IAgrE Journal

Landwards

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The new Institution logo

Michael J Dwyer
President

The new Institution logo was introduced at the Annual Convention on 13 May, 1997. It is an attractive and simple design which I hope will help to project the image of the Institution as an up-to-date and forward-looking organisation. Council were unanimous in selecting this design from among several which were submitted. Part of its appeal is that it conveys different images to different people. To me, its suggestion of tyre tracks or plough furrows gives it a thoroughly agricultural feel and the way it appears to be leading to the horizon implies a forward-looking approach. Direction and vision are not exclusive to one sector of the membership but apply to everyone involved in Engineering for Agriculture, Forestry, Amenity and Environment.

I know that many members, myself included, will not wish to see the original 'Ceres and sower' Institution badge disappear. This is not the intention. However, it was never suitable for use as a logo. When reproduced at the size necessary for letter headings, so much detail was lost that it became difficult to decipher. It will be retained as the Institution's insignia and used in appropriate places, when it can be reproduced at sufficient size for the detail not to be lost. It would be interesting to hear from any members who have first or second-hand knowledge of the discussions which took place on the original adoption of the insignia.

Many of you will know that, in parallel with the discussions which have been taking place in Executive and Council on the adoption of the new logo, there have also been discussions on the possibility of changing the name of the Institution. The aim in doing this would have been to find a name which better described the wide range of activities in which our members are involved and which might be more attractive to potential members. This has proved to be extremely difficult. The only alternative name which achieved any significant level of support was the Institution of Agricultural and Rural Environment Engineers (IAgREE). This proposal was put to Branch AGM's by myself or my representatives and the response which we got was almost unanimous support for retaining the existing name. It is not intended, therefore, to take any further action at this time on the possibility of changing the name of the Institution.

INSTITUTION OF **AGRICULTURAL ENGINEERS**

Creative rationale for a new corporate identity

Almond Design, the Edinburgh based Graphic Design partnership, were invited by the Institution to present proposals for a new corporate identity which would take the professional organisation into the next century and beyond. The design team were aware of the vast range of disciplines embodied within the Institution. It was precisely the need for equal representation of all the Specialist Groups together with the need for an influential image for the Institution as a professional body which determined the direction, style and content of the successful design.

A design approach which was symbolic, rather than typographic, offered a more democratic representation of the various groups because, in many ways, it was non-specific. Symbols were chosen to represent shapes in nature - free shapes - and shapes which represent the industrial or engineering world. Commenting on the creative rationale, the designer explained: "The new logo takes the form of a furrowed field within a dynamic arrow shape. The strategy behind this design is the common denominator of 'land' or 'soil' for all the various Specialist Groups. The field is also shown disappearing over the horizon, indicating a look into the distance, or future. The idea of furrowed land represents new growth and optimism."

The logo is visually very strong. It is simple and easily applied to various media, works well at all sizes and is suitable for projection in colour or black and white. The clean, legible design typifies the precision of the engineer, assisting it in becoming universally identified with the membership and aims of the Institution.

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Contents

Volume 52 No 2, Summer 1997

Institution news

Feature articles

News and comment

Front cover: *Banana flower. Per capita consumption of bananas in the UK now exceeds that of apples but tariff negotiators need your support as they seek fair trading arrangements for the single export product, island economies in the Carribean* (*photo: Land Technology Ltd*)

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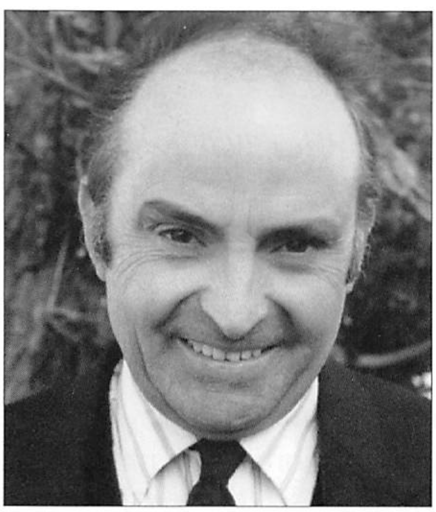
Tractor-based systems for traffic control in arable crops

John Bailey



This paper was presented at the IAgrE conference entitled: "Profit through traffic control?" organised by the Soil & Water Specialist Group and held at Silsoe College, Cranfield University on 20th November, 1996. John Bailey is Senior ADAS Mechanisation Consultant based at ADAS Bury St Edmunds, Southgate St., Bury St Edmunds, Suffolk IP33 2BD.

Since their inception in the early 1970's, few developments have been so universally and quickly adopted in UK arable farming as tramlines. Tramline spacings have a crucial bearing on the choice of drill, fertiliser and sprayer working widths, as well as more minor effects on cultivator working widths. Initially, farmers had to alter the drilling width by marginally narrowing or increasing the inter coulter spacing with the imperial width drills they had at that time. Gradually as metric widths were made available, the adoption of tramlines became more straightforward. The choice of the correct tramline width for the farm size is vital for work to proceed as effectively and cheaply as possible. This development was quickly followed by pre-emergence markers behind the drill, indicating the wheeling positions for early spraying.

Very few combinable crops are established without the formation of tramlines by the drill. The exceptions are cereals and bean crops drilled on the plough, with or without a traditional drill, and crops broadcast, either as a direct policy or in a very wet autumn when a large area needs to be covered quickly before the weather finally closes in.

In my experience within the Eastern Counties, I have not come across farms using fixed tramlines incorporating the initial primary or secondary cultivation stages prior to drilling. The width of the primary cultivators, especially the plough, does not readily allow this with a traditional tractor. The trend is very much towards wider sprayers and cultivators with wheel compaction as just one of the considerations. The present move is to establish tramlines in sugar beet crops and to an extent, in potatoes, to link in with the cereal machinery.

Tyres

Following the popularity of low pressure *Terra Tires*, technical developments in tyre construction have now brought about low pressure, high draught tyres. Having adequate rear tractor tyres, e.g. 700 -

Fig. 1 Large single tyres enable lower inflation pressures down to 0.7 bar to be used when ploughing but are also within the legal limit for road work.

800 mm wide, to fully utilise the tractor power in draught work and enable the tractor to work at relatively low pressures, e.g. 0.7 bar, is ideal for the main cultivation tractors, causing much less compaction *(Figures 1 & 2)*. Whilst these or more traditional width tyres can "manage" the early crop spraying, narrow tyres are still needed for the later crop stages. It is now common either to stipulate the largest tyre size option available when purchasing these large tractors, or buying the tractor without the tyres and rims and then fitting specialist rims and tyres. Strictly speaking, it is not just the tractor tyres that matter. Combine and trailer tyres and their working pressures are critical. A proportion of farms unload the combine tanks on the headlands, but it must be said that most forget compaction in the throes and urgency of the harvest.

Equipment available

Virtually all the tramlining equipment comes as a standard package with the particular drill purchased - very few would be purchased without the tramline attachments. Many of the control boxes are made by electronic control equipment manufacturers but marketed under the name and colour of the drill firm. The control box automatically blocks the respective coulters on the correct drill pass or passes, usually triggered by lifting the drill out of work at the headlands. There are over-ride facilities to move around telegraph poles and electricity pylons without upsetting the sequence.

One, or more usually two, and sometimes even 3 rows of seed are blocked, depending on the drill row width and to an extent the tyre widths on the drill tractors. The sprayers and fertiliser spreaders then work from the tramlines formed. It is now rare to see a blob marker on a sprayer to match up adjacent passes. The choice of fertiliser spreader is dependent on the spread width required and the quality and uniformity of the fertiliser. With a good quality fertiliser, a 24 m working width from a spinning disc machine is acceptable in reasonable cross wind conditions.

It is common within the Eastern Counties for autumn fertiliser in particular to be applied to the cereal stubbles on contract by a "Big A" type machine. As the working width of these large spreaders does not match the tramline width on the respective farms, the driver needs to "drive wide of existing tramlines, etc.", or use temporary markers, such as fertiliser bags in the hedgerow or even having a second person marking the field out. This may not be as accurate as one would wish, but the double overlap of the spinning discs helps to cover over any inaccuracies. About 10 years ago, there was a move to apply the base fertiliser required for the rotation using the tramlines within the standing crop, but this seems to have passed by the wayside.

It is preferable to have a system with an odd number of drill passes, perhaps 3 or 5, so that both tramline wheelways are laid down in one pass. A general exception is for one or more coulters to remain blocked the whole of the time. This can apply to a 6 m drill working within 12 m tramlines. This is not very common as most farmers with a 6 m drill will be opting for 18 or 24 m tramlines.

Tramline widths

The most common working widths are 12, 18, 20 and 24 metres. The 12 and 24 m options can be served by a 24 m sprayer which helps a contractor to work over a wide area. The drill manufacturers offer, therefore, a wide range of drill widths, such as 3 m, 4 m, 4.5 m, 5 m, 6 m, 6.66 m and 8 metres. Even then, there are other less common options such as 4.8 metres for a farmer wishing to have 5 passes within a 24 metre tramline width.

Looking at the economics, the cost, as with most machines, rises markedly as the working width increases. This is not always matched by an increase in work rate in proportion to the increased cost, and the extra output may in itself be

Fig. 2 A furrow widener is essential to accommodate the wider tyre in the furrow

unnecessary. It follows, therefore, that the capital cost per hectare for a "12 metre system", including the cost of the drill, fertiliser spreader and sprayer is frequently less (and sometimes very much less) than the cost of a "24 metre system" based around a larger area. For instance, the cost of a 12 metre system might be:-

4 m air drill	£10 000
12 m spinning disc fertiliser spreader	£3 500
12 m mounted sprayer	£9 000
Total	**£22 500**

Based on a 250 ha cereal farm, the capital cost would therefore be £90 per hectare. If we then consider a 24 metre system this may cost:-

6 m air drill	£15 000
24 m spinning disc fertiliser spreader	£3 500
24 m trailed sprayer	£23 000
Total	**£41 500**

Based on a 400 ha cereal farm, the cost would be nearly £104 per hectare. The area would need to rise to 460 hectares before this system starts to become cheaper than the £90/ha of the 12 m system. The 24 m spreading width with the spinning disc machines becomes more questionable (needing more expensive, more uniform fertiliser) and many farmers choose a pneumatic boom spreader or opt for liquid fertilisers utilising the sprayer for both chemicals and fertiliser. The former option increases the price markedly and the latter decreases the price considerably.

A good guideline centres around the daily output of the sprayer and the area of the main crop needing spraying, almost invariably the winter wheat crop. For instance, the farm should be capable of spraying the crop in 25 working hours or 3 working days. If the farm has 150 ha of winter wheat, therefore, the sprayer will need to cover 50 ha in a working day. This is quite possible with a 12 metre tractor mounted sprayer, and would be the basis for the drill and fertiliser spreader working widths. Many farmers have "unnecessarily" opted for a much wider tramline spacing than really required, and more sophistication in the form of pneumatic fertiliser spreaders or more expensive spinning disc machines, thereby increasing the capital cost. In order to justify these extra costs, however, they strongly argue the case for less wheelings, a greater percentage of the land "cropped" and less uneven ripening in crop disturbed by wheels to either side of the tramlines.

Remedial cultivations/ headlands

Depending on the field sizes on the farm, headlands can account for a relatively high percentage of the cropping area. For example, a 24 m headland at either end of a square 8 hectare field would account for approximately 17% of the field area. In general, this can be exaggerated if the tramline width chosen is perhaps larger than it might be. Whilst large fields and a "prairie" type landscape is given great publicity, field sizes are often surprisingly small and this then dictates the size of machinery purchased. In many instances, the largest tractor may plough the main part of the larger fields leaving a smaller tractor and plough to do the headlands and smaller fields. This makes good sense and potentially it could even be extended to drills on a large farm.

It is a common need to eradicate the tramlines as part of the cultivation sequence, although much depends on the season. In a dry year the tramlines are often the first land to crack and it is debatable whether further remedial work is necessary other than levelling of the surface. Satellite field mapping has given figures for the reduced yield on headlands and further highlighted the problems of compaction. With the introduction of heavy duty cultivator drills, it is now common to drill the headland last, and in some cases to plough the headland after the main part of the field has been cultivated. This may not be possible on heavier soils where the land needs to weather but, in other cases, a pass with a tined cultivator may be all that is necessary to level adequately the surface before drilling.

A few farmers have experimented with moving the headland or the tramlines from season to season to spread the compaction or the potential compaction. Others argue that it should be confined to as limited an area as possible.

Some of the latest cultivator drills include a row of tyres at the back to "roll" the crop, allowing much if not all secondary cultivation, drilling and rolling to be completed in one pass. The tyres support the drill and act as a means of transport on the headland when the drill is lifted out of work or moving from field to field. Whilst it can be rightly argued that no other cultivation passes, even a roll, may be necessary within the main body of the field, the headlands are often "wheeled" more than one would wish. Hence, the headlands are often tined prior to drilling.

Present developments and the future

The availability of farm labour, the cost and sometimes the quality of farm workers is focusing the farmer's mind on the future. The trends are very much towards less regular labour, fewer, but larger tractors with large tyres working longer hours in the year, combining cultivations and earlier drilling in the autumn. Earlier drilling, whilst giving more potential time to drill the crops, vastly reduces the time available for primary cultivations and the soil to weather. Potentially, it should be possible to drill virtually all cereal crops in four passes or less on even the heaviest soil plus any remedial work. The consistently high yields achieved by many cereal farmers have in general left the soil structure in a good condition where the primary and secondary cultivations can be completed in ample time without damaging the soil. The soil structure on farms is infinitely better than it was 15 years ago. Indeed in some cases, the subsoiler has been over used. It seems old fashioned and unpopular to dig profile pits and thoroughly investigate a problem or a need before subsoiling, but it is still vitally important to do so, if time and money are not to be wasted.

The situation is more complex with potatoes, sugar beet and vegetable crops where in some late seasons it is impossible to harvest the crop without damaging the soil structure. This can sometimes take years to put right.

On some specialist soft fruit and vegetable farms without livestock and a relatively low proportion (if any) of cereals, the soils have been abused by a tight rotation with little organic matter returning to the soil. The crops in themselves produce little organic matter and the soil tends to slump, becoming very "solid" and lifeless, even on a sandy loam site. Traditionally, many farms, especially in Suffolk and Norfolk, have each year received large volumes of turkey and broiler chicken litter. This has been invaluable, but much of the volume produced is now going to the local power station as a fuel.

Conclusions

The introduction of tramlines has had an enormously beneficial effect on UK cereal farming, improving the overall accuracy of drilling, fertiliser spreading and spraying. This in turn has had a good effect on the environment, with much more thought in general being put into the work. Many farmers have chosen wider tramline spacing than is actually necessary for their farm size and this has substantially increased their investment in machinery. Alongside, compaction has been widely discussed in the agricultural press, and many farmers have been prompted to do more subsoiling and subsurface cultivating than they need to. There is a reluctance to treat a field on its merits, preferring an over rigid cultivation policy.

POWER IN ACTION

Suffolk Farm Machinery Club will be holding its biennial Power in Action demonstration at Otley, near Ipswich on Wednesday September 10th 1997. The demonstration will feature ploughs, cultivation machinery and drills together with the usual static displays including mechanical handling equipment and the latest developments in precision farming systems.

The 1997 event will be very different from the Club's first Power in Action held on just 80 acres of the Felix Cobbold Demonstration Farm at Otley thirty years ago. The tractors, ploughs and cultivators demonstrated on that day in 1967 had a total value of about £60,000. A number of machines will have a list price in excess of this figure at the 23rd Power in Action on September 10th when the total value of equipment on show is likely to exceed £6 million.

Further details from: **Brian Bell, Hon Secretary, Suffolk Farm Machinery Club, Otley College, Otley, Ipswich IP6 9EY. Tel: 01473 890456.**

MF and Sambron join forces in telescopic handler market

A strategic alliance with French manufacturer FDI Sambron is set to take Massey Ferguson into the agricultural telescopic handler market for the first time. Under an agreement between the two companies, each has taken a 50 per cent shareholding in a new company formed in France to manage the development and supply of farm telescopic handlers, and MF becomes the exclusive distributor for the Sambron-made machines in all agricultural markets worldwide.

Sambron, however, will retain full responsibility for its sales of telescopic handlers to industrial and construction market customers.

In a joint statement, Sambron and MF said: the mutual benefits of this strategic alliance provide a sound long-term basis for both companies in telescopic handlers. As one of the first manufacturers to identify the potential of these machines for improving productivity on farms, the success of the Sambron G24S handler, particularly in France and the UK helped to create this important and still growing sector of the European farm equipment market. As a result, MF can confidently enter it with a quality product from an established and experienced producer, and this in turn will further strengthen Sambron's manufacturing base through being backed by MF's international marketing expertise and the combined dealer networks worldwide of MF and its parent company, AGCO Corporation.

MF are to market two brand new models. They will be fully hydrostatic and competitively specified to cover the major demand in Europe for agricultural telescopic handlers. The first and biggest of the two, the MF8937, made its debut for the European market at the SIMA show in Paris. The second model is scheduled for introduction towards the end of 1997.

Built specifically for agricultural use, the MF8937's long wheel base and mid-mounted engine design combines strength and stability with compactness and manoeuvrability for versatile high performance in all materials handling applications on farms. Its rear pivot boom will lift 3 tonnes to a height of 7.11 m and will reach to 4 m with a 1.2 t load. For the power plant, users can choose either naturally aspirated or turbocharged versions of the Perkins 1000 Series 4-cylinder engine, delivering 78 DINhp/57 kW or 106 DINhp/78 kW, respectively.

Electronic control of the hydrostatic transmission provides field and road speed ranges and 4 " aggressive" or "gentle" control. Maximum speed is up to 30 km/h depending on tyre specification. Hydraulic power is supplied by a 91 litre/min gear pump at 220 bar. Features include automatic levelling of attachments as the boom is lifted. Tear-out force is 5,500 kg.

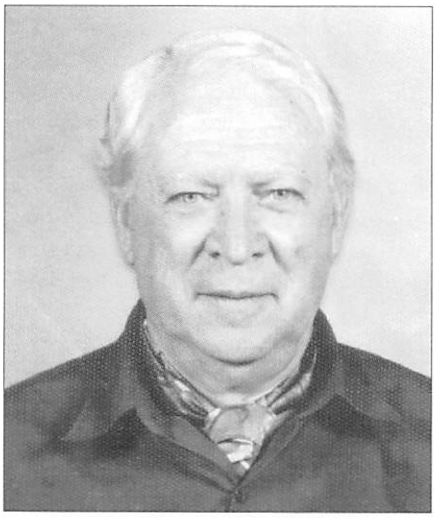
All-wheel steering, crab steering or two-wheel steering modes, selected from the cab, ensure optimum manoeuvrability for the MF8937 in wide-ranging conditions and situations.

Noise- and vibration-isolating rubber mounts for the cab contribute to a comfortable environment for the operator. Tinted glass is fitted, and the cab also includes heating and fresh air ventilation, tilting steering column, adjustable spring suspension seat, full instrumentation and 4-function joystick boom control. Air-conditioning, roof and rear screen wipers and windscreen grille are among optional equipment.

Improving the effectiveness of tertiary systems

Part 1 - Planning the tertiary units.

Erroll Coles



Introduction

The tertiary system is an integral part of the irrigation scheme and the core of the whole water management strategy. Water management at the tertiary level is essential achieve an equitable, equable and timely supply of water to the farmers thereby sustaining optimal production and providing reasonable profits for the farmers. The tertiary and quaternary systems should be designed and constructed to provide a system that allows water to be reticulated, controlled and managed by the farmers themselves.

The technical information, guidelines and criteria described in this paper were collected from many sources. The principles of water distribution and apportionment were established centuries ago in the old lands of Mesopotamia and of Asia. Toward the end of the last century, engineers in the old Netherlands Indies gathered information on indigenous water distribution and control procedures used in the irrigation of padi fields in Bali and Java. The mathematical processes of these systems were described by van Maanen (1924).

