PRB plots reduced soil temperature and water loss through evaporation, but it also delayed planting by up to a week compared with conventional tillage in the first season.

Disease incidence and wheat lodging were not apparent in PRB, but very prevalent under conventional farming conditions. Although demonstration sites are not instrumented as well as the research site, significant increases in yield and reduction in inputs were achieved.