

# GENERAL ASPECTS OF SOIL CULTIVATION AND POSSIBLE FUTURE TRENDS

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## Introduction

The more one knows about the soil the more one realises how dangerous it can be to generalise regarding tillage. Unfortunately the state of our knowledge in the Republic regarding the pros and cons of various tillage systems is very superficial since little research effort has been expended in this direction in the past. The contributions made by lone figures such as Carel Koch working in the Viljoenskroon area are the exception. It is to be hoped that the tillage team of the recently launched Summer Grain Centre will help remedy this situation.

## Ploughing

The ideal tillage system would be one having no disadvantages while resulting in optimum yields. Unfortunately no single tillage system is either perfect or suitable for all soils. Questions that should therefore be asked before deciding upon a tillage programme are the following:

- What soils are involved?
- Is water erosion a problem?
- Is wind erosion a problem?
- Is compaction a problem?
- Is moisture a limiting factor?
- What weed problem exists?
- Do nutritional problems exist?
- Is a drier available?
- What equipment is available?

Although a discussion of the above points would be interesting, the scope of this paper unfortunately does not allow for this, suffice it to say that although many good ideas exist regarding the matching of tillage systems to specific problems, we too often find that these are ignored completely and the so-called conventional system is applied irrespective of possible special considerations. For the purposes of this paper the conventional method consists of ploughing and a number of discings. Tradition dies hard and since the continuous stirring of the soil between successive crops has become instinctive, some even claim it is almost genetic and few people stop to question the merits of possible alternatives. The organising of ploughing contests on district, regional, national and international levels in many parts of the world only helps to strengthen this ploughing fixation. It is also a fact that many farmers simply enjoy ploughing and love the sight of long straight furrows of freshly turned soil. To many

others, any form of stubble farming looks untidy and is to be avoided at all cost.

The mouldboard plough is, however, the most important and widely used tillage implement in agriculture. It is a simple but ingenious tool being easy to operate and having wearing parts that can be relatively easily and cheaply replaced. Further, by changing the shape of the mouldboard it can be adapted to varying soil and climatic conditions so that under most situations it can be made to do a spectacular job of soil preparation. The plough, as can be seen, has many attractive features that make its displacement as the major tillage tool extremely difficult. The plough was originally developed for animal draught but today animals have been largely replaced by tractors. With tractors the transmitting of energy to the implement itself is possible and we have seen the development of power driven rotary hoes and even vibrating tools, but even these innovations have not been able to make any significant impression on the position of the plough.

These facts in favour of the plough are impressive but we should not allow ourselves to become mesmerised into believing that the plough is indispensable. Each step in a chain of events needs critical periodic evaluation if progress is to be maintained. Perhaps the time has arrived for us to take a good look at the role of the plough on some of our soils. With ploughing being the major consumer of time and energy the timing of this investigation could not be more opportune. It is of interest to note that E H Faulkner in 1943 in his book 'Plowman's Folly' stated that no one had ever advanced a valid scientific reason for ploughing. It is also worthy of note that although the sentiments expressed by Faulkner received little support from agricultural scientists, no serious effort was made to disprove his statement regarding ploughing. Even today much muddled thinking revolves around the plough.

## Conservation tillage

When deciding upon a tillage programme economic considerations are obviously very important. The conservation of natural resources should, however, never be overlooked. The plough's record in regard to conservation has often been appalling so that where the possibility of erosion exists strenuous efforts to find alternative tillage systems should be made. The advocacy of the total elimination of the plough or any other tillage implement for that matter is not for a moment being advocated. What is being suggested though is that agricultural scientists should establish and define tillage systems for specific situations that satisfy certain predetermined conservation requirements. The determination of these standards is a

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task requiring urgent attention if South Africa's potential for agricultural production is to remain unimpaired. A greater stimulus for encouraging tillage research would be hard to come by.

It is of interest to note that American agricultural scientists have become so concerned about erosion and pollution that they are encouraging what is termed conservation tillage. This campaign is also being pursued in the Midwestern corn belt where the soils are incredibly deep, high in organic matter and almost perfectly flat. To the casual observer these vast areas present little or no erosion problems. If the Americans consider that they have serious enough erosion problems in these areas to warrant conservation tillage methods then South African should not delay in promoting the idea here.

Conservation tillage in the American context refers to the system that creates as good an environment as possible for the growing crop and that optimises conservation of soil and water resources while still being consistent with sound economic practices. Conservation tillage is synonymous with the maximum or optimum retention of residues on the soil surface and the utilization of herbicides to control weeds where tillage is not or cannot be performed. It can be seen that the term conservation tillage does not necessarily refer to any specific tillage system but rather to the tillage programme that meets certain prescribed conservation requirements for a specific situation. For example on soils with a compaction problem the programme might include deep ripping. It is again suggested that South Africa with its serious erosion and moisture problems urgently requires that the conservation tillage approach be propagated here.