Other information was gathered from project papers, technical reports and unpublished sources found in site archives and irrigation offices in many the countries of the Middle East and Asia with extensive irrigation works. Much additional information was gathered from research projects, field observations and measurements on existing tertiary systems in the course of my work.

For those persons designing and constructing tertiary systems, there is one primary principle to keep in mind. Whilst patience is needed to win the farmers over to your suggestions, do not neglect the suggestions given by the farmers either. Bringing farmers in at the conceptual stage will provide a workable system that is more likely to succeed. Farmers have to use the system long after you and other engineers have gone. Rarely will the farmers received help running the system later nor will the authorities provide little more than a pittance for the maintenance of the irrigation works. Simplicity is the hallmark of good system design.

Erroll Coles is an Irrigation Engineer with Coode Blizard Ltd working on an irrigation project in the Wadi Hadhramaut, Yemen. He has worked on several contracts in Bangladesh, Egypt, Nepal, Indonesia, Swaziland and other African countries. His current address is Box 019/CPAKSBJ, Cipitat 15401, Jakarta Selatan, Indonesia.

2. The tertiary system

Irrigation systems generally consist of four parts:

- the diversion works located at the source of the water for irrigating the fields, the water source may be a reservoir, a river, or from groundwater wells,
- the conveyance system consisting of one or more primary canals carrying water from the diversion works to some point where water will be diverted into secondary canals conveying water to the command areas,
- the tertiary system consisting of one or two canals of a much smaller capacity than the higher level canals, conveying water to the quaternary canals,
- the quaternary canals carrying water directly to the farm boundary.

The capacity of the canals is directly proportional to the area of land supplied with water (the tertiary canal capacity is the aggregate capacity of all the quaternary canals).

Until recently, tertiary systems were not constructed as an integral part of a new irrigation scheme but were left to the farmers to find the necessary technical assistance to design the system and contractors to build the works (Hrobovszky, 1972). The farmers seldom had access to financial resources and the systems were seldom built. It was during the mid-1980's that water management became the catch-phrase and greater attention was given to tertiary system design.

To-day, the increasing demand for water by industry and urban populations means that less water is available for agriculture. Agriculture has to use water more efficiently, using new technologies, reviewing older methodologies, and contemporary water management procedures and improving the water distribution systems to farms.

For the foreseeable future, many irrigation system will have to be renovated and remodelled to improve the distribution of water and provide a system that can be managed by the farmers. Because of the high development costs, it is unlikely to that extensive areas of new irrigated land will be created in the future.

2.1 Planning the tertiary system

The planning of tertiary systems can be applied to three general situations which are described in detail in *Section 3.4*.

Maps of the irrigation area are the first

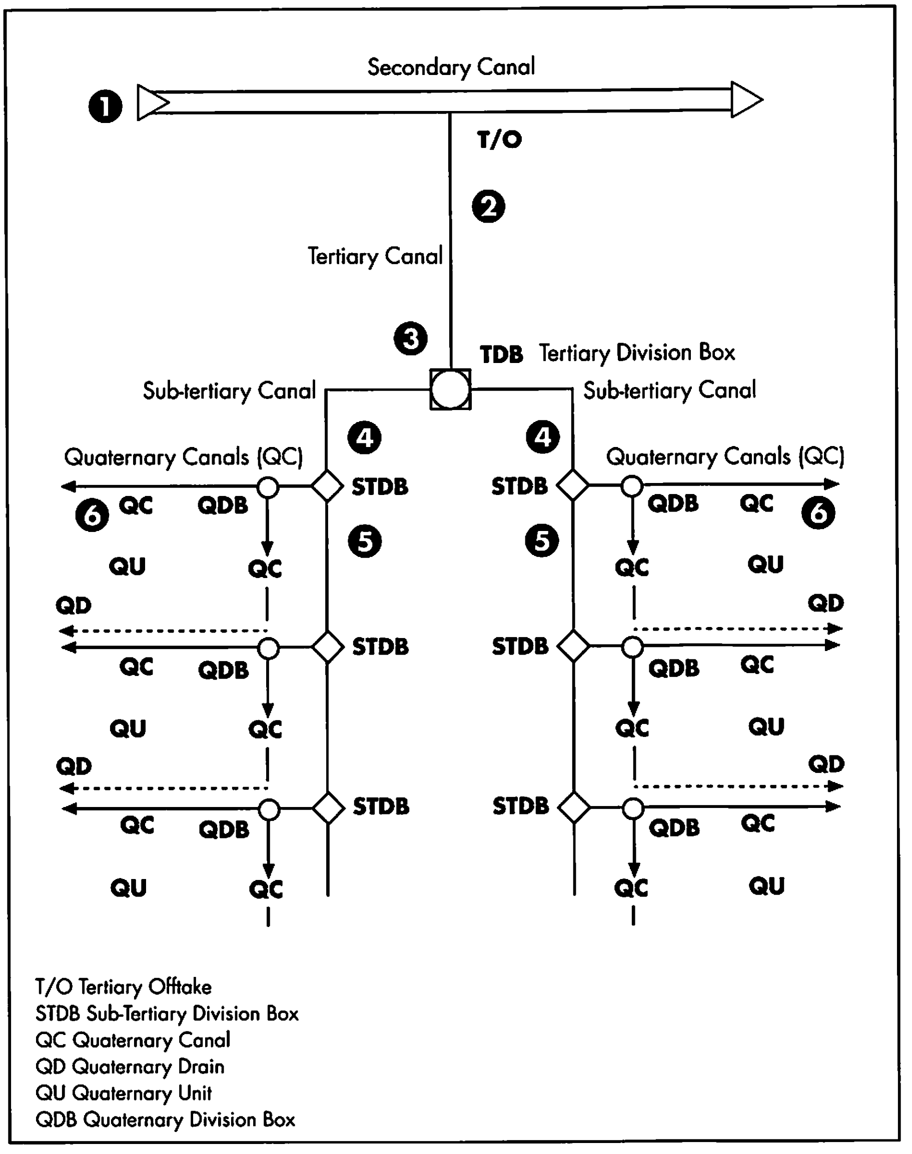


Figure 1 Layout of a tertiary and quaternary water delivery system.

element required for the planning of an irrigation system. Maps at the scale needed for designing the system are seldom available in third world countries. Besides, the cost of mapping and of maintaining the maps is not a priority of developing countries. Consequently, aerial photography remains the only least cost method of obtaining maps. Satellite imagery is not a satisfactory method for mapping at the scale required.

2.2 Surveying and Mapping

The cost of conventional land surveying and mapping at the scales used for irrigation system design is exceedingly costly. The use of Geographic Satellite Positioning equipment and laser or infrared distance measuring devices have simplified surveying and reduced costs. It is essential to use aerial photography to map the detail required for designing systems in old padi areas.

Experience has shown that the ideal base is either a controlled aerial photographic mosaic or preferably ortho-rectified or corrected photography enlarged to the required scale. These photographs are enlarged to a scale of 1 in 5000 (1 cm = 50 m) or 1 in 2000 (1 cm = 20 m). The ortho-corrected photographs are parallax free and show all of the necessary detail, such as farm boundaries, location of villages and other topographic information needed for planning and design purposes.

Although it is possible to use photogrammetry to plot contours on the photographs, the accuracy of the 0.50 m contour intervals has not always been satisfactory. Ordinary field levelling is still the preferred method for measuring the ground elevation. The detail on the aerial photographs can be used as horizontal control and the precise positioning of bench marks can be fixed using the geographic satellite positioning (GSP) equipment.

Field levelling of new irrigation areas is surveyed using a 20 m or 50 m grid. On developed padi areas, the padi fields are used as a control and single spot levels are taken in the middle of padi fields and located on the photograph. Padi fields are water levelled and the groundlevel is within a few centimetres over the whole surface, so a single spot height is all that is required.

The contour lines are drawn on the enlarged ortho-corrected photographs from the survey data with contour intervals of a quarter or half metre. The actual tertiary layout is drawn on the orthophotograph showing the location of the canals, structures and any other details. The design details are traced off and used as working plans.

3. The elements of tertiary system design

In rice growing regions, the tertiary system is the key element in distributing water to the small padi fields on the farms. The traditional layouts of old systems found in Bali, in Indonesia and elsewhere of the rice growing regions follow a definite pattern. These patterns have been adapted to contemporary designs for new systems and rehabilitating old systems, using modern technology to improve water distribution and implement management of the water by the farmers.

3.1 The layout of the tertiary system

A schematic layout of the tertiary unit shows the various components forming a typical tertiary system (*Figure 1*). The tertiary unit maybe divided into two subtertiary units that, in turn, are divided into an even number of quaternary units. Canals convey water from the secondary canal offtake and through the system which is described with the help of *Figure 1*.

i. The secondary canal turnout into the tertiary canal consists of a structure with check gates to divert a proportion of the flow.
ii. The tertiary canal below the turnout continues onto the tertiary division box that divides the water in proportion to the area of each sub-tertiary or quaternary unit.
iii. The tertiary division box consists of one or the other forms of regulator, either a proportional division box or

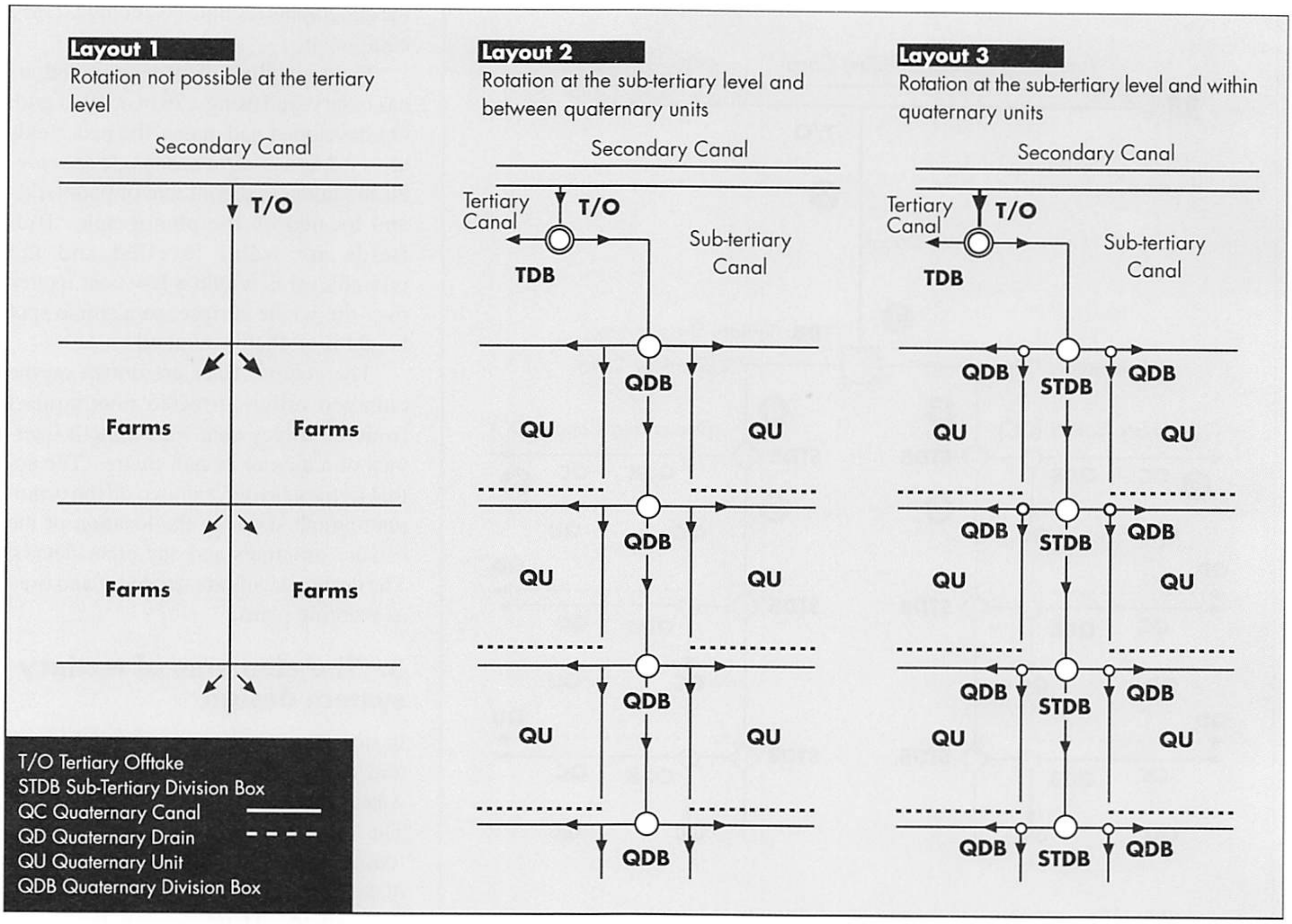


Figure 2 Layouts of three tertiary systems.

a box with lift gates.

iv. The sub-tertiary canal continues onto the first quaternary division box that diverts water into one or more quaternary units. The sub-tertiary outlet is usually gated to divert water into one or the other sub-tertiary canals.

v. The quaternary division box is usually a proportional division control type allowing water to flow to all the quaternary units below in proportion to the area irrigated.

vi. The quaternary canals convey water to the farm units, outlets are provided at each farm unit.

3.2 Three typical layout forms

There are typically three tertiary water delivery systems ranging from a simple system to a complex system and each level provides a greater control over the distribution of water to the farms. These are shown in the diagrams in *Figure 2*.

Layout 1

This is the simplest form for diverting water to the farms. Water is controlled at the secondary canal level and rotation is only possible between secondary canal controls. Water is diverted directly from the tertiary canal into the farm furrows without controls. Only continuous irrigation can be practised with water flowing from farm to farm. This system leads to inefficient water use and conflict between users. This is the least desirable layout. This system is widely used in India and Pakistan.

Layout 2

With branching at the tertiary division box to the sub-tertiary canals, continuous flow occurs on the quaternary canals and rotation regulation can only take place **between** quaternary units.

- At least one division box will be required for each quaternary unit.
- Equal time rotation (ETR) is possible using a fixed ratio sub-tertiary division box and the quaternary units are of approximately equal area.
- Water can be equitably distributed among a smaller number of users, lessening water disputes, but timely supplies to individual farmers is not always possible.

Layout 3

With branching at the sub-tertiary canal and diverting water into the quaternary division box and into each quaternary canal, rotation regulation can take place within quaternary units. This kind of layout is more sophisticated than the previous layouts and needs a higher level of system management but trained, competent water user personnel can operate the system efficiently.

- The sub-tertiary division box is fitted with gates for a two-way arrangement as shown.
- Usually, quaternary division boxes are of the proportional division type, that is the width of the opening is proportional the area of the quaternary unit supplied, all the sills being at the same level. Changing the water level over the sill changes the delivery to the quaternary canals. Gates may be used to control the discharge too.
- A greater number of tertiary and quaternary control structures are needed to achieve full rotational control.
- If variable flow controls are used then variable time intervals and unequal

area can be included in a rotation schedule. To simplify management procedures proportional control and equal area rules should be used.

3.3 A typical tertiary system layout

Figure 3 is a typical field layout of a tertiary system found in East Java. The land form is undulating and slopes in a northerly direction. The tertiary offtake is located on the bottom left corner of the drawing, at TP3, branching to three canals, one at Q1 (quaternary box 1), from T1 to T2 and to Q4, and so on.

All of the ten quaternary areas are nearly equal in size except b_1. Then ETR or equal time of rotation can be used. Rotational water delivery can be practised if the control boxes are of the fixed ratio type.

All the canals end at a drain carrying away surplus water. Drains run along the bottom of each quaternary block to collect runoff from excessive rainfall to prevent plant submergence.

The triple canal and drain between T2 and Q2 is not desirable as it may lead to maintenance difficulties besides taking up land for services. A farm road is located between the two canals. This layout is a compromise to achieve the best design suited to the lie of the land.

3.4 Tertiary system development

The design of systems can apply to three situations in practice.

- *New systems*
  Where new irrigation systems are being constructed on relatively flat lands and land levelling is economical, a square regular pattern of tertiary units can be designed with the padi fields all at right angles to the quaternary canals. *Layout 3* would the logical choice allowing maximum water management capability but such schemes will be rare in future because of the high development costs. Land levelling is very costly and is rarely justified for padi fields as the farmers are adept at constructing padis over a period of two or more years.

  The construction of padi irrigation on new land may require radical landscaping of the land to level it but this is a very costly operation and best avoided. New land should be selected with relatively even topography to obviate heavy earthmoving work.

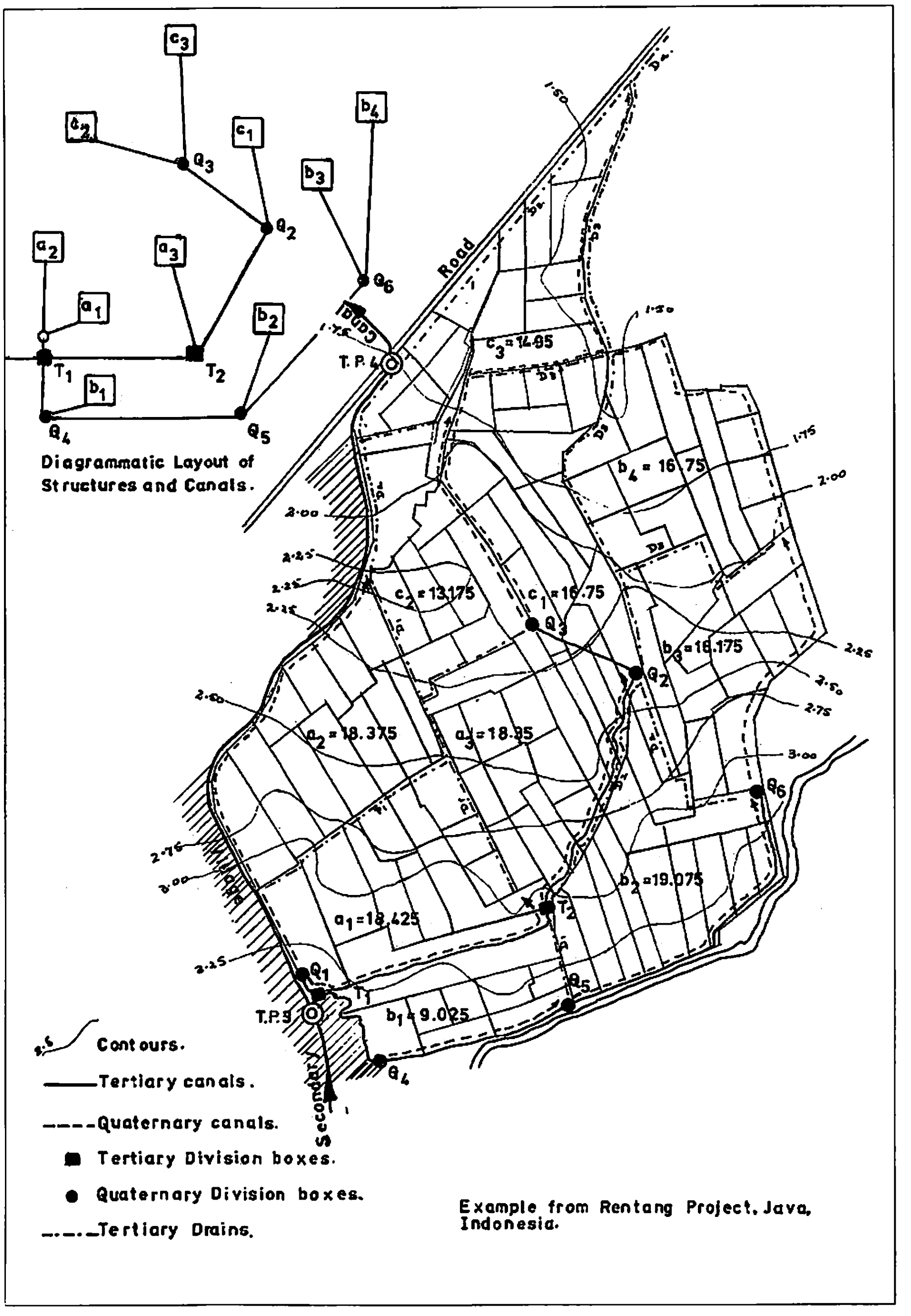


Figure 3 A typical tertiary unit layout.

