INNOVATIONS IN LAND PREPARATION

Hans Woldring

In recent times cotton growers have seen the need to adopt new land preparation practices. In the Macquarie Valley alone, only 35% of the 1987/88 cotton crop was prepared using conventional techniques. The swing away from conventional land preparation practices has largely been in response to economic factors. However, a further factor is the greater awareness growers have in relation to maintaining and improving their soils structure. Much of this awareness has been as a result of excellent research and extension programmes. In this paper I will be dealing with the research and technical inputs which have led to innovative land preparation practices.

A. Economics and Timeliness

Only two years ago we were listening to a presentation on "How I will save $100/acre in growing costs" following a collapse in cotton prices. Traditional approaches to land preparation can be both expensive and time consuming. Savings in land preparation costs by Direct Listing as opposed to conventional land preparation can amount to $46 per ha.

Recent innovations in land preparation have aimed to minimize the number of passes which are required to overcome soil structural limitation to cotton root growth. Fewer passes therefore represent a saving in time and costs. Timeliness is especially critical where crops are grown 'back to back'.

Soil Management Awareness: Changes in land preparation practices have also occurred as a result of:

1. Growers being more aware of the damage done to their soils when cultivated, especially in a wet condition.
2. An appreciation that traditional land preparation techniques (i.e. levelling hills) risks further compaction and delays when associated with wet weather.

Most innovations therefore have been based on economic considerations and the need to conserve, if not improve, soil structure.

B. Research and Technology

(1) <u>Research</u>

A substantial body of research work is now available within the cotton industry on different approaches to ground preparation. The most pertinent work is the eight year experiment on field 24 Auscott, Warren, led by David McKenzie, and the field 30 PhD studies carried out by Pat Hulme. Results from this research have been covered in previous ACGRA conferences and in the Australian Cotton Grower(ACG), (P. Hulme ACG 7(2):20-25;

D. McKenzie ACG (2):20-26, 9(1):30-34, ACGRA Conference proceedings, 1984 pp.260-271,1986 pp 65-75).

From this work it is clear that soil structure degradation is the greatest single factor that reduces cotton yields in Australia each year. It is high time for all growers and consultants to become more aware of soil structural deficiencies, to learn to identify them and to predict the best way to tackle them. A sound knowledge of the trial work carried out at Trangie and Narrabri will assist in decision making. A recent newsletter written by Pat Hulme for Hassall and Associates clients is presented as many growers may be interested in his thoughts. (See attachment A)

Field Diagnosis of Soil Condition: The key to physical decision making in ground preparation is 'what condition is my soil in?' We have all read or heard about the use of backhoe pits, but how many in the cotton industry know how to use them?

The soil pit can provide information about issues such as: Which blocks have the best soil structure

At what depth soil structural problems exist

The severity of structural problems after a wet pick

The effect of rotation crops on structure.

Soil pits are used routinely by most growers in the Macquarie Valley where soils are seen to be more limiting to production.

Identification of the extent of problems using soil pits is strongly recommended, particularly after a wet harvest. I refer you to the background paper by Adam Kay. (Attachment B)

Solutions to soil structural problems: With correct identification of the condition of soil structure, sufficient research results are available to recommend the ground preparation practices that are required to maximize returns. Innovations include the following:

(a) The value of subsoil drying and cracking by rotation crops.

(b) Benefits of chisel ploughing rather than deep ripping. Chisel ploughing under dry conditions often has a higher benefit : cost ratio than deep ripping.

(c) Additional inputs of nitrogen and water often are required when cropping compacted soils or permanent bed systems.

(d) Minimizing traffic and soil disturbance on wet soils.

(e) Compuclod - A decision support system for identifying the best land preparation method.

(2) <u>Technology Changes</u>

The last four years have seen a proliferation of technical achievements in the design and development of new equipment. The release of new equipment started in mid 1984 with the Israeli 'USM' stalk puller and has continued to the recent release of the 'Eliminator' from Janke Technology improvements in ground preparation can be divided into two categories:

(a) Technology to dispose of cotton stalks

(b) Middle busting/lister rigs.