With every tillage trip across the field the farmer has the opportunity to cover up any mistakes he may have made on the previous trip. With conservation tillage, where the number of trips is usually reduced, these corrective opportunities are fewer so that more care and precision is needed for each operation. The greater the degree of reduced tillage therefore, the higher the level of know-how and management required. This may unfortunately mean that initially at any rate, conservation tillage is only for the top operators.

### The ultimate system

In the soil, pore space and pore size distribution regulate water, gas and root movement. Tillage generally has an adverse effect upon soil structure but may be necessary to turn under residues, incorporate fertilizer, incorporate herbicides or pesticides, insure a satisfactory stand and control weeds. Tillage can also be used to correct adverse soil conditions such as plough or traffic layers that are created by the farmer himself. There can be no doubt, however, that on soils with good physical properties indiscriminate stirring of the soil should be avoided at all cost. Farmers tend to overwork their soils and any move towards reduced tillage can only have beneficial effects.

Let us briefly consider the ultimate tillage system: no-tillage. Here a narrow slot is opened in the soil just wide enough for the planting of the seed while competing vegetation is controlled with herbicides. This system has been under test at Cedara for more than five years and although problems with effective weed control have been experienced on some sites, it is interesting to note how well the maize plants manage to grow without ploughing. This phenomenon is not surprising, however, if one looks around at nature where most soils are decked in lush vegetation without even having been ploughed. These soils are also invariably in far better physical shape than adjacent arable fields.

In the natural state plant roots exist in a self-sustaining system in which by their growth and eventual breakdown they provide the pathways for aeration and drainage and most important the organic matter which stabilises these channels. In no-tillage fields, this root channel network starts at or near the soil surface while in a conventional tilled field it can only be maintained below the plough layer being completely destroyed each time the soil is ploughed. It is under tilled conditions therefore that soil physical conditions deteriorates. With no-till, less soil surface is exposed to the destruction of organic matter while surface residues eliminate the pounding effect of rain drops. These factors must help in maintaining the soil's physical properties. No-tillage should therefore satisfy both the farmer and the conservationist.

### Discussion

Theoretically there would appear to be no reason why conservation tillage should not be the major soil preparation method among South African maize growers. When hard facts are faced, however, somewhat different conclusions are arrived at.

Firstly the vast majority of farmers believe that ploughing is an essential part of crop production and what is probably more important they feel that with the conventional method they are more or less in control of matters in their fields. This latter point is well illustrated by the fact that some top farmers who switched from ploughing to ripping and discing have reverted to the conventional method after finding that they were no longer able to control unwanted weeds and pests to their satisfaction. A further problem that can arise if farmers are not properly equipped for stubble tillage is that surface trash can cause the choking of the implements. None of these problems are insurmountable, however, but because overheads are already so high, most growers can see no advantage in switching from a well tried to a new programme which has built-in unknowns and risks and most important, is not backed up locally by solid research facts. As far as no-tillage is concerned, research at Cedara has already established that watergrass can be so troublesome that the system cannot be recommended where this weed is a problem.

## The future

Advisors and planners might be interested in future tillage trends in South Africa. Since farming methods in the Republic invariably follow those in the USA it is of interest to note the areas being tilled using different methods in that country. As confirmation of our habit of following the American lead it could be mentioned that the trend towards bigger tractors and wider implements that became apparent in America some years ago is now beginning to make its presence felt in the Republic.

In the USA in 1975 70 million ha were planted to maize. Of this, approximately 18,0 million ha were planted using some form of reduced tillage while of this, 2,6 million ha were no-till planted. The area down to reduced tillage therefore amounted to 25,7 per cent of the total. This is a very significant amount and it is interesting to record that this figure is expected to increase dramatically in the future. There is no reason to believe that similar trends should not develop in the Republic particularly since we suffer from periodic moisture shortages and surface residues are reported to enhance moisture availability. It can be stated with reasonable confidence, however, that the change to stubble or reduced tillage in South Africa will be slow. Besides the natural conservatism of our farmers, herbicide know-how is not as well developed as in their American counterparts. Certainly therefore no dramatic changes in tillage patterns are foreseen in the immediate

future and it would take spectacular developments in the economic, herbicide or energy fields to alter this prognosis.

## Conclusions

If conservation tillage is to be promoted in South Africa then any advantages to be gained from the system will need to be proved and demonstrated to farmer satisfaction. The key to acceptance, however, will undoubtedly lie in successful and economic weed control. If the cost of the additional herbicides and pesticides required for conservation tillage methods are higher than the cost of the mechanical operations saved then it will prove extremely difficult to sell the idea despite any other advantages that may result. This will be a great pity as it is sincerely believed that South Africa desperately needs to adopt the conservation tillage approach.

## References

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