- *Improvement of existing padi lands*
  Installing tertiary systems on existing padi lands is the usual approach to system development using a combination of *Layouts 2 and 3.* The layout in *Figure 3* is a typical combination of both types. The length and density of canals and structures is governed to some extent by the topography, the size of the farm holdings and other natural and structural features.

- *Rehabilitation of existing tertiary systems*
  Most of the irrigation systems constructed over the past two or more decades were designed with the type of *Layout 1* for distributing water to the farms and it is not a simple matter changing to a new layout form. Before the system can be rehabilitated and adapted to a new form, the vested interests of farmers and the hierarchy between farmers along the single canal have to be resolved by socio-technical interaction. A priority is the development of a cogent water management procedure to operate the system. The choice of an appropriate layout, similar to either *Layout 1 or 2,* depends of the physical and hydraulic consid-

eration within the tertiary unit area.

4. Tertiary system design criteria

The ability of water user associations to manage and operate their own system is an important factor in achieving sustainable long term irrigation efficiency. However, to achieve this objective, a holistic approach to the design of tertiary systems is essential.

Over the past two decades, the policy of donor agencies expected the farmers to find technologists and contractors to design and construct their tertiary systems (Hrobovszky, 1972). Besides, aid donor policy precluded funding tertiary system development. The result of these policies has been poor water distribution, poverty amongst the farmers along the lower reaches of water courses or tertiary canals and similar unmanageable systems.

The systems designed by the irrigation agencies proved over-complicated and unmanageable (Horst 1984). However, there is now increasing awareness that farmers have the ability to participate in developing the design and layout of tertiary systems in their own localities. Farmers' experience of the management of water in their own areas should be included in the system development and, with their co-operation, is likely to improve their capacity to manage the system. One reason for some of these problems has been the lack of a coherent set of guidelines and criteria for the design of tertiary systems.

The number of control structures, canal length and density have a definite effect on the manageability of the tertiary system. Complex control structures and measuring devices are treated with suspicious by farmers. Too many control structures are also suspect. Long canals and too many canals are not acceptable, requiring a great deal more maintenance besides passing through many neighbouring lands. Systems that are unacceptable to the farmers will be either destroyed or ignored. The co-operation of the farmers is a long term investment in success.

4.1 System characteristics and farmer acceptance

A method used to describe the characteristics of a tertiary system was proposed by Pusposutargjo (1990) using Kansky's (1963) procedure. It was originally applied to transportation systems and by analogy applied to the conveyance of water in a canal distribution network.

The two criteria studied were:

a) the density of control structures per unit area of the tertiary system
b) the complexity of the interconnections among the canal segments between the control structures, different ratios defined by Pusposutargjo being used to obtain the index values.

The results from the study of tertiary units on four projects in East Java provided guidance for future design criteria and corresponds closely to criteria gathered from field observations from other studies. This study showed that damaged or bypassed structures were lower in areas with optimum canal and structure density. Canal and structure densities corresponding to these criteria are more likely to be accepted by the farmers. These details from the study are summarised below.

i. Canal densities were between 50 to 100 m per hectare.
ii. Quaternary structure density varies between 0.1 to 0.4 structures per hectare (or 1 structure per 5 to 10 ha).
iii. Each quaternary division box serves not more than 2 to 3 canal segments.
iv. The optimum length of quaternary canals range from 250 to 500 m, shorter canals are possible but may reduce the cropping area.
v. Optimum length of the tertiary canals is 500 to 1000 m.
vi. Not more that one tertiary turnout on the secondary canal per tertiary unit but specific conditions may require additional turnouts.
vii. Bridges, syphons, tail spillways, side spill weirs, should not exceed one per 10 ha.

These criteria correspond closely to the guidelines in following section.

4.2 Tertiary system design guidelines

These guidelines are used as a basis for designing the components of a tertiary systems.

i. Tertiary unit boundaries should follow natural features, such as streams, and statutory boundaries, such as village and regional boundaries, roads and railway lines.
ii. The water distribution system should follow the topography as closely as possible as land forming costs money.
iii. Tertiary units should not exceed 150 ha, the ideal sizes being between 80 ha and 100 ha.
iv. Quaternary units should be of equal area and paired sub-units of the tertiary unit not less than 5 ha and not exceeding 20 ha.
v. Tertiary canals can be from 500 m or more in length but should not exceed 1500 m.
vi. Quaternary canals should not exceed 500 m in length.
vii. No field should be more than 200 m from the nearest canal.
viii. Canals should be lined in non-cohesive soils and the critical tractive force design procedure should be used to design unlined earthen canals.
ix. Multiple canals running parallel be each other should be avoided, if unavoidable the canals should be lined.
x. The water level in quaternary canals should be 100 mm above the 'critical' field level - the highest ground level in any field in the tertiary unit.
xi. Higher canals should flow into lower canals to conserve water, otherwise all canal spillage should discharge into a drain.
xii. Tertiary unit drains should be designed to remove surplus rainwater to prevent the critical submergence period for the rice crop.
xiii. The distance between quaternary canals and drains should not exceed 350 m.
xiv. Proportional fixed ratio division boxes should be used in preference to gate operated boxes.
xv. Systems are designed for rotational water distribution rather than continuous flow distribution.
xvi. All services such as canals, roads and structures should not occupy more than 7% of the tertiary unit area, 4% being the ideal.
xvii. Service roads should not be more than 3 metres in width, farm roads 2.0 to 2.5 m, footpaths 1.5 m wide along quaternary canals.
xviii. The road level should be not less than 0.45 m to 0.55 m above padi ground level.

5. Water supplies for the tertiary system

The amount of water diverted from the

main conveyance system into the tertiary system is determined by two considerations:

a) the amount of water required for soil saturation and land preparation, and for maintenance of crop growth over the growing season to ensure optimum yields,
b) the amount of water to cater for system losses.

5.1 Water requirements for padi rice and upland crops

Maximum water supplies are required during the nursery and land preparation and early growing stage; less water but more reliable supplies are delivered during the critical flowering and maturation stage; water delivery is less crucial during the late maturing stage; and finally for the ripening stage, no water is used and the padis are dried off for harvesting.

Land preparation is spread over 30 days for mechanised padi preparation and 45 days for traditional land preparation using animals.

As the amount of water delivered to the irrigated area varies over the crop growing season the capacity of the canals are designed to deliver the maximum discharge to meet the maximum demand for water. For padi rice, the maximum demand occurs early in the season for land preparation. But for field or upland crops, the maximum demand occurs during the middle third of the growing season. Where padi rice and upland crops are grown in the same tertiary area, the maximum demand for rice usually exceeds that for upland crops.

The crop water requirements can be estimated by plotting the crop growth cycle for the whole growing season. The crop season is divided in periods of 7, 10 or 14 day intervals and the various parameters are entered for each period and the **Gross Water Requirement** (GWR) calculated. The parameters for these calculations are given in the general equation in *Part II, Section 2.3*. However, crop water requirements can be calculated using computer software obtainable from universities and international organisations, for example, Cropwat program from FAO (FAO, 1996).

• **Crop water requirement**

The method used to estimate the water required for crops is based the potential evapotranspiration for a reference crop, preferably for grass, E_p, and multiplying the E_p by the appropriate seasonal crop factor, k_c, to obtain the $E_{t(crop)}$. The E_p is calculated on a daily basis for the whole cropping season and averaged for irrigation intervals of 7, 10 or 14 days. The effective rainfall is deducted from the estimated crop water requirement and percolation losses are added. The rooting depth and the plant stress factor are applied to obtain the **Crop Water Requirement** (CWR) for upland crops.

• **Gross water requirement.**

The inclusion of the various efficiency factors converts the crop water requirement to the **Gross Water Requirement** and can be calculated using a spreadsheet; special computer programs are also used to calculated the GWR.

• **Peak Water Requirement**

The **Peak Water Requirement** (PWR) is the maximum periodic gross water requirement occurring over the growing season and includes the canal conveyance and tertiary system losses, or efficiencies. The PWR is used as a basis for designing the capacity of the system.

5.2 The irrigation cycle

The irrigation cycle time for padi rice is usually 14 days based on an average $E_{t(crop)}$ of 7 mm/day, the depth of the water layer is 100 mm, then 100 mm divided by 7 mm/day gives 14 days. However, shorter intervals of 7 days or 10 days may be used where upland crops are grown. In any case, the water requirement calculations are preferably based on the shorter interval of 7 days which gives a better estimates of $E_{t(crop)}$.

5.3 Water requirements for different crop growth stages

• **Seedling stage** - Only a small amount of water is needed at this stage. The seedlings are planted out after about 30 days, and to 45 days require about 200 to 300 mm of water. The nursery area covers no more than a **tenth** of the area for transplanting.

• **Soil saturation and land preparation stage** - The depth of 100 to 150 mm is needed to saturate the top soil and 80 to 100 mm to establish a water layer on the surface. This stage corresponds with the seedling stage and lasts for 30 or 45 days and this work is carried out simultaneously with the seedling stage. The depth of water required for land preparation can be calculated using the method described by van de Goor and Zijlstra (1977) and explained below.

• **Growing stage** - Water requirements during the tillering, flowering and early maturing stages are high and reliable water deliveries are critical. Water requirements during the late maturity and ripening are the lowest.

5.4 Crop water requirements

The crop water requirement for a particular crop is based on the potential evapotranspiration for a reference crop. The reference evapotranspiration, E_{ref}, is calculated using the Penman equation using either lucerne or grass as the reference crop (Penman, 1948). The Jensen - Haise equation is another method for estimating evapotranspiration from climatic data based on lucerne as a reference crop (Jensen & Haise, 1963). The appropriate crop coefficient either for grass or lucerne is used to convert the E_{ref} to $E_{t(crop)}$.

The equation below is used to calculate the $E_{t(crop)}$ for each interval over the growing season,

$$E_{t(crop)} = k_c \times E_{ref}$$

The crop coefficients, k_c, for most commonly grown field crops can be obtained from irrigation publications (Jensen, 1980; Wright, 1979; FA0, 1996). More recent data on crop coefficients can be obtained from literature on irrigation.

The crop coefficients widely used in for padi rice are as follows:

1^{st} & 2^{nd} weeks,	$k_c = 1.0$
3^{rd} to 5^{th} week,	$k_c = 1.1$
6^{th} to 9^{th} week,	$k_c = 1.35$
10^{th} to 13^{th} week,	$k_c = 1.3$
14^{th} to 17^{th} week,	$k_c = 1.05$
18^{th} week on,	$k_c = 1.0$

5.5 Gross water requirement

The water required for **Land Preparation** (W_L) of padi rice can be calculated using the following equation:

$$W_L = A_1(k_c E_t + P - R) + A_2[W + 0.5(E_o + P - R)]$$

where,

W_L = water supplied for nursery and land preparation, mm/day

A_1 = area planted to padi rice, % of total tertiary area

A_2 = area used for nurseries and/or for land preparation, % of the total tertiary area

E_{ref} = evapotranspiration in mm/day for each crop growth stage
k_c = crop factor for rice or other crops for each stage
E_o = evaporation from a free water surface, mm/day
P = percolation losses, mm/day
R = effective rainfall, mm/day
W = water layer in padis, amount of water supplied to A_2 for land preparation or nurseries, mm/day.

The equation is used to calculate the water requirement for each irrigation interval. The first term of the equation pertains to calculating the crop water requirement while the second terms applies to the water used in land preparation. During the first interval of 7 days, A_1 will be zero and A_2 will be about (7/45) or 16% of the tertiary area, obtained by dividing the irrigation interval by the land preparation period of 45 days. During the second 7 day period, A_1 will be 16% and A_2 will be 32%. Thus, the land preparation area increases for each successive interval until the end of the land preparation period or 100% of the tertiary unit. Once the land preparation period is complete, A_1 equals 100% and the whole area receives water to maintain the growing crop.

Of course, conveyance and tertiary efficiency factors are applied. And, the maximum periodic water requirement represents the PWR which is used for designing the system.

5.6 Water required for land preparation

An alternative method of calculating the amount of water required for land preparation was developed for a pumped water irrigation system in Malaysia. Of course, this method can be used elsewhere.

The method used for double cropping in Malaysia by van de Goor and Zijlstra (1977) to estimate water delivered during the short period of presaturation, I A dt, representing the water required to maintain the water level in the areas completed, M y dt, and to presaturate a new portion of the area, S dy, is expressed as:

$$I\,A\,dt = M\,y\,dt + S\,dy$$

where,
A = tertiary unit area, ha
M = water required to maintain the water layer, mm/day
= $[W + 0.5(E_o + P - R)]$ (see *Section 5.5*)
S = depth of water for presaturation, mm
I = water required during presaturation, mm/day
t = time taken from the beginning of presaturation, days
y = area presaturated in time t, ha
T = total presaturaion period, days
W = water layer depth, mm.

The equation can be rewritten as,

$$dt = S[dy/(I\,A - M\,y)]$$

Integrating this equation and rearranging terms, the following equation is obtained:

$$I = [M\,e^{(MT/S)}]/[e^{(MT/S)} - 1]$$

where, e = base of natural logarithms. For example, if M = 8.3 mm/day, S = 300 mm, T = 40 days,

$$M\,T/S = (8.3 \times 40)/225 = 1.47556$$

$$I = (8.3 \times e^{1.47556})/(e^{1.47556} - 1)$$

$$= 36.29976/3.37346$$

$$= 10.76 \text{ mm/day or } 1.24\ l/s \text{ ha net.}$$

This calculation shows that 1.24 *l*/s ha will be required for the 40 day period of land preparation. The depth of water, S, required to saturate and puddle the soil is estimated as 5% to 10% by volume of soil. A depth of 150 to 200 mm is used for most padi rice soils. Once the land preparation stage is completed, normal crop water requirements will supplied.

5.7 System water distribution

Many years ago, it was empirically established that a larger discharge had to be supplied to smaller areas than to larger areas to complete the irrigation cycle in time. This lead to the establishment of the Tegal principle that is described below. In Indonesia, the Tegal curve (or the Pemali curve of van Maanen, 1924) is used to estimate the proportion of water delivered. Similar procedures have been used for determining the system capacity of canals on irrigation systems (Haley, 1974).

The curve is based on empirically derived information from East Java. The following equation is used to plot the Tegal curve.

$$k_m = 5.22(A^{-0.33}), \text{ for areas} \leq 142 \text{ ha}$$

where,
k_m = proportionality coefficient, plotted on the vertical ordinate,
A = tertiary area, ha, plotted on the horizontal ordinate.

This curve only applies to areas up to 142 ha while the next equation is used to calculate the system distribution capacity for areas greater than 142 ha but not exceeding 710 ha. However, this equation produces a value of approximately one and a straight line occurs for areas over 710 ha.

$$k_m = 0.95 + \{[(710 - A)/568]0.05\}$$
$$142 \text{ ha} < A \leq 710 \text{ ha}$$

Table 1. Design discharge capacity for a normal water demand of 1.5 *l*/s ha.

Tertiary unit area, ha	Tegal coefficient*	Tertiary offtake capacity, l/s
80	1.23	148
100	1.14	171
140	1.02	214
150	1	225

*Tegal coefficient=5.22 $A^{-0.33}$

The capacity of canals supplying water to small areas must be larger to carry the water faster to the irrigated area. The larger canals can also remove overflow water from padi fields, rainfall and surplus water from gate closures. For example, assuming that the PWR is 1.1 *l*/s ha, the discharge of a quaternary canal supplying water to a 5 ha area would be 17 *l*/s (1.1 *l*/s x 5 ha x 3.1), where k_m = 3.1. Similarly for a 10 ha area, the discharge will be 27 *l*/s; for a 50 ha area, the discharge is 79 *l*/s and for a 100 ha area, the discharge will be 126 *l*/s. The system discharge capacity is expressed in *l*/s ha, thus for 100 ha, 126 *l*/s is 1.26 *l*/s ha.

5.8 Design discharge capacity

The **Design Discharge Capacity** (DDC) refers to the quantity of water diverted from the main canal, at maximum discharge, through the tertiary turnout to each tertiary unit. The DDC is used to design the canal system and control structures and includes the maximum crop water requirement and the system losses.

The **Design Discharge**, Q_m, for the tertiary unit includes the net area of the unit, land proportionality factor and the relevant efficiency factor; furthermore, it is assumed at this stage that the appropriate efficiency factors are included in PWR:

$$Q_m = (PWR) \times k_m \times 0.11574$$

where,

Q_m = design capacity, *l*/s ha

PWR = peak water requirement, mm/day

k_m = proportionality coefficient (see above).

In this example, the PWR is 9.5 mm/day, the net tertiary area is 80 ha and the system distribution factor calculated using the equation for areas less that 142 ha, k_m = 1.23. The calculated design capacity follows for the 80 ha unit.

$$Q_m = 9.5 \times 1.23 \times 0.11574$$
$$= 1.35 \text{ } l\text{/s ha}$$

The design discharge capacity for the 80 ha unit is 1.35 *l*/s ha. *Table 1* gives examples of the design discharges for different sized areas.

This procedure is also used to design the capacities of the quaternary canals once the discharge $Q_n = Q_m$ has been calculated, thus Q_n is multiplied by the appropriate k_m value for the area of each quaternary unit. The DDC of 1.35 *l*/s ha is multiplied by each quaternary unit area in the 80 ha tertiary unit and multiplied by the appropriate value of k_m for the quaternary area.

6. Preview of Part II

Once the physical planning of the tertiary unit is completed and the canal and drain network finalised. The next step is to calculate the water supply and delivery procedure and decide whether a continuous or a rotational supply is appropriate.

The decision to use a continuous supply would depend on the source of water such as a perennial river or large reservoir and on the size of the irrigation scheme. Conversely, rivers with small catchments or with seasonally fluctuating discharges would indicate the choice of a rotation system.

On large irrigation schemes, however, rotational water supply is the preferred method of water distribution: firstly, it reduce costs; and secondly, it is essential for effective water management.

The procedure for designing continuous or rotational water control will be considered in Part II.

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Centrifugal sump pump launched by Ingersoll-Rand

Ingersoll-Rand has launched an updated version of the company's popular air-powered 35 Series Centrifugal Sump Pump. The new P35 Series pump is a direct replacement for the 35 Series model and is a heavy duty unit, offering a comprehensive range of features for operation in arduous conditions.

The new P35 Series pump maintains the 72 m 'high-head' specification of the previous 35 Series unit and offers a cost effective performance to match any sump pump application, but from a product package reduced in height by over 17%, to only 570 mm. Features include grease-pressurised water seals for extended seal life with less required maintenance; oversized bearings for longer life performance even when the pumps are being continuously worked at maximum stress and a simple, robust governor design to prevent over-speeding and cavitation.

Other significant features of the new P35 Series pump include a high wear resistant impeller; a tough, durable cast iron housing; laminated phenolic resin rotor vanes running in a cast iron cylinder for optimum service life and an inlet air filter screen to help prevent airborne contamination which can be easily removed for cleaning.

The P35 Series sump pump weighs 36 kg and has a 50 mm discharge, with an air inlet 25 mm in diameter and air exhaust of 32 mm. The pump will pass through an opening 360 x 220 mm in size and offers a maximum discharge at zero head of 880 litre/min.

Contact: **Peter Chaffer, Ingersoll-Rand Sales Co Ltd, PO Box 2, Chorley New Road, Horwich, Bolton, Lancs BL6 6JN. Tel: 01204-690690.**

Branch Diary

South East Midlands Branch

Saturday 27th September, 1997 - 10.30am to about 12.30pm.