Cotton stalks are disposed of by a variety of new equipment:

- Stalk pullers generally do a superb job of pulling stalks and chopping into short lengths. Stalk pullers do have trouble late in the season after frosts which cause stalks to snap at ground level.
- Combined slashers and middle busting equipment: The 'Aussieater' and Janke 'Eliminator' are recently released and specialized four row slashers that will remove the stalk from the row whilst slashing. They are cheaper to own and operate than a stalkpuller, but the effects of running a knife or shank through the middle of the hill under wet conditions has yet to be qualified.
- The new Bond cotton stalk rakes do an excellent job of raking cotton for burning. The windrows burn very well. In the not too distant future it is hoped an Australian manufacturer will make an eight row stalk puller that pulls and windrows stalks ready for burning.
- The Jetstream row runner produces a good seedbed with a single pass after slashing. Operation under wet conditions is not recommended because of smearing and compaction.

The Jim Smith designed middle busting shanks and listing rigs are the only real innovations in primary ground preparation technology. The gas shanks are selling very well to many cotton growers, and allow middle busting and gas application with minimum smearing under moist conditions. Under wet conditions no middle busting is recommended. Work by Constable and Rochester has shown urea is a satisfactory alternative to anhydrous ammonia. An added advantage of the delta wing on the shank is to disturb the hill sufficiently to kill pupating heliothis larvae.

All of the hardware outlined is designed to reduce traffic and simplify permanent bed systems.

Conclusion

Before using any of the recently introduced minimum tillage equipment rather than conventional equipment, the following must be considered:

(1) Soil structure

(2) Soil water content

The most profitable rotation, tillage and trash management option can then be chosen for each field.

References.

1. Hulme, P.J., Anthony, D.A., Cass, A., McKenzie, D.C., and Macleod, D.A. (1986). Is ripping necessary? The Australian Cotton Grower. 7(2):20-25.

ATTACHMENT A

OPTIONS FOR COTTON SEEDBED PREPARATION AFTER 1987/88 HARVEST - PAT HULME

Given the current high soil water content of cotton fields, structural degradation during picking and subsequent cultivation is inevitable. Combination of wet conditions during picking and seedbed preparation witb inappropriate tillage practices can reduce cotton yield potential by as much as 30%, as occurred in the Macquarie Valley in the 1976/77 season. Poor structure can also reduce irrigation interval by 30%, and increase crop nitrogen requirement. These limitations will not be overcome until the structural degradation is repaired by either tillage or drying of cracking soils.

When making tillage decisions for wet soil, it is important to remember that every wheel and tillage implement pass will degrade the structure of wet soil. The damage caused by tyres and tracks near the soil surface increases with both the static pressure on the soil and the amount of wheel/track slip, whilst subsoil damage increases with the weight on each axle. The extent of structural damage from tillage implements is affected by the proportion of the soil sheared by contact with cutting surfaces, the depth of tillage, and soil water content.

In general, the smaller the surface sheared the less the damage (thus a ripping line causes less damage than a Texas sweep tillage at the same depth), and the drier the soil the deeper it can be tilled without damage.

The zone of soil most important to root growth during the period before the first crop irrigation is beneath the plant row. This soil is most susceptible to degradation as it is the least compact. If permanent hills are to be used the hills should not be shifted above the old furrow line during seedbed preparation, and wheeling should be confined to the base of the furrow.

The following sections outline, in descending preference, the options to deal with structural degradation caused by the current wet soil conditions.

The most reliable way to repair the degradation is to dry the soil with a winter crop, then cultivate the soil when it is dry next summer. However, this option is not applicable to fields where back to back cotton is to be planted.

A winter crop or weeds could be used to dry the soil before seedbed preparation for back to back cotton as it is now too wet to till the soil without suffering structural damage.

A winter crop should attain full ground cover quickly to maximize transpiration. Field peas at high seeding rates (90kg per ha) have been successfully used to dry soil for back to back cotton by some northern cotton growers. Other crops include ryegrass, which is claimed by Victorian researchers to improve structure of red-brown earths and oats. Seedbed preparation would then continue as normal after the plants were dessicated. Success of this option depends on an extended period of dry weather to enable the plants to dry the soil, and the availability of enough machinery to prepare a seedbed rapidly once these plants are killed. The risk that plants will not dry the soil soon enough to prepare a seedbed for back to back cotton will increase as cotton picking is delayed.

The second option for back to back cotton is to minimize structural degradation by using some form of permanent hills, thus limiting tillage, and minimize the degradation which causes the production limitations outlined above. Some growers at the eastern end of the valley have successfully planted back to back cotton into fields in which the plant line has been left. The seedbed can be prepared with as few as three passes: slashing and two tillage operations. This system leads to the least soil degradation within the hill.

However, it has the disadvantages that planting into moisture is made difficult by uneven seed placement and the risk of regrowth is considered a problem by many growers.

Most growers believe that the problems from poor seed placement and regrowth necessitate removal of the plant line from the proceding crop. Two of the ways this can be done are: stalk pulling, and an effective slashing followed by ripping beneath the hill and injecting gas. At this stage the extent of structural damage should be assessed and measures such as in-furrow ripping taken to break up the degraded soil. This system has been the most widely used one for permanent hills and back to back cotton in the Macquarie Valley.

The option most likely to cause problems with structural degradation of wet soil is to use a conventional seedbed preparation where the hills are knocked down and reformed. Extreme care should be taken to ensure that the lower availability of water and nitrogen in the degraded soil does not severely limit cotton growth is this option is adopted.

The untimely rain, which has delayed picking, will cause many problems in preparing seedbeds for back to back cotton. The best seedbed preparation method will depend on the rainfall pattern between now and planting of the 1988/89 crop. While the soil remains wet both the number of passes over the soil and the area of each field disturbed by tyres and ground working tools should be minimized.

Source: Hassell & Associates
July 1988 Newsletter

ATTACHMENT B

SOIL PITS AND HOW TO USE THEM

Adam Kay, N.S.W. Agriculture & Fisheries, Warren

Soil pits are used routinely to diagnose yield - reducing soil problems in several irrigation districts of eastern Australia.

Within the cotton industry, the Macquarie Valley has led the way in the use of soil pits. The system was introduced by local farm managers and researchers (e.g. Dave Anthony, Dave McKenzie). The N.S.W. Department of Agriculture now offers an advisory service to irrigation farmers in the Warren district based upon the use of soil pits. It is being run by John Sykes and myself. Apart from using soil pits to examine problem soils, they are being used increasingly for the routine assessment of soils that appear to be in good condition. Both the physical and chemical properties of a soil can be assessed to determine land preparation requirements, irrigation layout, and the need for fertilisers.

Soil pit testing services are not confined to the cotton industry. On a recent visit to the Loxton Research Centre run by the Department of Agriculture in South Australia, I was very interested to find that workers there use soil pits on a grid basis (approximately 1 every 100 metres) in the existing horticultural holdings and on land for development.

Their system has been so successful that growers now pay for the survey and the information that it produces. Soil pits are also used by advisory staff in parts of Britain and by the U.S.A.

WHAT ARE SOIL PITS?

Soil pits are holes dug (usually by backhoes) in representative parts of a field to a depth of 1.5 metres. They are dug this deep because plant root systems usually go down well below a metre. The pits are dug at right angles to the direction of water flow and wheel traffic, i.e.at 90 degrees to the hills where they exist. The pit walls are trimmed with a flat-edged implement, e.g. a knife, to remove the smeared soil left by the backhoe. This exposes undisturbed soil.

Some of the procedures used to assess the soil physical condition in pits prior to land preparation are:

(1) Follow the root system of the previous crop or even weeds. Taproots are top indicators of soil condition. If they are bent or stunted there is evidence of a structural problem.

(2) Observe the size and shape of clods in the root zone. Horizontal, platey coarse clods usually coincide with zones of compaction and/or smearing. These normally cause roots to bend sideways. Also look for evidence of a wet layer above or in some cases below the damaged (compacted) zone as water movement may be impeded.

(3) Look carefully for the presence of stable vartical channels. These channels may have been created by earthworms, ants, old plant roots or cracks, and are indicative of good structure for cotton root growth.

(4) Check for signs of salinity. If white salts occur on the surface or if the subsoil is unusually friable and salty to taste, salinity can be suspected. This will be confirmed by laboratory tests.

(5) Check soil moisture content. Clay soils should not be worked in a moist condition otherwise they smear rather than shatter. In the paddock collect soil from the proposed depth of working. Attempt to roll it between the hands into 3mm diameter rods. If it produces rods it is too wet, if it crumbles it is dry enough to till.

(6) Check for signs of surface dispersion (separation of clods into sand, silt and clay particles after rain). Gypsum will be required if dispersion is occurring; laboratory testing of samples collected from the sides of soils pits will assist with the determination of gypsum requirements.