Technical visit to Marshal of Cambridge - SPV and Aircraft Divisions

Numbers limited. Contact: David Pullen
Tel: 01525 863038
E Mail: d.pullen@cranfield.ac.uk

Tuesday 28th October, 1997 - 8.00pm

Englands Hall, Silsoe College

The Lotus Elise - Back to the Future

by Tony Shute, Lotus Cars

Monday 3rd November, 1997 - 7.30pm

Silsoe College

Using virtual reality to improve safety in equipment based operations.

by Bryan Denby, University of Nottingham

Monday 1st December, 1997 - 7.30pm

Silsoe Research Institute

Improving the welfare of farm animals during transport- solutions not problems!

by Peter Kettlewell, Silsoe Research Institute

Nirex brings back heather

An industrial site in West Cumbria, which has been derelict for many years, is being restored to coastal heathland by environmental scientists working for Nirex. Using innovative reinstatement methods over two growing seasons (1995 and 1996), the two hectare site at Whitriggs near Seascale is now well established with an abundance of indigenous heather beyond first true leaf growth stage, and a selection of grasses and clover to bind the topsoil. The site will be able to support light grazing by sheep later this year if success with heather seeding continues.

The natural coastal heathland was destroyed when a railway line was built last century between Barrow-in-Furness and Carlisle. The vegetation cover which followed was typical of natural regeneration of industrial dereliction: low productivity grasses interspersed with gorse, heather and scrub. The area is officially classified as *'other land primarily in non-agricultural use'*.

In the early 1990's, Nirex took over a site near the former railway sidings to drill a deep borehole into bedrock as part of the Company's research programme to assess the suitability of Longlands Farm, about 4.5 km to the north-east, as a potential site for an underground repository. Rather than return the site to agricultural use, Nirex agreed with English Nature and Cumbria County Council to clear the site and restore it to the original coastal heathland once drilling and scientific work were completed.

Reinstatement methodology

The borehole site scheme was designed by ADAS Environmental and the chartered surveyors, Dixon Webb, on behalf of Nirex. Its aim was to re-contour the site in sympathy with the surrounding landscape and provide diverse vegetative cover to attract a variety of wildlife. An important aspect of the project was to establish heather from locally harvested seeds on the restored site.

Coastal heathlands in the area encompass a wide range of habitats. Generally, the soils are low in mineral nutrients, with a low-to-neutral pH level. These often develop an organic rich layer created by decomposing leaf litter from dwarf shrubs such as heather, bell heather and crossleaved heath species, as well as gorse and grasses.

Once the infrastructure and hardstanding associated with the borehole were cleared, the subsoil was replaced. In summer 1995 the site was cleared, contoured and cultivated. The disturbed area was ripped to a depth of 900 mm in two directions at right angles and all stones over 300 mm diameter were removed. Topsoil was replaced, chisel ploughed and stone picked to remove debris.

A fine-leaved grass mixture, of Chewing Fescue and Browntop Bent, was seeded as a companion species for heather across the area followed by a compound fertiliser before the site was harrowed and rolled. Open ditches and surface grips were dug to provide a diversity of habitat and to control surface water run-off during the early stages of vegetation establishment.

Detailed discussions were held with English Nature to decide the best way to establish heather the following year. An area of Blengdale Forest, some 8 km away in the Lake District National Park, was identified as a suitable donor site. Seed capsules on the heather were carefully monitored for ripeness and 25 kg of seed was harvested using a purpose built, tractor-mounted brush seed harvester. This successfully stripped the capsules without damaging Blengdale's heather plants. After cleaning, screening and barn drying, the seeds were stored in a controlled environment. Regular germination tests in a laboratory confirmed that the seeds had not deteriorated.

In spring 1996, controlled sheep grazing was used to reduce the grasses to an even height (about 50 mm). Subsequently, white clover and broad leaf weeds with the sward were destroyed with a selective herbicide before the heather seedbed was cultivated. Suitable soil conditions for heather establishment were created by scarifying the site with a rotary cultivator to disturb about 40 per cent of the ground surface. Heavy rain and high winds prevented mechanical heather seeding, so band seeding was used instead.

By mid-September 1996, heather seedlings were well established across the site at about 50 per square metre. Further germination occurred throughout the autumn. The area was mechanically topped by flail mower in January 1997 to reduce competition from grass and red clover.

Management plans for 1997 will depend on the success of heather establishment. It should be possible to return sheep to the area, although even light grazing will be of secondary importance to the welfare of heather and the long term success of this project to restore a coastal heathland habitat.

- Over 80% of lowland heath was destroyed in the last century. The heaths are now being identified as rare habitats of high conservation value.

Revised guidance on avoiding danger from overhead lines

Death or serious injury is the usual result of inadvertent human contact with overhead electric power lines and with up to a third of such contact proving fatal, the Health and Safety Executive (HSE) has published revised guidance aimed at those who work near overhead lines.

Called *'Avoidance of danger from overhead electric power lines'* (GS6), it is a revision of the existing guidance which has been available since 1991. The new publication has a revised layout to improve clarity and includes separate sections dealing with construction, agriculture and horticulture, forestry and aboriculture, and railways and other transport systems with overhead conductors.

The guidance applies to all types of overhead power lines including those supported on wooden poles and steel towers. With contact potentially lethal on all such lines, whether they are carrying voltage as high as 400 000 V or as low as 230 V, the guidance offers practical advice on the range of safety precautions which need to be taken.

Copies of Guidance Note GS6, priced at £5, are available from HSE Books, PO Box 1999, Sudbury, Suffolk CO10 6FS. Tel: 01787 881165.

Spectrum Concepts' range of irrigation equipment

Spectrum Concepts, the Bedfordshire-based irrigation specialists, have launched two new ranges of hosereel-type irrigators, incorporating 10 models.

Super-Rain 'G' and 'J' Series hosereels are manufactured in Italy by RM, one of Europe's leading specialists irrigation equipment. Established in 1952, the company produces a wide range for the agricultural and amenity markets. Its products combine Italian design flair with the most advanced technical features and the highest standards of manufacturing quality. Despite this, prices are extremely competitive.

There are six models in the Super-Rain 'G' Series. Smallest is the 550 which offers 250 - 200 m of 63 - 75 mm hose and is priced at £5675 - £6483. Largest 'G' Series machine is the 890 with 450 - 380 m of 100 - 125 mm diameter hose, priced at £15,059 - £16,548.

The 'J' Series includes the 700 (400 - 270 m of 90 - 125 mm hose) priced from £12,868 - £13,766, up to the top of the range, Major 1000, costing £24,685 - £25,943 and offering 650 - 550 m of 110 - 125 mm diameter hose.

The Super-Rain 'G' and 'J' Series machines are extremely stylish, easy to use and engineered to provide maximum reliability. Compact, yet brimming with technically advanced features, they incorporate wide wheel tracks and are exceptionally stable.

At the heart of each machine is RM's unique Flow Distribution Turbine which enables these machines to operate at very low pressures, requiring minimal power input. Constructed from aluminium alloy, the turbine incorporates a by-pass and stainless steel throttle valve, which minimises losses, maximises operational efficiency and results in exceptional reliability. To eliminate any risk of water being trapped inside the equipment and causing damage during the winter period, all turbines are self-emptying.

The Flow Distribution Turbine is coupled directly to a four-speed gearbox reduction unit which eliminates the need for a transmission belt to connect the turbine to the gearbox. This makes the system very simple, compact and efficient.

Incorporating a high level of standard specification, the Super-Rain 'G' and Super-Rain 'J' Series machines can be tailored to suit individual requirements by selecting from a wide range of options. These include diesel-engine hose rewinding, low pressure standard or trellis-type booms up to 48 m wide and hydraulic machine rotation.

Contact: **Chris Steele, Spectrum Concepts, Polehangar Farm, Meppershall, Bedfordshire. Tel: 01462 811009.**

Tractor accidents on rural roads

Independent consultants, Richard Gard Associates have produced a report on: 'Agricultural Vehicles: Influencing Safety through Accident Data Provision' for the Department of Transport. The report (ISBN 1 897897 10 3) considers agricultural tractors and trailers for road use and includes an analysis of casualty tractor accidents on the roads together with supporting information including press cuttings and tractor driver experiences. The cost of agricultural vehicle accidents is estimated at over £60M per annum.

Those interested in the findings are expected to include manufacturers, the police, agricultural colleges, insurers, road safety specialists, farmers and contractors.

Recommendations for accident reduction cover indication and difficulties with the right-hand turn, lighting, conspicuity, braking and the importance of adequate trailer brakes and the need to review the problem of trailers unhitching while travelling on the rural roads. A summary of the main findings is presented below.

1. Indication

The visibility of agricultural vehicle indicators to car drivers, under in-service condition of agricultural use, should be improved.

- Agricultural accidents occur on bright, sunny summer days. A higher proportion of right-turn accidents take place with agricultural vehicles than other vehicles. Approximately two-thirds of these accidents involve other vehicles approaching from behind, but it appears significant that one-third of right-turn accidents occur when the other vehicles are approaching from the front. Any improvement in indication will need to consider forward, rear and side indicators.
- Accident reports highlight comments from other vehicle drivers that they were unaware that the agricultural vehicle was turning.
- The majority of agricultural vehicles involved in road accidents are tractors, approximately half are towing trailers.
- Trailers should have indicators. The report highlights that it is not easy for farmers to connect trailer electric's to tractor electric's and this practical aspect should be investigated. There is a doubt that the current common practices of direct harnessing of trailer lighting systems to the tractor via multi-pin connectors is adequate under agricultural working conditions.
- Implements harnessed to the front or rear of tractors can obscure indicators from various angles as other drivers approach the agricultural vehicle.
- Under agricultural working conditions farmers report that it is easy for indicators to be broken. Observation of tractors shows that more design could be applied to location and protection of indicators. It is also likely that improvements to the lenses and fittings would provide better performance in adverse conditions.

2. Lighting

The use of a rotating beacon for agricultural vehicles at all times, visible from the front and from the rear, should be considered as a warning to other drivers.

- A large proportion (86%) of agricultural vehicle accidents take place during daylight, typically on sunny summer days.
- There is an apparent increase in the incidence of rear impact at night, particularly to towed vehicles. It appears likely that towed vehicles will be moving more slowly and also that the rear lights do not provide sufficient warning of the presence of the agricultural vehicle to following traffic. A rotating beacon, visible from the rear, would be expected to reduce rear-impact accidents.
- The question has been raised, however, whether a amber rotating beacon would obscure the amber right-turn indicator, both in daylight and darkness.
- Agricultural vehicle accidents typically take place on rural roads with a 60 mph speed limit. It is possible that car drivers do not register the presence of the slow moving agricultural vehicle in time to take appropriate actions.

3. Conspicuity

Tractors and tractors towing trailers are not particularly easy to see on country roads, The use of reflective materials and lighting to increase conspicuity is worthy of investigation.

- Agricultural vehicles appear in different shapes and sizes, there is no common profile.
- Greater conspicuity would allow a longer reaction time for other drivers.
- The more brightly coloured parts of the tractor bodywork are often not visible from the front and rear, only from the sides.
- Generally, agricultural vehicles blend in well with hedges and roads.

4. Braking

A full assessment of the in-service requirements of tractor and trailer brakes is indicated, including the need for maintenance.

- Agricultural vehicles have a long working life; three-quarters of the vehicles assessed in the report are over three years of age.
- Assessments of vehicles involved in accidents have highlighted the need for improved maintenance.
- The manufacturing standard is one consideration, but it would appear that the in-service performance of agricultural vehicles is unknown. It is expected that some tractors and many more trailers are driving on the roads with under-maintained brakes.

The specification and testing of trailer brakes on new vehicles and the specification of braking linkage fittings to tractors, is indicated.

- Trailer braking is an essential part of stopping distance and control of the agricultural vehicle tractor/trailer combination.
- It is indicated that new trailers may not have adequate braking.
- It is indicated that when trailers are connected to tractors there are difficulties in matching the two braking systems.
- It is suggested that trailers should be manufactured to match specified types of towing vehicle fitments.

The performance of tractors and tractors towing loaded trailers, under emergency braking on the roads, should be examined for stability and vehicle control.

- It is not known how tractors and tractors towing trailers perform under emergency braking.
- The report shows a potential for wide variation in braking performance.
- Stability under emergency braking is important for control of the agricultural vehicle.

5. Unhitching

A review, of the tractor trailer connection with use on the road and the safety of the hitch under road accident conditions, is recommended.

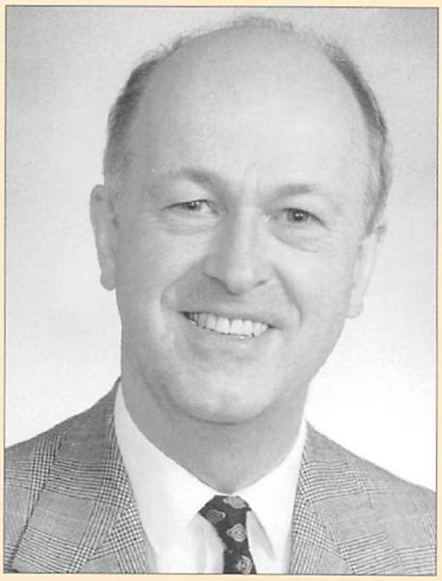
- Trailers do become unhitched from tractors.
- Unhitching occurs on hills, up and down, in collision accidents and when the tractor or trailer overturns.
- Fault lies with the trailer eye ring and the use of the tractor pickup hitch.
- Maintenance of the pickup hitch is important.

Copies available at £25 plus £3.50 p&p from: **Greystones Publishing, Greystones House, Park Road, Crediton, Devon EX17 3ES. Tel/Fax: 01363 774342.**

Membership Matters

Quarterly The Newsletter of the Institution of Agricultural Engineers Summer 1997

Honorary Fellowship for Professor Brian Witney



Professor Brian Witney has played a leading role in the agricultural engineering profession in the UK and Europe.

Following his university education centred on Edinburgh and Newcastle Universities and a short period in research posts in the UK and USA specialising in soil mechanics, traction and tillage, he returned to the Edinburgh School of Agriculture as Head of the Agricultural Engineering Department. He later rose to the Directorship of the Scottish Centre of Agricultural Engineering and was awarded an Honorary Professorship of Edinburgh University. In the course of his career, he has published widely in the form of both papers and books. He is a respected external examiner in agricultural engineering subjects, both for individual candidates and of courses at undergraduate and postgraduate level.

Having relinquished his post in academia, he is now actively engaged in consultancy through his own incorporated company.

Brian's contributions to the Institution have been equalled by few others and culminated in his term of office as President from 1988 to 1990. He is a prominent member of the Scottish Branch, having held all the major appointments in that very active region. At national level within the Institution, his major interests have been concerned with the Journal, formerly 'The Agricultural Engineer' and now, due mainly to his inititiave, 'Landwards' of which he is currently Editor. He has also influenced the standard and content of most agricultural engineering degree courses in the UK as a member of many Accreditation Panels over several decades.

At international level, Brian has played a leading role in the creation of the European Society of Agricultural Engineers, 'EurAgEng', whose very existence owes much to Brian's drive and persistence. He was President of the Society in 1993-94.

The Institution awards Brian the Honorary Fellowship in recognition of his outstanding contribution to the work and development of the Institution at regional, national, and international levels and to the advancement of agricultural engineering particularly in the fields of education, research and authorship.

Award of Merit for Rod Herbert

The Award of Merit is made to a person distinguished by work in agricultural science or engineering which has made a major impact on agricultural engineering developments or technology.

In 1970, Rod Herbert was looking for a suitable potato grader for use on his own family's large, arable farm. He was disappointed that he could not find a suitable machine on the market, and not being one to accept a lesser machine than was needed, set about designing the first Herbert potato grader.

This machine was constructed in the farm's own workshop and put to the test in 1971. It was a complete success and the interest of other local farmers was so aroused that, in 1972, the firm of R J Herbert Engineering was established to manufacture the 'Multigrader' potato grader in order to satisfy this local demand. The 'Multigrader' became the mainstay of the business for several years, but following many requests for more sophisticated machines, the company developed a new range of potato graders, which proved equally as popular, but far more versatile in their ability to adapt to special conditions.

The company has grown considerably since those early days, now having over 8,000 m² of factory space. The facilities have similarly increased, with computer aided design, computer controlled high

precision punching and bending machinery, together with the most up to date welding and paint spraying equipment. A workforce of 130 are involved in manufacturing the very latest generation of root crop handling machines, as well as a wide range of associated equipment. The company is now established in the industrial food handling side of the business and is able to offer complete handling lines for the pre-pack and processing industries. Several such installations have been successfully completed.

The company policy remains one of continuous controlled expansion, with the introduction of more computer controlled workshop tooling, enabling it to achieve more efficient production, combined with greater accuracy in the production of critical components. This remains the strength of R J Herbert Engineering Limited, a total understanding of the customers' needs, together with the production support to ensure that the machines will perform efficiently for many years to come.

Branch Meritorious Awards

John Kilgour FIAgrE joined the Institution in 1957 as a student and, following a post graduate apprenticeship at the Ford Motor Company, took up an appointment at what is now Silsoe College in 1963.

Since then, John has been an extremely active member of the South East Midlands Branch of the Institution. During most of this period, he has been a committee member and has served as Chairman, Vice-Chairman, Secretary and Treasurer. His contribution to the Branch technical activities has been very valuable and his long experience has meant that his ideas for programmes and speakers have always been innovative, balancing a mixture of information and entertainment.

His encouragement to younger members has been exemplary as shown by his keen promotion of student competitions at the annual conferences.

Socially, John has been at the forefront of Branch activities. He has organised events at his own home on several occasions and he and his wife, Pat, are regular attendees at all Branch social functions.

For his long service stretching over 35 years, the South East Midlands Branch has no hesitation in nominating John Kilgour for the Branch Meritorious Award.

Rodney Pragnell MIAgrE has served the East Midlands Branch in many ways since at least 1980. In all his activities, he has ensured that his input was highly professional and that this was reflected in his contributions to the Branch. He has served in almost every capacity on the Branch committee, holding some positions for several years.

In addition to these duties, Rodney assisted the Branch conference organisers for a number of day conferences and took a leading role in the Golden Jubilee Branch Celebration Day at the then Lincolnshire Agricultural College at Caythorpe.

Rodney has always been ready to assist in all Branch activities, probably as one of the most active members of the Branch throughout his 13 years of formal service. During this time, his contributions have extended beyond the normal extension of his specialism of Health & Safety to assist, promote and encourage other members in supporting the Branch.

In summary, Rodney has given outstanding service to the Branch and the Institution. The East Midlands Branch felt that recognition of Rodney's service was most deserving and nominated him for the Branch Meritorious Award.

Brian Scantlebury CIAgrE has been a member of the Institution since January 1972 and has been a committee member of the Herts & Essex Branch continuously since 1975. He has been a very active supporter and helper in organising a number of Branch events including Irrigation in 1976, Electronics in Agriculture in 1979, Materials Handlers in 1981, Front End Linkage in 1987 and All Terrain Vehicles in 1989.

In 1988 at the Essex Show, he organised a grand ring event entitled '50 Years of Agricultural Machinery Development' publicising the IAgrE. In addition, he has hosted two Branch summer visits to his farm, and has served on the Institution's Membership Committee and Council.

In summary, Brian has been a true stalwart of the Branch and of the Institution. The Herts & Essex Branch felt that recognition of Brian's service was long overdue and nominated him for the Branch Meritorious Award.

Obituary

Robert Davis (Dip Agr Eng 1975/ MSc 1976)
[Also: MBA, Dip Ed, BSc, MIAgrE, IEng]

Rob's many friends from Silsoe - now spread all over the world - will be saddened to learn of Rob's sudden and untimely death on 17 June 1996 whilst on holiday in Portugal.

The cover of the last (July 96) issue of the Society Newsletter featured Graduation Day - it doesn't seem 20 years since we were celebrating together at Silsoe, but Rob still kept in touch with many of his friends. Rob had packed much into his 46 years and led a very active life, flying and sailing amongst other hobbies, when his work permitted. However, in his work he had his feet firmly on the ground, developing and applying his organisational and management skills (evident back in the 70s!).

Many large organisations worldwide have benefited from his expertise and, at the time of his death, he was working for international consultants, Gemini Consulting Ltd. In honour of his "exemplary management skills, his character and his contribution to the Company and its clients" Gemini have established the "Rob Davis Memorial Scholarship Fund", which will be awarded each year to one of their Principals, who will attend an executive education course at the London Business School.

This is a fitting tribute to Rob's skills and professional contribution, but most of us will remember him for his quiet, charming character, his fresh, round, smiling, ruddy face and his friendly, welcoming approach - a true Gent.

Our thoughts and condolences go to Lily and Peter (his mother and father) and his sister, Anne-Marie.

Alan Plom

Kenneth Smyth scoops Johnson New Holland Award

Kenneth Smyth has been awarded the Johnson New Holland Trophy Award in 1996 for his work on optimizing the performance of semi-mounted ploughs, whilst on placement at Dowdeswell Engineering.

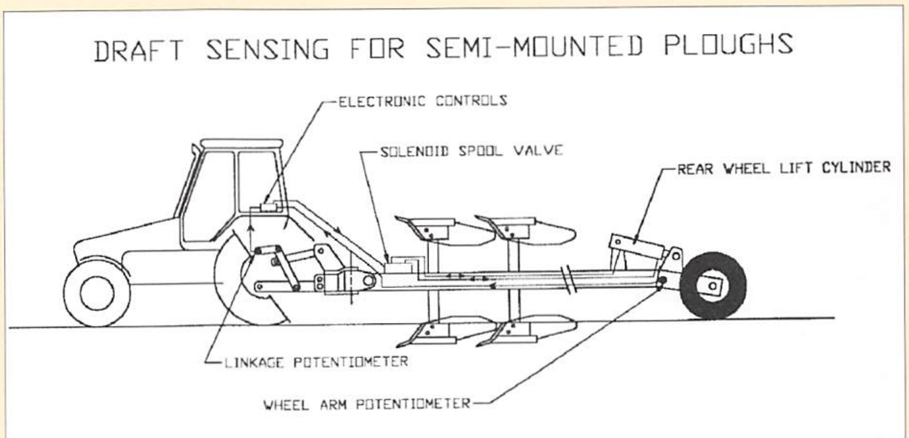
The award is presented annually, with the object of encouraging and recognising innovation by younger students, to the best final year project submitted by a student or group of students, as part of a first degree, Higher National Diploma or Higher National Certificate course in Agricultural Engineering. In addition to the student prize, the college submitting the prize-winning project receives a trophy to hold for one year. This year, the presentation was made by Mr J R N Keech, Chairman & Managing Director, New Holland UK Ltd, the kind sponsors of the Johnson New Holland Award.

The winner comes from a family farm in Ireland where he progressed from school to Tralee Regional Technical College. From there, he began a BEng course at Silsoe College, emerging in 1966 with a 2.1 honours degree. It was during this course that he undertook the industrial placement at Dowdeswell.

He has now returned to Ireland and works as an R&D engineer for McHale Engineering on bale wrapping machines. Kenneth's hobbies include collecting and restoring vintage agricultural machinery and off-roading, a hobby he took up whilst at Silsoe.

The basis of his project stemmed from his placement at Dowdeswell where he had carried out much of the in-field test work on their 180 series semi-mounted ploughs. From the test work, he set about identifying areas where the ploughs could be improved. This included a literature survey of work that had already been carried out by other people, analysis of manufacturers' data and solutions, each being evaluated against the specification. The most appropriate solution turned out to be a potentiometer device which measured and compared the angular movement of the tractor three point linkage with the angular movement of the rear wheel movement of the plough. An electronic circuit was developed to allow some practical evaluation which sufficed to confirm the merit of the concept.

The justification for such a sensing device was to maintain a more even ploughing depth over varying soil conditions. For example, if the plough hit tough ground, the draft sensing on the tractor would raise the front of the plough but the rear would stay as it was. Therefore, the front might raise 50 mm and the rear nothing. With



Draft sensing for semi-mounted ploughs

discussions with many operators and owners. Ten areas for possible improvement were identified and, applying cost/benefit ratio analysis, the most attractive option was draft sensing for the rear wheel. The specification which was drawn up for the sensing device resulted in eight

draft sensing controlling the rear wheel as well, the complete plough would only raise approximately 25 mm. Thus, the ploughing depth would be more consistent and the finished ploughing more level, easing subsequent cultivations.

Membership Movements

Mem No	*Name*	*From*	*To*
6076	N J D Adley	Nottinghamshire	Shropshire
2030	A L Baldwin	London	Russia
6409	J M Bellarby	London	Carmarthenshire
2845	G E R Blakely	Bedfordshire	Cambridgeshire
6509	W Bowden	Bedfordshire	Suffolk
3708	C S Campbell	Dyfed	Botswana
6100	S V Chinnadurai	West Midlands	Ethiopia
2257	J M Edwards	Italy	Somerset
4808	J M K Ellis	Wiltshire	Bedfordshire
3385	N Ford	Nottinghamshire	Scotland
4468	H G Gilbertson	Bedfordshire	Hampshire
0939	M R Kennedy	Isle of Skye	Portugal
5171	R A Landen	Hertfordshire	Bedfordshire
6607	A S Mac Gloinn	Bedfordshire	Hereford
6293	M McLeister	Norfolk	Gloucestershire
5727	S M Owen	Warwickshire	Leicestershire
6164	K W Priddle	Devon	West Sussex
4779	M van der Matten	Berkshire	Surrey
6485	T M Varga	London	Lancashire
3880	J D Wilken	Oxfordshire	Herefordshire
5970	D E Williams	Hertfordshire	Denbighshire
6191	A Wilson	Lancashire	Mozambique

Gone Away

Name	*Last known address*
T D Eyre	Violet Cottage, Lydham, Bishops Castle, Salop SY9 5HB
M D Hatton	Old Post Office Cottage, Sandon Road, Hilderstone, Stone, Staffordshire ST15 8SF
A T Zeleke	3 Belton House, Belton Street, London NW2 5LY

Douglas Bomford Paper Awards

The Douglas Bomford Paper Award is presented to the author(s), at least one of whom is an Institution member, who demonstrate originality and technical excellence in a scientific paper published during the previous year in either the Institution Journal, 'Landwards', or in the Journal of Agricultural Engineering Research. Assessment criteria for the award include: engineering content; potential for practical and commercial use; relevance to the current problems and needs of the industry; as well as quality of presentation and the authors' authority in the subject material. As a result of the very high standards of the publications scrutinised this year, the Board of Trustees is delighted to present two awards, one to Mr Brian C Stenning, FIAgrE, of Silsoe College and the other to Mr Peter J Kettlewell, MIAgrE, of Silsoe Research Institute, and their respective co-authors.

The two papers by **Brian Stenning FIAgrE and his co-author, P A Berbert** from Brazil, are concerned with the on-line measurement of the dielectric properties of wheat and the expression of the results in a way such that the measurements are effectively independent both of the density and flow rate of the flowing grain. Considerable time and effort must have been devoted to careful experimentation and analysis. The contribution holds the potential for overcoming the need for specific calibrations for drying different grain varieties.

Berbert P A, Stenning B C (1996). Analysis of density independent equations for determination of moisture content of wheat in the radiofrequency range. *J. agric. Engng Res.*, **65**(4): 275-286.

Berbert P A, Stenning B C (1996). On-line moisture measurement of wheat. *J. agric. Engng Res.*, **65**(4): 287-296.

The three papers by **Peter Kettlewell MIAgrE and his five co-authors, C J Baker, S Dalley, R P Hoxey, A M Meehan, and X Yang**, present a report of an extensive investigation into the problem of ventilation of poultry transport vehicles. It comprised full scale measurements of surface pressures on a lorry/trailer combination during commercial operations, tests on models in a wind tunnel and a computational model to calculate internal environmental parameters to which birds are subjected during transport. This was a major study and the contribution is of great importance to the improvement of animal welfare. The results are of direct applicability to the design and operation of poultry transport vehicles.

Hoxey R P, Kettlewell P J, Meehan A M, Baker C J, Yang X (1996). An investigation of the aerodynamic and ventilation characteristics of poultry transport vehicles: Part 1, Full scale measurements. *J. agric. Engng Res.*, **65**(1): 77-83.

Baker C J, Dalley S, Yang X, Kettlewell P J, Hoxey R P (1996). An investigation of the aerodynamic and ventilation characteristics of poultry transport vehicles: Part 2, Wind tunnel experiments. *J. agric. Engng Res.*, **65**(2): 97-113.

Dalley S, Baker C J, Yang X, Kettlewell P J, Hoxey R P (1996). An investigation of the aerodynamic and ventilation characteristics of poultry transport vehicles: Part 3, Internal flow field calculations. *J. agric. Engng Res.*, **65**(2): 115-127.

Engine Emissions

*A talk presented by **Carl Ahlers of New Holland** to the Herts & Essex Branch on 13 March 1997 is summarised by Richard Langley and Paul Hill in note form.*

Mr Ahlers began his talk by outlining several current agricultural engine characteristics:

- one litre per cylinder (approx)
- both naturally aspirated and turbocharged
- mechanical injection
- 2 valves per cylinder.

Current unregulated emissions are typically:

1. CO - 10 g/kWh or less - i.e this is **not** an issue
2. Hydrocarbon emissions - 3 g/kWh
3. NOX (oxides of nitrogen) - 18 g/kWh, i.e. 10% of the total and this is high for diesel engines (petrol engines are lower)
4. Particulate matter - 1.2 g/kWh, i.e. too much.

It was emphasised that (3) and (4) above are the problem issues.

New agricultural diesel emissions standards

Tier 1

NOX levels down to 9 g/kWh.
Particulates down to 0.5 - 0.8 g/kWh.
The timing for tier 1 is as follows:
California by 1996;
Rest of USA by 1996 - 98;
Europe (non road mobile machinery) by 1998 - 99;
Europe (tractors) by 2000.

Mr Ahlers commented that tractor engine manufacturers were learning from both automobile and truck technology. The objective was to develop integrated emissions control, not simply as an add-on. Benefits would be improved performance, longer service intervals with minimal cost increases. Tier 1 would most likely be achieved by the use of:

- more turbochargers with wastegates
- more intercooling (or aftercooling)
- re-entrant design combustion chambers
- modified air swirl
- retarded injection timing
- higher performance fuel injection equipment.

As well as giving lower emissions, other advantages would be:

- quieter engine (by 1-3 dBA), with higher frequency noise being decreased
- less visible smoke, across the size range
- improved torque back-up
- improved fuel efficiency (particularly when using air-to-air coolers).

Mr Ahlers specifically mentioned the "NH 70" series tractors, where torque rise and specific fuel consumption performance figures were very good.

Tier 2

NOX levels down to 6-7 g/kWh.
Particulates down to 0.2 - 0.4 g/kWh.
Timing:
USA by 2003 - 2004
Europe by 2002 - 2004.

The technology required for these standards would entail:

- more turbochargers, with wastegates
- naturally aspirated engines under 75 kW only
- improvements of air motion (cross flow)
- 4 valves per cylinder
- higher pressure fuel injection
- electronically controlled injection timing i.e. "fly by wire" technology.

Customer benefits would include:

- quieter engines (by 2-4 dBA)
- no visible smoke
- ideal torque curve shape
- improved fuel efficiency
- extended service intervals
- integrated electronic controls.

Tiers 3 & 4

Mr Ahlers surmised that any future tier 3 or 4 would most likely involve:

- advanced fuel injection systems.
- advanced air handling systems (air-to-air intercooling best?)
- variable geometry turbocharging
- full authority electronics
- exhaust gas recirculation
- alternative fuels eg modified petroleum, renewable fuels (eg rape seed oil), gaseous fuels.

In summary, Mr Ahlers said that agricultural regulation is coming; by the year 2000, tier 1 would be with us. He commented that the emissions improvements would be achieved only through the use of more advanced technology, and this was down to the various engine manufacturers. The meeting ended with a lively question and answer session. It has been an enjoyable and informative evening.

London Professional Engineering Institutions

At the formation meeting on 26 February 1997, Eur Ing John Richardson CEng FICE FIMechE FIEE was elected Chairman of the London PEI Board. Eighteen Engineering Council affiliated bodies were represented at the meeting.

The Host Institution to LPEI is the Chartered Institution of Building Services Engineers. The LPEI Secretary is Sylvia Kendall, CIBSE, Delta House, 222 Balham High Road, London SW12 9BS, Tel: 0181 675 5211, Fax: 0181 673 3302. The Senator representatives on the LPEI Board are Dr David Evans (Deputy Chairman) and Mr David Lush.

Our institution was represented by **Mr John Weir.** All Engineering Council affiliated bodies were encouraged to have their nominated representatives to the LPEI made known to their members as the first contact. Only in cases of difficulty should individuals contact Mrs Kendall.

Institution membership changes

Admissions - a warm welcome to the following new members

Companion

H B Crabtree (Berkshire)

Associate Member

R V Bhusia (Guyana)
M B Douthwaite (Philippines)
C M Moore (Uganda)
M Pardo-Chacon (London)
N W T Parry (Oxfordshire)

Associate

P A Fagan (Berkshire)
R O Hale (Bedfordshire)
D J Taylor (Cumbria)

Student

D Bentley (Bedfordshire)
G Berry (Oxfordshire)
R J Cant (Bedfordshire)
J S Garner (Buckinghamshire)
O Pahl (Bedfordshire)
D Price (Bedfordshire)
M Shamsi (Bedfordshire)
J O Williams (Bedfordshire)
P R Young (Bedfordshire)

Reinstatement

G Newsome (Kent)

Transfers - congratulations on achieving a further phase of your professional development

Companion

D A Butler (Lincolnshire)

Associate Member

A Finney (Northern Ireland)
A D Gregory (Hertfordshire)
C M Heslin (Essex)
E J Hughes (Hampshire)
J M J O'Sullivan (Hampshire)

Deaths - with great sadness we record the death of:

D A Bell (Cumbria)
J P Inglis (Cornwall)

Engineering Council

Registrations

CEng

U B Bindir (Papua New Guinea)

EngTech

J M J O'Sullivan (Hampshire)

Transfer

CEng

F Cutler (Worcestershire)

European Engineer (Eur Ing)

T E G Lee (Devon)

Letters to The Editor

Dear Sir,

Overseas experience

I am writing because I want to inform my young colleagues within the Institution of the benefits I am gaining from taking the plunge and going overseas to do development work.

I finished an HND at Writtle College, Chelmsford in June last year and, whilst preparing for my final year to gain my degree, another ex student and I were offered an opportunity to work overseas for a company funded by the Commonwealth Development Corporation (CDC). The offer to work as an estate engineer for Rwenzori Highlands Tea Company in Western Uganda was made within two weeks of my college start date. It can be imagined the amount of thought (and worrying) that those two weeks contained but, after seeking advice from anybody and everybody who was offering it, I decided to take the plunge and accept. Within a week, I had been jabbed by more needles than I care to remember and presented with a one way ticket to Uganda. The one way ticket and the fact that my knowledge of tea machinery consisted of fixing a broken handle on a tea pot did not fill me with amazing confidence!

Despite my initial fears, on arrival in Entebbe on a hot October day we were met by the estate manager, put up in a hotel, and generally treated very well. The next day, we were driven three and a half hours down mud roads to our home for the next year.

Once the initial culture shock wore off and we got down to work, I began to realise that my time in all the seemingly endless lectures at college was standing me in good stead along with my engineering apprenticeship I had done previously. What I found on the estate was an engineering department which had suffered many years of neglect due to war and bad management from the previous owners. Much work had already been done but the problems were far from being solved. The work was difficult and the hours long but my initial fears of being totally out of my depth were unfounded.

Where am I now? Well, I am half way through my year contract and am still alive! I am slowly beginning to reap the benefits of my first six months work: we still have a long way to go and, although I will not see the end product, I will always have the knowledge that I achieved a small part of it.

Nowhere at home would I get the opportunity at my age to be in a managerial position of a large company dealing with everything from installing plant machinery, hiring employees, and doing accounts. When my time here is finished I intend to do an MSc if funding is obtained or otherwise get my degree and continue from there. So if anyone reading this feels they are in a similar position, I would say to you, 'Take the plunge and grasp the opportunities offered to you.' Education and a good dose of common sense are the most important tools we have with which even the most daunting challenges can be tackled confidently.

Yours faithfully,
David Gregory AIAgrE
Estate Engineer
Muzizi Estate, Rwenzori Highlands Tea Co, Uganda

Dear Sir,

Engineering Council Senate

I have just been elected to the Senate of the Engineering Council as a registrants' nominated member for Electoral College A. I wish we had regionally based elections then I would feel more able to represent engineers in a more manageable constituency. As it is, I am elected to represent the rank and file membership of registrants in College A and that includes your Institution.

I am very anxious that your members should feel able to contact me direct on any matters they believe should be brought to the attention of the Senate of the Engineering Council. As the bigger institutions are going to dominate the deliberations of the Senate, it is even more important that those Senators who were nominated and directly elected by registrants should be active on the part of their constituents.

The problem is how to do this! Physically, I share with a few other Senators, College A members who live throughout the whole of the UK!

So I am asking for your help. I only see the journals of the civils and structurals and if your organisation has a publication with members' letters, say, this might be a way for me and them to exchange ideas. Or you may allow me to produce the occasional newsletter about the Senate and my own views on how we should proceed as a profession.

I certainly want engineers to have a greater influence in the affairs of this nation which means all of us becoming more politically aware. This is difficult for the Engineering Council (as it is with all the Engineering Institutions) because of its Royal Charter and charitable status.

I believe we must grasp the nettles of licensing of engineers and the way in which we select, educate, train, employ, motivate and reward our young men and women in the several distinct roles that make up the engineering workforce.

In my election address I promised to "make the profession of engineering as highly regarded in Britain as it is in France and Germany" and I am going to need a lot of help.

Please, do you have any ideas of how I can best make this Senate work with the help of your members?

Yours faithfully,
Rowland Morgan
BSc CEng MICE
Dept of Civil Engng, University of Bristol, Queen's Building, University Walk, Bristol BS8 1TR

News of Members

Philip K Afful is now working in Kigali, Rwanda for British Direct Aid (BDA) which is an NGO with charitable status and has its headquarters in Leyburn, North Yorkshire. BDA have a sub-contract and are implementing partners to the United Nations High Commissioner for Refugees (UNHCR) in Rwanda. They are responsible for the maintenance, service, and recovery of a fleet of some 470 light and heavy vehicles. This is done through a network of four workshops throughout Rwanda. Philip manages 17 expatriate (British) and 101 National employees of various disciplines and has a total budget of $1.4 million. As well as the workshops, BDA also operates a fleet of water and fuel tankers for bulk distribution throughout Rwanda. When writing, Philip said that he was seeking a new contract for BDA, hopefully with UNDP, as the emphasis in Rwanda has shifted from one of emergency to development.

G E R Blakely has been in business for 33 years as a specialised Electrical Contractor, dealing only with agricultural electrical installation and repair. In 1992 he bought a 47 hectare farm at Upper Dean near Huntingdon and now has planning permission to live there, although only in a mobile home. He has a small herd of Belted Galloway cattle and if the farm is successful he may retire from the electrical business in about 5 years time.

A letter from J W Hargreaves acknowledging the 50 year membership certificate which was recently sent to his father, **D B Hargreaves**, who is now 84, gives some interesting information. Mr Hargreaves has retired to Dorset but still takes a close interest in the development work of the company (Sisis Equipment (Macclesfield) Ltd). He recalls a pleasurable occasion in the 1950s when he made a personal visit to Mr Harry Ferguson at his then home in the Cotswolds, in order to demonstrate their first lawn scarifier. Apparently, Mr Ferguson only asked one question, "Why the direction of rotation?" and, after this was explained and the machine demonstrated, it was purchased immediately.

Prof Wang Maohua of the China Agricultural University has interests in strategic research on engineering services for sustainable agriculture, electronics and information technology in agriculture and agricultural engineering education. He is now leading a national project on studying agricultural engineering education for the 21st century. He is also interested in GIS and GPS systems for precision farming. Prof Maohua says that he has many friends in the Institution and is pleased to meet them at international meetings.