RESEARCH

Research is in progess to develop improved methods for measuring properties such as compaction using soil pits, and to relate them to other approaches such as the use of neutron probe data to indicate soil physical condition.

In the Macquarie Valley cotton producers are using soil pits in three ways.

1. Soil Pits as a Routine Decision Making Tool. Soil pits can be used regularly to make objective tillage decisions, even when the soil appears to be in good condition. After a rotation crop has been harvested, pits should be dug at representative locations in the field. The soil structure that these pits show should be the basis for the decision on what form of primary tillage is needed.

A grower that I visited in December, for example, was going to deep rip his wheat fields before putting them back into cotton production next season. After digging some pits I was able to show him that on some fields the soils structure was already in excellent condition with deep cracks running right through the profile and fibrous roots from the wheat plants deeper than one metre. The compaction he suspected had been repaired by the shrinking and swelling of the clay and the penetration of the fibrous root system into the subsoil. In this situation a discing under appropriate conditions was all that the field needed.

Pits should also be dug after cotton has been picked. In this way a grower can make a decision about cropping sequence and the need for deep tillage. Where compaction is found we can determine to what depth it exists; any operation to rectify it need only go a few centimetres below that zone. The soil pit also shows the soil moisture content at various depths, which is extremely important. If soil in a compacted zone is too moist, pulling an implement through it does not break out the compaction, but rather causes further damage, through smearing. Pulling a tyne through moist soil is akin to pulling a hot knife through butter.

2. Soil Pits as an Aid to Developing New Country.
Subsoils and top soils with inherent problems can be avoided if soil pits are dug prior to development. If soils are going to need any amelioration before cropping this can be costed into the project. Soil evaluation also allows selection of appropriate irrigation systems and can assist with the development of fertiliser programmes. Problems in the first cropping sequence thus can be predicted and avoided.

Four pits that I inspected on some river country near Narromine are graphic examples of the value of soil pits on country proposed for development. Two of the pits showed excellent profiles of alluvial river soil down to two metres, with lots of root activity and earthworm channels throughout. The other two pits showed the same soil for the first 20 centimetres but underneath was a very tight red soil with little root activity. It certainly looked as though it would cause problems. Further chemical analysis showed it to be totally unsuitable for irrigating due to sodicity. Pits put down later allowed the area with unsuitable subsoil to be mapped and then the country was developed around these problem soils.

3. **Soil Pits for Problem Solving.** Most soil pits in the past have been put down to help growers come to grips with suspected soil problems. Two recent examples that stick in my mind occurred on heavy grey clay soils near Warren.

Initial inspection of pits in the first field suggested that the soil was in good order, but closer inspection of the hills showed consistent evidence of compaction.

Whilst we were in the pit, the grower said that one pass over the hills with go-devils was carried out when they were still wet. This accounted for the layer we observed. Our recommendation was that the field could be used for cotton again next season, by leaving the hills in place and shattering the zone of compaction with a gas shank when the anhydrous was applied. The moisture content of the soil at the time was satisfactory to carry out this operation successfully.

A second grower had a field where he was having trouble getting water to infiltrate, and he suspected compaction. However, the inspection of soil pits found no evidence of compaction, the soil appeared to be in good order throughout the profile. It was only when the laboratory soil test results returned that we realised what the problem was. The exchangeable sodium percentage was quite high whilst the calcium to magnesium ratio was low, causing the surface soil to run together and set hard. Our recommendation was to apply gypsum to the soil. Gypsum stabilises clay, stops it dispersing and increases water infiltration.

Pits can also be used to monitor management adjustments that are made in response to a soil problem. In this way the grower and advisor can see the results of changed agronomic practices.

THE FUTURE

Soil pits have a proven place in the cotton growing system. As soil pit technology is improved, simpler and more accurate field tests should become available. This will make observations systematic and comparable. Soil pits can also be related to soil survey work that has been carried out. This can allow us to accurately predict several important soil properties at a given location. Observations and test results from soil pits are likely to be an integral part of the Compuclod decision support system which presently is being designed by irrigated soil researchers.

So, cotton producers in all districts are encouraged to dig soil pits and examine them, where possible, with an experienced observer. Soil samples should also be collected from the pit for laboratory analysis. Each pit is a valuable learning experience that improves our understanding of soil management, and usually boosts profitability.

Source: Australian Cotton Grower,
February - April 1988.