Tom Varga has moved from London to Lancashire to take up a new appointment as the Formulations Controller for AF plc. His work involves the formulation of animal feeds mainly for general livestock. His educational background includes an Honours Bachelor of Science degree in Biochemistry from Queen's University, Kingston, Ontario, Canada and a Bachelor of Engineering degree in Agricultural Engineering from the University of Guelph, also in Canada.

David Hinchcliffe who was previously Head of the Mechanisation Department at Pershore College of Horticulture has become Vice-Principal of Duchy College at Rosewarne, Camborne, Cornwall. Rosewarne itself is the site of the old MAFF/ADAS horticultural experimental station which has now been taken over as part of Duchy College, but all of the facilities are still there. Whilst at Pershore, David was a member of the senior management team and was responsible for a number of major initiatives including Investors in People and staff appraisal. He was also involved with consultancy work which included the creation and testing of a chainsaw teaching package for a company in Brunei. His teaching of horticultural mechanisation at Pershore was concerned with all levels, including HND and Degree. David has a degree in agriculture which he gained at Nottingham University and has spent the last 20 years in horticulture. He gained his initial experience at Brinkman Brothers in Sussex, a wholesale producer of trees and shrubs, and has worked at both Hadlow College in Kent and Merrist Wood in Surrey. Other qualifications include an Advanced Diploma in Educational Management and a Certificate in Education. As well as being a member of this Institution, he is also a member of the Institute of Horticulture. Before taking up his new post he was an active member of the committee of the West Midlands Branch of this Institution.

John Gander is now working in India for FAI Ltd as a Project Planning and Management Advisor. He is involved with an assisted alkaline land reclamation programme in the Ganges floodplain covering parts of the States of Bihar and Uttar Pradesh.

Alister Macmillan, who is Chairman of an Interim Committee of Professional Chartered Engineers (PCE) in the United Arab Emirates (UAE) would like to hear from any members of this Institution who are working in the area. The aims of the PCE UAE Interim Committee are to move towards unification of the Engineering Profession, to provide a basis for more viable activities within the Emirates and to establish a sounder basis for education, training and CPD activities. The Committee also wishes to establish a body to which members of Institutions having few members in the Emirates could belong and help raise the profile and status of all Chartered Engineers and other registrants and to continue to contribute to the development of the host country. Mr Macmillan can be contacted at PO Box 46621, Abu Dhabi, United Arab Emirates, Tel: (9712) 795 179 or Fax: (9712) 795 179(PC).

John Munson recently received his 35 year long service certificate from the Institution and responded magnificently to the President's request for news of members. His interest in farm machinery started while working on his uncle's farm in Buckinghamshire during the school holidays of times past. Joining a tractor dealership, he spent five years visiting farms in Essex and Suffolk repairing and selling almost every type of equipment used on the farm. It was a Ferguson tractor distributor and, in the early 1950s, the Ferguson Model TE20 was selling like hot cakes - "we just couldn't get enough of them", he said.

In 1958, he joined Ford Tractor Operations as a draughtsman in the engineering design department and stayed with Ford for 33 years, qualifying as a Chartered Engineer in 1966. His time with Ford took him to assignments in many locations in Europe and the United States. Ford's first "World Wide" tractor range was being planned in 1961, with initially only three models, 32hp, 44hp and 56hp, to be produced in the US, the UK and Belgium. The original programme, known as the 6X programme, involved 24 prototype tractors, 5000 drawings and 56,000 field test hours and he was lucky enough to be sent to the field test station at San Antonio, Texas, to receive the first prototypes for field testing in 1963.

In 1965, he was assigned to work on a Developing Nations Tractor, which proved to be a project somewhat out of the ordinary. The Ford Motor Co was aware of the need for the introduction of some form of agricultural mechanisation for the developing countries of the world. The objective was a simple two wheeled "walk behind" machine with a production cost of $100. Many were built and shipped to remote territories for test and evaluation, but the project didn't reach commercial production.

In the late 60s and early 70s when Ford first included industrial equipment into their range of products in Europe, he was assigned to a small group set up to introduce the US manufactured equipment into Europe. They started by having three assembly locations, in the UK, Belgium and Denmark using US manufactured components and later gradually changing to locally manufactured components. Later, he managed the Manufacturing Quality Control department at the Copenhagen plant after a period of auditing all three plants for manufacturing quality.

In retrospect, he feels that he has been very fortunate in seeing major changes in farm mechanisation from the 50s to the 90s. Not all changes have been for the better and the demise of so many small companies is sad to reflect on. "We've seen more buyouts, consolidations and re-organisations over this period and the trend hasn't stopped yet."

Interlaced with all of his industrial experience he has enjoyed his association with the Institution in various capacities at Branch and National level. He strongly recommends to all young engineers in the industry to use the Institution to make contact with friends across the country and beyond, who work in our industry and who can broaden knowledge with shared experiences. He concludes: "For all the benefits that I have gained from my membership of the Institution I would like to say, 'Many Thanks'".

AAWC

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INSTITUTION of AGRICULTURAL ENGINEERS, WEST END ROAD, SILSOE, BEDFORD, MK45 4DU, UNITED KINGDOM. Tel: 01525 861096 Fax: 01525 861660

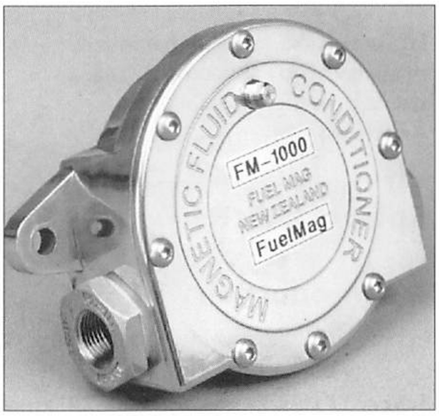
Beat the fuel bug

Misfires, power loss, fuel starvation and clogged fuel filters caused by a strange spaghetti like substance in diesel fuel is becoming more commonplace. The cause is microbiological contamination which cultivates in the diesel and often results in expensive steam cleaning of fuel lines, filters and tanks. In severe instances, permanent damage to fuel injectors, pumps and cylinder heads can occur. Until now, the only prevention and treatment of diesel contamination is by using a biocide.

Separ's new FUELmag decontamination unit will prevent biological attack and is a safe and cost-effective alternative to biocide. The unit will pay for itself in just one season. Whilst being effective against the bug, biocide manufacturers do not tell users that their products contain carcinogens (cancer causing chemicals) and, in their promotional videos, scientists wear protective clothing, gloves and respirators while treating fuel. Biocide is also expensive.

FUELmag's revolutionary new treatment process passes diesel over very strong magnets which disorientate and break down the cellular structure of the bug into single cells. The magnets disrupt the electrical balance of the cells and permanently disable them. Once broken down, the individual cells are small enough to pass through fuel filters and injectors to meet their end in the engine's combustion chamber. Remaining bugs in the return fuel flow will not re-group or multiply due to their denatured state.

The maintenance-free FUELmag is designed specifically for harsh use. Due to it's internal spiral structure, the unit is self cleaning. There are no electrical connections or moving parts. Non-corroding, high grade aluminium castings and brass connections mean that the unit will provide years of trouble-free service.



Until now, FUELmag has only been available overseas. However, units are already fitted to many overseas truck fleets, farm vehicles, commercial fishing boats, lifeboats and larger yachts. FUELmag is becoming a vital piece of equipment, gives insurance against costly bug related repairs and is available in various sizes to suit all diesel engines from 1 to 2600 kW, prices starting from £95. Separ Distribution also supply the proven Separ range of primary fuel filters and oil filtration systems.

Contact: **Separ Distribution, 428 Whippendell Road, Watford, Hertfordshire, WDI 7PT. Tel: 01923 819041.**

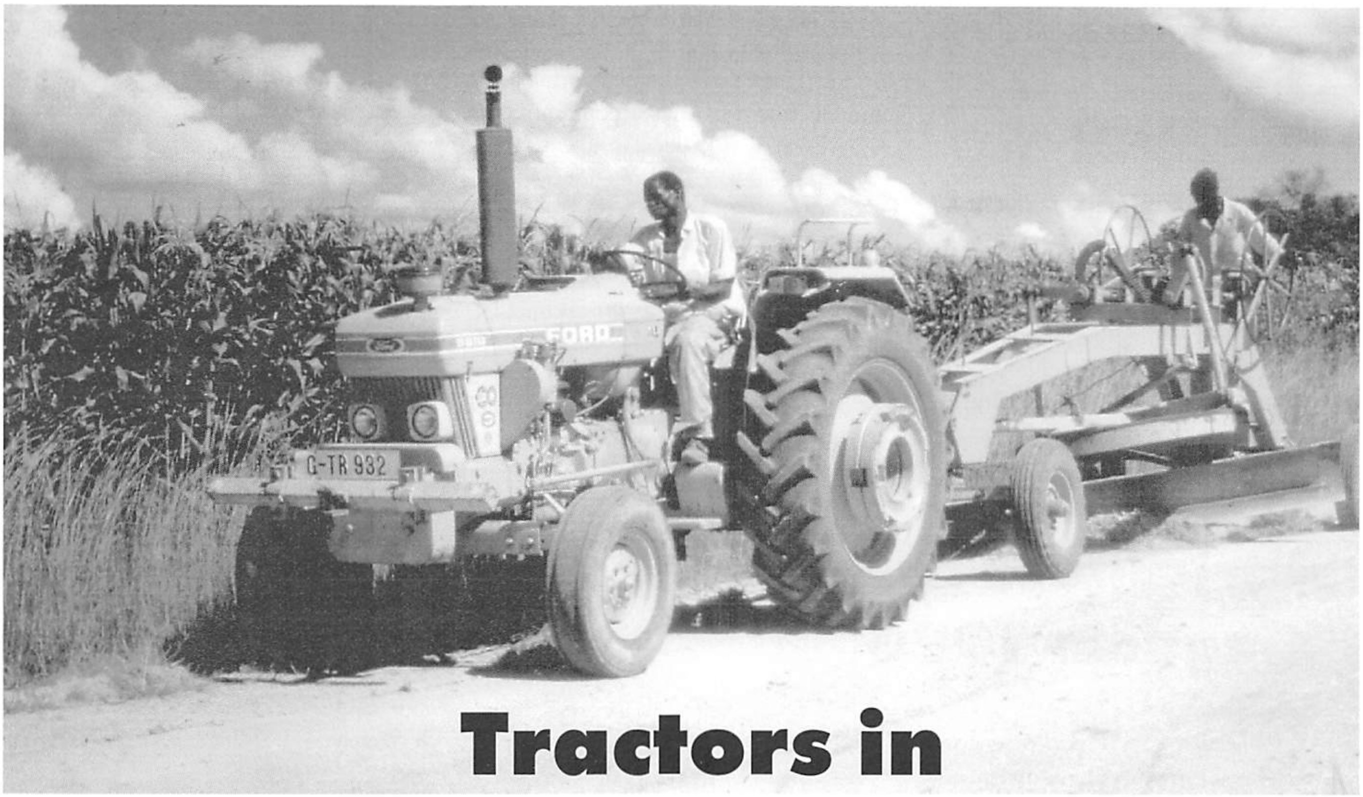
Agriculture in the United Kingdom 1996

"Agriculture in the United Kingdom 1996" is the ninth volume in an annual series which describes agricultural and environmental policy developments, reports on each of the main agricultural commodities and presents information on agricultural incomes.

The report highlights the main agricultural events last year. These included Bovine Spongiform Encephalopathy (BSE) - the Government's intensive efforts for lifting the export ban on UK beef and beef products and measures introduced to deal with the short term impact of the BSE crisis; developments on CAP reform and EU enlargement; an agreement on phasing out close confinement veal crates in the Community by 2006 and environmental policy initiatives. AUK 1996 gives full details of the Aggregate Agricultural Account for the 1996 calendar year.

- Agriculture accounted for 1.4 per cent of the UK Gross Domestic Product and 2.0 per cent of the total workforce.
- The 22,000 largest holdings in the UK accounted for roughly half of all agricultural activity.
- The UK is 53 per cent self-sufficient in all food and feed and 69 per cent self-sufficient in indigenous type food and feed.
- The values of the industry's Gross Output and Gross Input increased by 2.1 and 7.0 per cent respectively. The value of agriculture's Gross Product fell by 2.1 per cent.
- Over the year, interest rates fell slightly and the industry's interest payments were 6.6 per cent lower.
- The cost of hired labour rose by 0.9 per cent despite a slight decrease in the overall amount of time worked.
- *Total Income from Farming*, representing the total income from agriculture of farmers, partners, directors, their spouses and family workers, is estimated to have fallen by 5.4 per cent. *Farming Income,* which covers only farmers and their spouses, is estimated to have fallen by 7.3 per cent. In real terms, these changes represent decreases of 7.7 and 9.5 per cent, respectively. However, Total Income from Farming has risen by 65 per cent in real terms over the last five years.

'Agriculture in the United Kingdom 1996' (Price £ 13.00, ISBN 0 11 2430236) is available from HMSO, tel: 0171 873 9090.



Light towed grader for minor reshaping of the camber and turnoit drains (photo: Intech Associates)

Tractors in roadworks and the MART initiative

Robert C Petts

This paper reviews the role of the wheeled agricultural tractor for roadworks in economically emerging and developing countries. It considers the rationale, and range of suitable activities, for tractor applications in roadworks. The MART (Management of Appropriate Road Technology) initiative is discussed as well as its intended function in supporting the development of a sustainable roadworks sector in these countries, based on the use of appropriate technology and the private sector. This paper is based on MART Working Paper No 6 which is currently under preparation.

1. Introduction

Economically emerging and developing countries (EDCs) vary enormously in their economic, resource, industrial, service sector and social circumstances. This suggests that the technologies and methods used for road construction, rehabilitation and maintenance should also vary and be appropriate for their individual circumstances. Unfortunately, it is not always immediately obvious that the 'state-of-the-art' technologies used and taught in developed country organisations and institutions are often neither appropriate, economic nor sustainable in many other countries. What is required is an *Appropriate Technology and Management* approach.

EDCs are usually characterised by a resource base that is very different from that found in developed countries. For example, they may have abundant low cost labour (wages often less than US$5/ day) local traditions and procedures, and a fledgling or intermediate-technology industrial and service sector base (Edmonds & de Veen, 1982; Petts, 1993 & 1995). It makes economic and management sense to seek an optimal use of these lower cost, locally available resources before resorting to importing expensive (and often extremely problematic) heavy equipment and expertise on a large scale. There are also strong political and social arguments for adopting a more local-resource orientated approach *(Figure 1)*.

Robert Petts is the Principal of Intech Associates, 53 The Park, Great Bookham, Surrey, KT23 3LN; Consulting Engineers to the road management and maintenance sector. Robert is the MART Programme Manager. He is a member of the Appropriate Development Panel based at the Institution of Civil Engineers and a UK representative on the World Road Association standing committee on Technological Exchanges and Development.

LOCAL RESOURCES

These can include: human resources; local government, private, NGO and community institutions; local entrepreneurs such as contractors, industrialists and artisans; local skills; locally made or intermediate equipment; local materials such as timber, bricks, and marginal materials; locally raised finance or provision of materials or services in kind.

LABOUR BASED ROADWORKS

Operations carried out principally by manual methods. They may be supported by intermediate or sophisticated equipment for activities not ideally suited to labour methods, e.g. medium-long distance haulage, heavy compaction. Labourers usually walk or cycle to work each day from their homes.

INTERMEDIATE EQUIPMENT

Simple or intermediate equipment designed for low initial and operating costs, durability and ease of maintenance and repair in the conditions typical of a limited-resource environment, rather than for high theoretical efficiency. It is preferable if the equipment can also be manufactured or fabricated locally.

Fig. 1 Definitions and interpretations of terminology used in the appropriate technology roadworks sector.

Many problems encountered in the road sector in EDCs can be attributed to the application of inappropriate technology, as well as problems of inadequate policy guidance, insufficient funding, inadequate institutional arrangements, poor manpower development and motivation, and inadequate decision making arrangements (Anon., 1988, 1989, 1993a & 1995; Riverson *et al.*, 1991; Heggie, 1995).

This paper reviews the experience and potential role of tractor technology in the development of an appropriate and sustainable road sector in EDCs, and introduces the MART initiative.

2. Experience with tractors

The use of wheeled agricultural tractors is well established in the private and public sectors in many EDCs.

Even on many of the labour based (LB) road programmes, tractors and fixed dump body trailers are used for hauling natural gravel for the running surface of roads; with excavation, loading and unloading achieved by manual labour. Gravel road construction/rehabilitation is typically achieved for a cost of US$10,000 to 20,000 per km using tractor and labour technology, with labour wage rates of between US$1 and 3.5 per day (Edmonds & de Veen, 1991).

On conventional capital intensive road projects, wheeled agricultural tractors are normally used for tasks such as towing compaction rollers and sweeping.

Many of the LB road programmes have concentrated on road construction or rehabilitation, rather than maintenance. Furthermore, the method of implementation has focused on works management using a civil service organisation, with the notable exception of the Ghana, Lesotho and Indonesia projects (Lehobo, 1995; Stock, 1996; Miles, 1996; Beusch *et al.*, 1997). The programmes have usually concentrated on gravel roads - unpaved roads often constitute between 80% to more than 90% of national road networks in EDCs (Anon., 1988).

Despite this encouraging experience with agricultural tractors, most roadworks in EDCs are still carried out by civil service organisations or large contractors using traditional heavy equipment technology.

There is now widespread pressure, particularly from the international agencies, for a move away from implementation using the problematic civil service machinery, towards works carried out by the private sector. There is also strong argument for better use of local resources (Anon., 1988 & 1993a; Riverson *et al.*, 1991; Heggie, 1995; Stock & de Veen, 1996).

Unfortunately the road contracting sector is poorly developed in many of these countries after decades of force account road maintenance operations (a 'force account' operation is where the Road Authority carries out works using its own permanent manpower and equipment fleet). Typically, major road schemes are carried out by international contractors, a few large indigenous contractors, or a partnership of both. In the small number of countries where 'labour based' contractors have been actively encouraged, these at least have a toe hold in the market.

3. Intermediate equipment

Intermediate equipment often is, or can be, manufactured locally to meet some of the needs of the roadworks sector, thus creating local employment and wealth. It can be tractor-based, self propelled, animal drawn or hand operated. Capital costs of local manufacture can be significantly lower than imported sophisticated equipment. Other potential benefits include easier maintenance, lower operating costs and the added advantage of the local manufacturing capability (which creates local employment). This should encourage greater sustainability compared with sophisticated imported equipment (Petts, 1993a & 1993b; Petts & Jones, 1991) *(Figure 2)*.

PROBLEMS

- Dedicated function (can only be used for one operation)
- Inter-dependence (e.g. dozer, loader, trucks, motorgrader, bowser, roller all required for gravelling - what happens when ONE link in the chain breaks down?)
- All equipment and spares imported - consuming scarce foreign exchange
- Long spares supply lines and delivery times
- Limited local market for equipment sales of each model
- Few dealers able to provide the necessary close support
- High capital costs
- High costs of stocking and provision of spares
- High pressure hydraulic systems
- Sophisticated mechanisms
- Specialist repair and maintenance skills, tools and facilities required
- Frequent model 'improvements' ensuring spares stocking and procurement problems and 'planned' obsolescence
- Disposable components; difficult to repair or refurbish
- Lack of continuity of workload for plant items of dedicated function

RESULT - low availability & high overall costs!

Fig. 2 Problems often associated with sophisticated imported heavy equipment for roadworks.

Wheeled agricultural tractors are the simplest, most robust and versatile mobile power source; furthermore, the proven uses in the road sector are extensive *(Figure 3)*. Applications cover bitumen, gravel and earth roads. Even where the tractors are not manufactured or assembled locally, the attachments usually can be. Tractor technology suffers much less from the problems summarised in *Figure 2*.

Towed Earth Scraper

Light Towed Grader (Up to 3 Tonnes)

Heavy Towed Grader (Over 3 Tonnes)

Towed Drag

Towed Gravel Haulage Trailer

Towed Rubber Tyred Roller

Towed Steel Wheel Roller (deadweight/ vibrating)

Front End Loader Attachment

Ripper Attachment

Towed Accommodation/Workshop Caravans

Lime/Cement/Bitumen Stabilisation Harrows/Mixer Attachments

Towed Water Bowser/Sprayer

Towed Fuel Bowser

Towed Bitumen Heater/Distributor

Towed Bitumen Slurry Seal Mixer

Towed Concrete Mixer

Towed Compressor and Pneumatic Tools

Towed Mobile Stone Crushers and Screens

Towed Premix Manufacture Equipment

Rotary Grass Cutter

Heavy Duty Automatic Pick-up Hitch

Low Loader Trailer

Fig. 3 A substantial range of attachments can be fitted to wheeled agricultural tractors for road construction, rehabilitation and maintenance. Often only minor modifications are required, such as the fitting of a heavy duty hitch and Roll Over Protection Structure (ROPS), but the designs and fabrication need to be robust for roadworks use.

Recent experience in Kenya (Anon., 1993b) has shown that a team of three 75 kW 4wd tractors working in association with two 5 tonne heavy towed graders and a towed compaction roller and local unskilled labour can rehabilitate the camber and drainage system on earth and gravel roads for direct costs of less than US$2,000 per km. Subsequent routine maintenance can be established for between US$250 - 750 per km per year, depending on towed grading frequency.

Tractor technology offers local entrepreneurs a lower risk and more flexible investment than traditional heavy roadworks plant. The latter will require investments in specialised equipment with a new procurement cost of more than US$1 million, even for just a full regravelling capability (with high running costs to match). From as little as US$25,000, however, a contractor or subcontractor can buy into tractor technology with the versatility to carry out a range of operations and serve clients in the road, agriculture and water sectors *(Figure 4)*. An extensive roadworks, water and agricultural sector capability using tractor technology can be achieved with an investment of less than US$ 300,000. This substantially reduces the risks and increases business opportunities compared to a 'one client' relationship using single function items of plant.

Tractor technology also creates a natural development path for successful pure-labour contractors (who can be established for capital sums of about US$10,000) who come up against the management constraints of large unskilled labour forces.

4. Paved road potential

Wheeled agricultural tractors have been used independently for all of the key activities required for reconstruction of a deteriorated paved road with a thin bituminous surfacing (Anon.; Petts, 1993a, 1993b & 1994; Petts & Jones, 1991). There is potential for contractors to carry out these works using tractor based equipment for ripping up the existing pavement, pulverising the existing materials, applying and mixing in a stabiliser such as bitumen emulsion binder, shaping and rolling, then sealing with a conventional surface dressing *(Figure 5)*. The approach would optimise the use of the existing pavement materials, have the energy and environmental attractions of a cold, low waste process and should have capital requirements and overall costs significantly below those of traditional heavy plant, hot-mix reconstruction processes.

Fig. 4 Heavy towed grader fitted with ripper attachment for earth and gravel roads [photo: Simba International].

5. The MART initiative

The Management of Appropriate Road Technology (MART) initiative aims to reduce the costs of constructing, rehabilitating and maintaining road infrastructure, and vehicle operations in develop-

Fig. 5 Bitumen emulsion road rehabilitation using tractor technology [photo: Coles].

ing countries. It is based on a research project funded principally by the British Overseas Development Administration (ODA) under its Technology Development and Research (TDR) provision. The initiative is led by the Construction Enterprise Unit of Loughborough University's Institute of Development Engineering, in association with two UK-based specialist consultants, Intech Associates and I.T.Transport. The MART programme is currently implementing its initial 3 year programme.

Although it has started as a UK initiative, the MART partners are anxious to draw in complementary international expertise, and to work with a range of donors, consultants, organisations, research and academic institutions to support and promote appropriate construction technologies and management techniques. MART linkages have already been established with a wide variety of potential collaborators and beneficiaries.

The MART programme is concerned with supporting sustainable improvements in road construction and maintenance in developing countries. This implies the effective use of local resources, particularly human resources and readily available intermediate equipment (especially wheeled agricultural tractors and related ancillary equipment). To optimise the use of scarce financial resources, it also requires the effective mobilisation of the indigenous private sector (particularly small domestic construction enterprises), and the application of good management practices in both contracting and employing organisations.

The current phase of the MART programme will *inter alia* draw together existing expertise in labour - and intermediate equipment-based technology and the development of private construction enterprises to produce a series of guidelines on the four priority topics of:

- handtools;
- intermediate equipment;
- private sector development; and
- institution building.

The MART initiative is strongly research-based, and both the ODA and the MART partners see its main impact as providing analysis and codification to support practical project initiatives. Thus much of the output will be in the form of journal papers and other formal publications suitable as reference material and providing an independent and reliable record of the advancing state of the art.

MART welcomes dialogue with engineers, equipment designers and manufacturers regarding designs, products or experience of intermediate equipment with the objective of the promotion of a sustainable road sector technology and management approach for EDCs.

6. Conclusions

The wheeled agricultural tractor is a proven technology for a wide range of roadworks in economically emerging and developing countries; however, the application and benefits of tractor technology are not widely recognised or utilised. The tractor approach has particular benefits for smaller contracting enterprises with respect to lower capital requirements and risks, and flexibility of operations and clients in various sectors. Better understanding of the capabilities, flexibility and advantages of this technology is necessary, particularly by the engineers, contractors and suppliers of tractor based equipment. Where necessary, contract procedures and documentation need to be adapted to accommodate the use of local contractors and appropriate technology. The MART initiative is assisting in these endeavours by codifying and disseminating the experiences and potential of intermediate equipment technology.

Acknowledgements

Material for this paper has been assembled from assignments and colleagues working in the appropriate technology roadworks sector in Africa, Asia and the Pacific, as well as available reference documentation. Important cooperation from engineers and other personnel in the road authorities in these countries has been supported by a number of agencies and organisations including ODA, BPWA, CIDA, DANIDA, DGIS, EU, Helvetas, KfW, NORAD, SDC, SIDA, USAID, ILO, TRL and the World Bank. The author wishes to acknowledge the cooperation and support received from these individuals and organisations.

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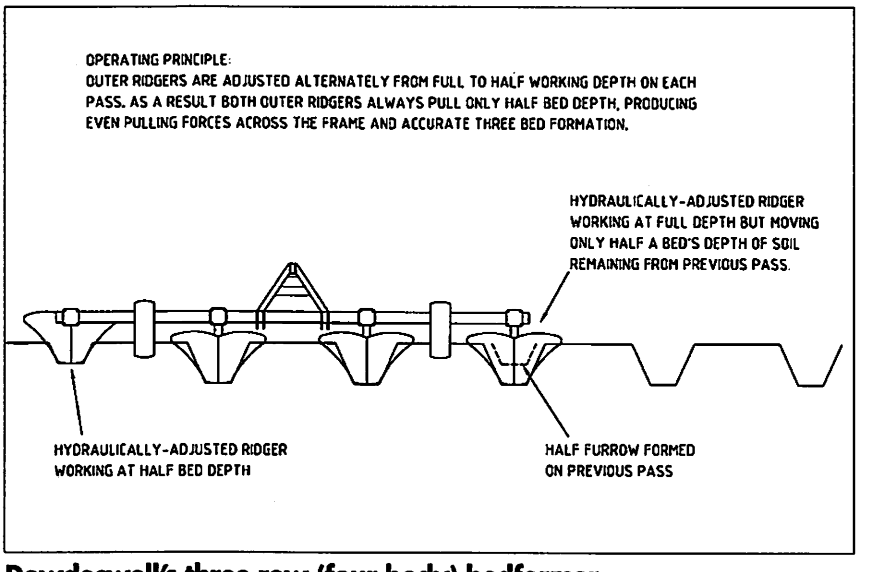
Latest three-row bedformer boosts workrates and planting accuracy

A novel three-row bedformer designed to improve workrates and encourage more accurate planting and improved establishment of vegetable and potato crops has been introduced by Dowdeswell Engineering.

Available in fixed and folding versions, the bedformer has been developed primarily for work ahead of three-row planters. By producing uniform seedbeds, with all three beds spaced equidistant from each other, the bedformer ensures that the following three-row planter places seed accurately and in the same position within each bed for optimum germination and crop growth. This is not guaranteed when using a three-row planter on beds formed with a two-row implement.

Equipped with four sideways-adjustable ridging bodies, Dowdeswell's three-row bedformer is able to form beds in widths ranging from 1.8 to 2.0 m centre to centre. To minimise stress and promote equal pulling forces across the frame, the bedformer's two outer ridging bodies are hydraulically adjustable up and down from full to half working depth. By working them alternately at half depth and then at full depth on each subsequent pass across the field, the outer ridgers never move more than half a bed's depth of soil per pass, maintaining even draught forces across the frame to help keep the implement and tractor moving in a straight line.



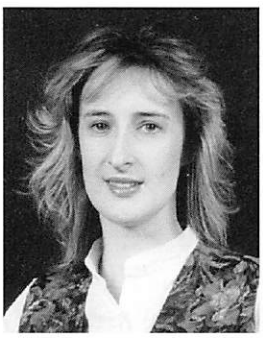
Dowdeswell's three row (four body) bedformer.

Options available for the new Dowdeswell three-row bedformers include shearbolt or auto-reset ridging bodies, hydraulic markers and subsoilers. Suitable for use with tractors of 112 kW-plus with category 2 or 3 linkage, the Dowdeswell fixed and folding frame bedformers cost from £6,186 and £7,300, respectively.

Contact: **Michael Alsop, UK Sales Manager, Dowdeswell Engineering Co Ltd, Blue Lias Works, Stockton, Nr Rugby, Warwickshire CV23 8LD. Tel: 01926 812335.**

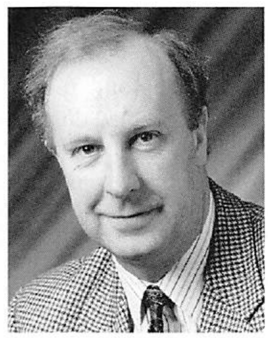
Profitability of traffic systems for arable crops in Scottish soils

Leonie E D Stewart, Thomas A Copland and John W Dickson



Leonie Stewart

Tom Copland



Ian Dickson

Introduction

The substitution of labour by mechanisation has meant that tractors and equipment have grown in terms of both physical size and power. Total tractor power in the UK has almost doubled between 1972 and 1989 (Cracknell, 1994/5) with the average tractor size increasing from 32 kW to 53 kW. This trend, and the associated reliance on agrochemicals in intensive crop and animal systems, questions the sustainability of such agricultural systems.

This paper was presented at the IAgrE conference entitles: "Profit through Controlled Traffic?", organised by the Soil & Water Specialist Group and held at Silsoe College, Cranfield University on 20th November 1996. Leonie Stewart is in the Rural Resource Management, Tom Copland is Head of the Resource Engineering Department, and Ian Dickson is in the Soils Department, and all are members of the staff of SAC, West Mains Rd, Edinburgh EH9 3JG.

A project was undertaken to identify the impact of different traffic systems in an arable rotation on a clay loam in Scotland. The main aim of the project was to minimise soil compaction and to quantify soil and crop responses under two novel traffic systems, namely zero and reduced ground pressure (RGP) compared with the conventional system. A secondary aim was to assess the effects of reduced fertiliser applications under the three systems. The soil and crop responses and cultivation power requirements have already been analysed (Dickson & Ritchie, 1996a, b).

The aim of this report was to assess the financial implications of these systems. The objectives of this analysis were to:-

- calculate a gross margin per hectare for each traffic system
- calculate annual costs for each machinery system
- produce a net margin on a whole enterprise basis
- identify the most profitable traffic system.

Experimental data was collected over a five season period from field plots in an arable rotation of potatoes, spring and winter barley and spring oilseed rape. Three fertiliser rates were used in each crop which were 100 per cent of the recommended rate as well as reductions to 80 and 60 per cent.

The financial analysis produced a model in three parts. Part one gave gross margin data for comparison across traffic and fertiliser systems on a per hectare basis. In part two, annual ownership costs of the three machinery systems were calculated. These costs were then used in part three to give a net margin for each crop enterprise.

Model Methodology

Part One

A financial analysis to compare the profitability of each traffic system under the various fertiliser regimes was carried out using the Gross Margin concept. Gross Margin (GM) is defined as Enterprise Output less Variable Costs. Enterprise output in this case was assumed to be the total value of the crop produced as if sold. Variable Costs are defined as those costs which can be readily allocated to the specific enterprise and which vary in proportion to changes in the scale of the enterprise.

Enterprise output in the spring and winter barley and oilseed rape crops was based on the yield data collected from the plots and historical price information. The straw was chopped and incorporated. After harvesting, the total yield of the potatoes was sieved to find the marketable yield based on standard ware specifications. The remainder was assumed to be stockfeed. Any differences in the

Table 1 Indexed averages of Gross Margins.

Traffic System	Indexed averages of Gross Margins											
	Spring Barley			Winter Barley			Potatoes			OSR		
	Fertiliser rate, %			Fertiliser rate, %			Fertiliser rate, %			Fertiliser rate, %		
	60	80	100	60	80	100	60	80	100	60	80	100
Conv	62	81	100	67	89	100	61	91	100	95	77	100
RGP	70	88	102	75	92	103	73	87	106	63	55	90
Zero	84	115	122	100	141	153	73	88	101	131	178	129
	100 = £405/ha			100 = £216/ha			100 = £1775/ha			100 = £164/ha		

(100 = the GM of the conventional system at 100 per cent fertiliser rate).

quality of the marketable potato yield were ignored in the model for all three traffic systems. The fertiliser, seed and spray costs were calculated from the application rates and historical cost information. Average casual labour and contract costs were used in the potato GM (Chadwick, 1990-95). Other crop expenses were set at £3/ha to cover any other minor items. Average historical prices were used because it was thought to be sufficiently accurate based on the fact that there is tremendous variability within and between years at the farm level.

Average gross margins were then calculated for each traffic system based on the recorded numbers of crop years. These average GMs were then indexed to the conventional system with the 100 per cent fertiliser rate as a base value of 100. This enabled a comparison of the overall profitability of the two novel systems to the conventional system.

Part Two

The annual ownership costs of the conventional, reduced ground pressure and zero traffic (gantry) systems were calculated as detailed below.

The experimental work was undertaken with equipment typical of the 1980s, with chisel ploughing for primary cultivations and power cultivators for secondary cultivations, separate drilling operations and rolling. The costing model included direct labour associated with all operations and assumed a modern mouldboard plough, one-pass system with subsequent rolling. This precluded the use, at this stage, of the operational fuel consumption data from the experimental work.

Machinery costs were based on sets of matched equipment sized to suit four arable areas of 100-250 hectares in 50 hectare steps. The present annual ownership costs were calculated to take account of inflation and discounting to give for each machine an equal annual cost during the planned period of ownership (Witney, 1995). The repair and maintenance costs were based on the ASAE models and, like the depreciation and interest charges, use current list prices of the machines (ASAE, 1993; Chadwick, 1996). The current list prices do not make allowance for the present commercial practice of heavy discounting on new machines which may be as high as 15-25 per cent (Yule, 1995). The depreciation and interest charges calculated may therefore be slightly high, but affect equally all machines in the study.

Table 2 Machinery costs.

Traffic system	Machinery costs, £/ha				
	Potatoes	Cereals			
	50 ha	100 ha	150 ha	200 ha	250 ha
Conv	747	221	188	162	154
RGP	777	229	201	172	163
Zero/gantry 75 kW	717	290	213	181	169

Tyre equipment for reduced ground pressure was assumed to cost £5000 extra for 75 kW and 100kW tractors. Conventional combines with straw choppers with 1.32 m and 1.58 m wide drums were selected for the cost model (Yule *et al.*, 1988). No cost was allocated against baling and transport of straw and grain.

The repair and maintenance and fuel costs calculated for the gantry are based on the ASAE repair and maintenance coefficients and fuel use for an equivalent 2WD tractor of equal power. Depreciation and interest charges reflected the additional costs of the 12 m gantry versus a 2WD tractor. Implement costs are assumed to be equal to those used with conventional tractors (Dowler, 1996).

The potato costs were based on the actual systems used in the experiment. Materials handling costs were based on the use of three formerly high-use tractors of 52 kW kept till 12 years old. Trailers were base model six tonne units costed over 10 years. Current models of harvesters and destoners were selected as typical Scottish potato growers' equipment (Langley, 1996). The gantry did all field operations for zero traffic except at harvest when the conventional tractors and trailers were included in the model for transport.

To simplify the analysis, machine capacity is assumed not to incur additional timeliness costs. This does not fully represent our field experience where the soil can dry more quickly, allowing field operations to commence occasionally a day or two earlier for zero traffic compared with either RGP or conventional traffic systems.

Part Three

The third part of the analysis was to assess whether the increase in yield of the crops grown under the RGP and the zero traffic system would cover the higher machinery costs. The Net Margin was calculated for each system. Net Margin is defined as the Gross Margin of an enterprise less some allocatable fixed costs. In this case, only the machinery and associated labour costs were allocated. Net Margin was an appropriate measure for this analysis as it suits comparison of whole enterprises better than per hectare (or unit) (Giles, 1986). Although in some cases a machine can be specifically allocated to an enterprise, in general, machinery costs do not vary much with small

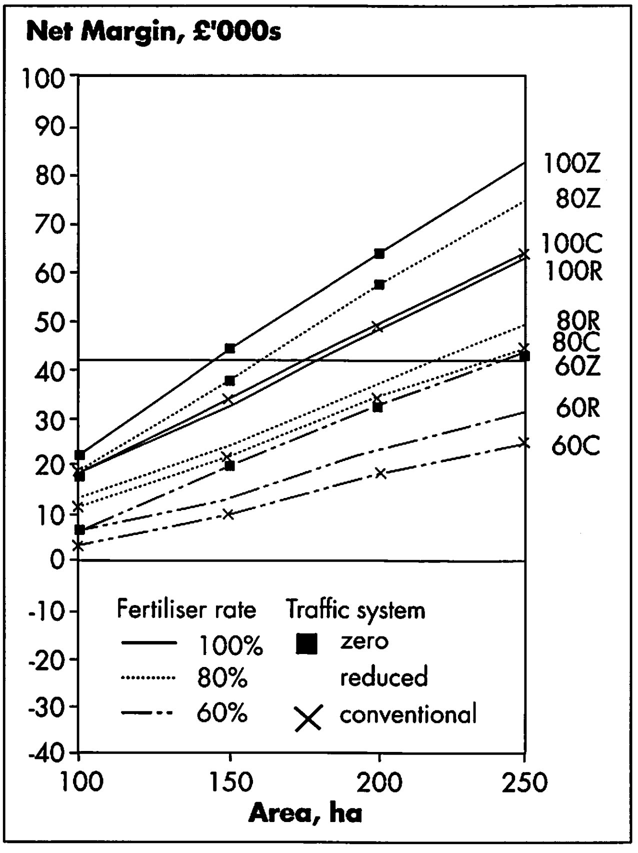


Fig. 1 Net margins for spring barley.

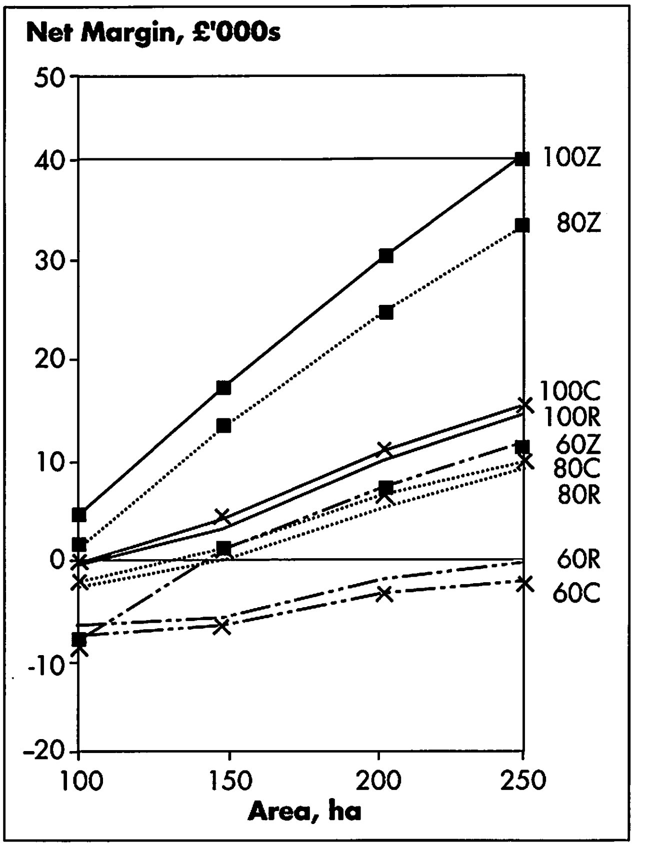


Fig. 2 Net Margins for winter barley.

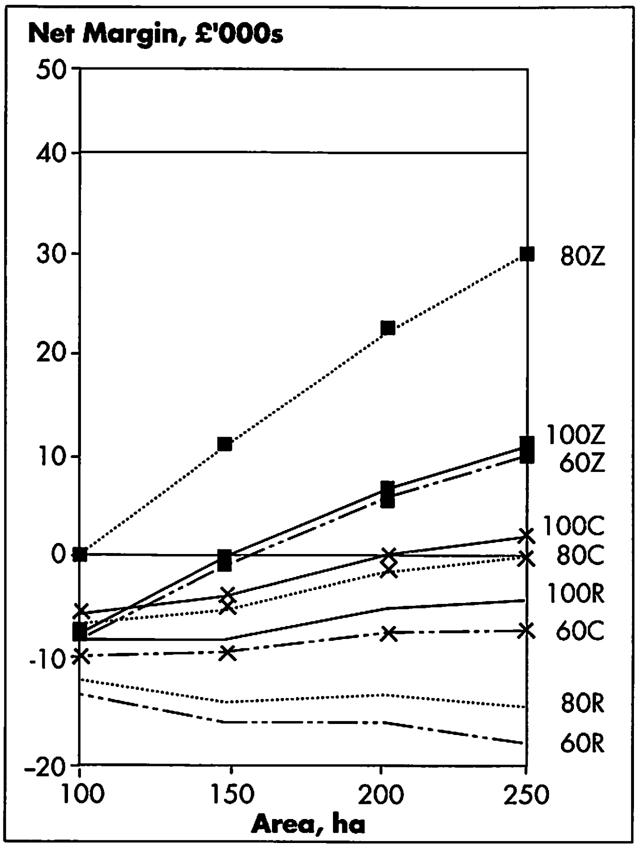


Fig. 3 Net Margins for oilseed rape.

changes in the enterprise. Therefore, it is more useful to look at allocatable costs by enterprise.

Each cereal enterprise was assumed to comprise a block based on the four areas of 100-250 hectares in 50 hectare steps as above. Potatoes were treated as a separate 50 hectare block.

Results

Results - Part One

Effects of the traffic systems

If the average gross margins across all years and all fertiliser rates are compared, the zero system has the highest GM in all four crops. The zero traffic spring barley GM (£459/ha) is 19 per cent more than the RGP GM and 23 per cent higher than the conventional GM. The winter barley suffered from several bad springs and did not fair well. This was reflected in the zero traffic winter barley GM (£284/ha), which was nevertheless 32 per cent more than for RGP and 35 per cent higher than for conventional.

In potatoes, if all four years are considered the rank order decreases from zero traffic (GM £1667/ha), followed by RGP (GM £1647/ha) and conventional (GM £1584/ha). However, the variability of GM across years within a traffic system was greater than these average GM differences.

In the oilseed rape, there was only yield data for two years. The zero system oilseed rape GM (£238/ha) was significantly higher than for the conventional (42%) and the RGP (53%). The GM is low because it was calculated without arable area payments.

Effects of fertiliser across traffic systems

The overall effect on the GM of lowering the fertiliser rate was also analysed. *Table 1* shows the indices of the average gross margins at all fertiliser rates.

In the spring barley and the winter barley, the zero traffic system at both the

80 and 100 per cent fertiliser rates had a higher GM than the conventional at 100 per cent fertiliser rate. The RGP GM in spring and winter barley at 100 per cent fertiliser rate was similar to GM for the conventional. In the oilseed rape, the zero traffic system GM was higher than conventional at all fertiliser rates. The RGP GM was slightly lower than the conventional systems at all fertiliser levels. In the potatoes, lowering the fertiliser application had a much greater impact on the GM than the traffic systems, mainly due to the reduction in output and to a lesser extent by the lower fertiliser costs.

Results - Part Two

The results of the machinery costings that were used in the analysis in part three are given in *Table 2*. These are calculated in £/ha for a whole farm with equal spring barley and winter barley enterprises. The potatoes were calculated as a separate 50 ha area. In the cereals, the costings were based on a 75 kW tractor at 100 hectares and a 100 kW tractor at 150 - 250 hectares.

In the potatoes, the higher machinery costs should be allocated specifically to the potatoes because it unrealistically biases the on-farm costs for the cereals. By using 50 ha the machinery is essentially fully allocated. In potatoes, the zero traffic costs are lower than those for the RGP and conventional systems because there is one less pass of a rotaspike and no requirement for clod separation.

Results - Part Three

The machinery costs were allocated to their appropriate GM. The 100 ha areas used the 75 kW tractor and machinery costs per hectare in the RGP and conventional systems. The zero gantry system was rated at 75 kW over all areas. Net Margins for spring and winter barley and oilseed rape are shown in *Figures 1, 2 and 3*, respectively.

In the spring barley, the Net Margins, in all scenarios, were positive. With conventional traffic, the Net Margin range from £3,068 at 100 hectares to £24,419 at 250 hectares, at the 60 per cent fertiliser rate. At 100 per cent fertiliser, the Net Margin for the spring barley with zero traffic range from £20,953 at 100 hectares to £82,632 at 250 hectares. The rate of increase in Net Margin with area for the zero traffic system is greater than for the other two traffic systems at the 80 and 100 per cent fertiliser rates. The performances of the Net Margin in the RGP and conventional systems were similar at the 100 per cent fertiliser rate, with a slight advantage in the RGP system at the 80 and 60 per cent fertiliser rates.

In the winter barley, Net Margins were uncharacteristically much lower with some negative results but the rank order of the Net Margins was similar to that in spring barley. With zero traffic, the Net Margin at both 80 and 100 per cent fertiliser rates is positive over all areas. Both also exceed the conventional and RGP Net Margins at 100 per cent fertiliser rate.

In the oilseed rape crop the majority of Net Margins were negative but again the rank order of profitability was similar to those in both barley crops. In the enterprises with 60 and 80 per cent fertiliser applications with RGP traffic the Net Margins decrease because the allocatable machinery costs increase at a rate greater than the increase in the associated gross margins. This would not happen if the arable area payments had been included.

In the potato crop, a comparison of Net Margin for each traffic system showed virtually no differences. However, fertiliser rates dominated the sensitivity of Net Margin for a 50 ha area, which was a reflection of the extreme care taken to produce similar good quality soil for seedbed and ridge formation in all three traffic systems.

In terms of soil and crop sustainability, in Scottish soil and climatic conditions, the results indicate that Net Margins in the spring and winter barley and oilseed rape crops can be maintained to at least those in the conventional traffic system where 100 per cent fertiliser rates are given by altering the traffic system to eliminate wheels from the growing areas with a reduction of nitrogen fertilisers by 20 per cent. There are indicators that the RGP systems would have to operate at the same 100 per cent fertiliser rate and may make only a few small increases in the Net Margin for these three crops.

Conclusions

- The average spring and winter barley and the oilseed rape Gross Margins for the zero traffic system were higher at all fertiliser rates than the RGP and conventional systems.
- In the potatoes, there were no traffic system effects on the Gross Margins.
- The spring barley Net Margins were positive at all fertiliser rates and enterprise areas under the three traffic systems.
- At each fertiliser rate, the zero traffic system produced the highest Net Margin in all crops except potatoes.
- Yield and Net Margins of cereals were greater at the lower fertiliser rates for the reduced ground pressure compared with the conventional traffic system.

Acknowledgement

This work was funded by the Scottish Office Agriculture, Environment and Fisheries Department.

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Book reviews

Soil and water management systems

4th Edition
by Glenn O. Schwab, D.D. Fangmeier and W.J. Elliot
Publisher: John Wiley & Sons, Inc
ISBN 0-471-10973-8
Price: £26.95

This is the 4th edition of "Elementary Soil and Water Engineering" which is aimed primarily at instruction for students. The new title reflects a more systematic approach to the solving of soil and water problems related to agriculture, natural resources and environmental sciences. The text includes material on the management and design of soil and water conservation practices. It also considers surveying practices and their applications to practical problems.

The first chapter deals with the broad issues of population, pollution and land use. The following four chapters cover surveying and satellite and computer mapping systems. Chapter five introduces rainfall and runoff whilst chapters six to nine include channel and upland erosion and control practices. Water storage and supply are discussed in chapters ten and eleven. The following seven chapters cover aspects of surface and subsurface irrigation and drainage systems. Finally there is a section on water measurement techniques.

It has been my privilege over several years of reviewing for our Journal to consider several of the works of Glen Schwab and his co authors. They are of the highest quality in both content and presentation. So much so that they are usually regarded as "Standard Works" within the discipline of soil and water engineering.

This new addition falls into the same mould. The authors suggest the purpose of the book is to "present up-to-date information gathered through experience and research, in a simplified form that will be useful to the beginning student of soil and water engineering". In my view they surpass their aims; well done - another excellent text.

MJH

Modern Tractors (A Photographic Collection)

by Stephen Richmond and Jonathan Whitlam
Publisher: Farming Press
ISBN 0-85236 - 348 - 6
Price: £16.95 (hardback)

As readers of our reviews will have come to realise, books on vintage tractors have become immensely popular. This volume is an attempt to interest younger readers by concentrating on more recent models.

Basically it is, as suggested, a collection of over two hundred pictures taken by the authors.

There is, accompanying each photograph, a caption giving some technical information. This is essentially very brief as the book aims to entertain visually rather than through the written word.

As always with Farming Press productions of this type, it is very well presented with a good back up index.

For those who would like an information picture gallery of the modern power unit, it should make an excellent present.

MJH

Solar sensors

ELE International, a leading world supplier of environmental and agricultural monitoring equipment, has launched a new range of solar sensors designed for use in a variety of monitoring applications. Based on the respected Didcot range, the new solar sensors are accurate and reliable, and have already been used in applications as diverse as the depths of the North Sea and the heat of the Arabian desert.

The new ELE range of instruments includes net radiometers, albedometers, solarimeters and PAR (Photosynthetically Active Radiation) sensors for the effective measurement of a range of solar characteristics for meteorological, environmental and agricultural applications.

ELE's net radiometers provide direct energy measurement of the earth:sky radiation balance. The net radiometers have a wide spectral range of 0.35 to 80 μm, and operate across a temperature range of -30° to +70°C without the use of power or gas cylinders.

The basic net radiometer essentially consists of two black receiving discs, one oriented towards the sky, the other towards the earth, with a Moll thermopile being used to measure the difference in temperature between the two. The net radiometer can alternatively be supplied with a thermocouple in place of the Moll thermopile for use in low cost applications.

ELE's solarimeters provide accurate measurement of sunshine in any location throughout the year, and when used in conjunction with a datalogger, can provide measurement of the total sunshine hours available. The units have a raised rim which provides low angle cosine correction, while holes in the rim allow surface water, which could otherwise affect accuracy, to drain away.

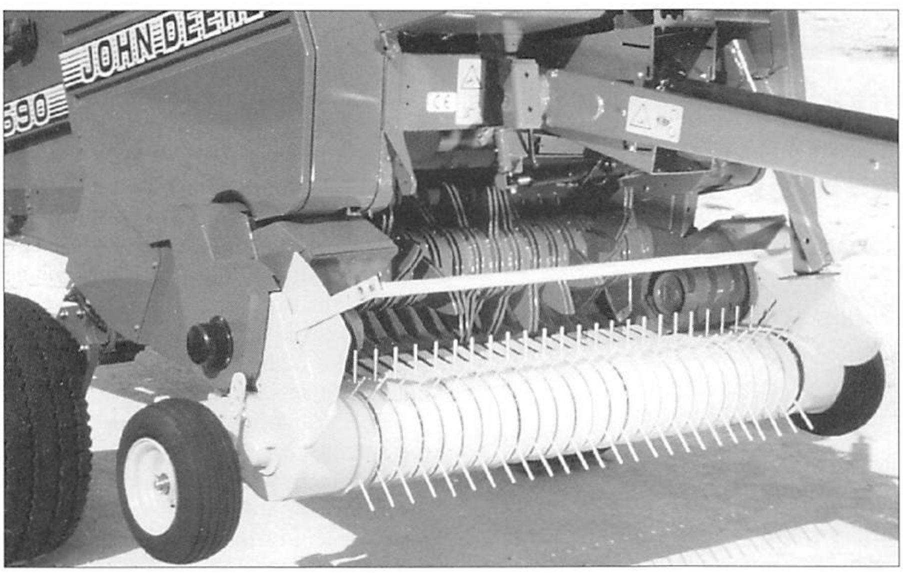
The solarimeters are available in a number of different configurations, for example one model responds solely to the area of the spectrum which is used by plants for photosynthesis: the 400 to 700 nm waveband. Alternatively, two solarimeters con be used in combination, either to compare the amounts of direct and incident radiation, or to function as an albedometer, to measure the reflectivity and brightness of the ground cover beneath the sensor.

All sensors are supplied with a 2 m cable and connector and can work either independently, in combination with ELE's data loggers, or as part of an integrated monitoring system such as ELE's freestanding Environmental Monitoring Station.

Contact: **ELE International Ltd, Eastman Way, Hemel Hempstead, Hertfordshire, HP2 7HB. Tel: 01442 218355.**

New developments on round & square balers

John Deere's 590 variable chamber round baler is now optionally available for 1997 with a 2 m pickup and precutter mechanism, featuring a new choice of knife positions for standard or high performance. This is the same precutter unit previously introduced on the company's first ever fixed chamber round baler, the 575, and added last year as an option to the 580 variable chamber model.



New 590C variable chamber round baler with 2 m pickup and precutter.

Suitable for making high density silage or straw bales which can be easily broken up for feeding or bedding, the new 590C produces 1.17 m wide bales from 0.6 to 1.8 m in diameter. During operation, a feed rotor grabs the crop, and pushes it across a set of 14 knives into the bale chamber. The knives are individually spring mounted to retract in case of obstruction, and the feed rotor can be reversed from the tractor cab.

There is now a choice of two working positions for the cutting knives. One provides maximum cutting performance, while the other is a more standard setting and requires less power in operation. The knives can be switched from one position to the other simply by relocating the lower pivot shaft by hand, which only takes a few seconds. There is a third 'home' position which allows the baler to be operated without using the precutter.

The choice of knife positions is available as a standard feature on all three precutter models in the John Deere round baler range. Price of the new 590C with 2 m pickup and precutter is £24,370.

575 round baler

John Deere's fixed chamber round baler, the 575, is now available in two versions - the existing model, with 2 m pickup, precutter and optional front-mounted netwrapping, has been joined by a new, standard machine with narrow 1.41 m pickup only.

Designed to produce round bales measuring 1.17 m wide by 1.25 m in diameter, the 575 standard baler requires a tractor developing 37 kW at the pto for operation. It includes an electronic twine wrapping control monitor, which fits in the tractor cab.

Pickup height is adjusted manually, or by using the optional hydraulic lift. The pickup unit features a stripper diameter of 425 mm to lift the windrow into the machine without the assistance of an extra transport roller.

Price of the John Deere 575 standard round baler with 1.4 m pickup is £14,435. In addition, the 575 round baler with 2 m pickup and precutter will be offered for 1997 in a net only version without twine wrapping, for customers working exclusively with netwrapping. Price is £22,618 fully equipped, less £1440 for the twine only version or less £791 for the net only model.

Large square balers

Several optional features have been added to the John Deere 680 and 690 high-capacity large square balers for the 1997 season. The new Multi-Cut precutter mechanism allows length of cut to be selected to produce the optimum bale quality required by the customer. On the 680 model, the number of knives used can be set at 0, 3, 8 or 13, while on the 690 the choice is 0, 5, 12 or 23, producing a minimum theoretical cut length of 50 mm. There is also a new hydraulically controlled bale roller ramp which allows faster, easier bale ejection and folds up conveniently for transport.

Model 680 produces 80 cm wide x 80 cm high bales, and model 690 1.2 m x 80 cm bales, with bale length adjustable from 1 to 2.5 m, to match the different loading capacities of trailers and transporters.

Both models can handle all crops, including silage, and require a tractor of 75 kW or 78 kW at 1000 rpm pto speed for operation. Basic price of the John Deere 680 large square baler is £54,896, or £62,746 with the Multi-Cut precutter; the 690 costs £64,046, or £72,046 equipped with Multi-Cut; the bale roller ramp adds a further £839.

Contact: **John Gilbert, John Deere Ltd, Langar, Nottingham NG13 9HT. Tel: 01949 860491.**

Front-mounted implement doubles as cultivator-packer and plough press

A new version of the Franquet 'Synchrolab' furrow press/cultivator has been developed to suit UK ploughing and cultivation practices at the suggestion of the French manufacturer's GB agent Anglia Imports, North Walsham, Norfolk.

Like the original Synchrolab, the new design has coil packers mounted on wing frames carried on the front of a tractor. Each wing is used in turn to consolidate ground ploughed on the previous pass. But instead of adding a centre section to create a full-width cultivator, the Synchrolab II has coil sections that can be repositioned on the frame to work side by side and match 3 m to 6 m seed drills and combination units.

"It takes just a few minutes to release a couple of retaining pins and manoeuvre the tractor to re-mount the coil sections side by side," explains Alistair Paterson of Anglia Imports. "The implement can then be used as a full-width press or packer ahead of a seed drill or other cultivation equipment."

The Franquet Synchrolab II comes in four sizes, with either 1.5 m, 2 m, 2.5 m or 3 m twin coil packers. The smallest size will work as a plough press in front of a four- to five-furrow plough or as a 3 m wide cultivator, while the biggest version will work with seven- to eight-furrow ploughs or as a 6 m cultivator. The middle sizes suit four- to five-furrow and six- to seven-furrow ploughs respectively, and work as 4 m and 5 m full-width cultivators.

"Many farms use front-mounted cultivators to combine final seedbed preparation with drilling, and many also like the transport and operational convenience of using tractor-mounted front furrow presses," says Alistair Paterson. "With the Synchrolab II they have both implements in one while using a standard front linkage - like Franquet's Trim design - without needing extra brackets or supports."

The implement features Franquet's unique Synchrospire coil packer design which comprises two close-spaced coils positioned so that the steel hoops interlock. Each coil keeps the other free of soil when working in sticky conditions, so there is no need for scrapers or cleaning chains, and the effective spacing of the hoops is halved which intensifies the clod crushing, surface consolidation and soil levelling action.

Drive chains connect the axles of the two coils to prevent the hoops rubbing against each other. Two or three rows of spring tines can be added in front of the coils to increase the activity of the implement when being used as a cultivator.

Principal advantages of the Synchrolab II tractor-mounted furrow press, compared with a conventional press pulled by the plough, include the lack of 'crabbing' forces and the fact that two ploughing tractors can work in tandem without getting in each other's way. The tractor-mounted design is also more easily worked around field obstacles such as trees and telegraph poles, and more convenient to transport between fields.

Buyers also get two implements in one - furrow press and front packer. Prices range from £6495 for a 3 m Synchrolab II (plus £1220 for optional cultivator tines) to £7950 (plus £1985) for the 6 m version.

Contact: **Alistair Paterson, Anglia Imports Ltd, Folgate Road, North Walsham, Norfolk NR28 OAN. Tel: 01692 407233.**

New portable tachometer

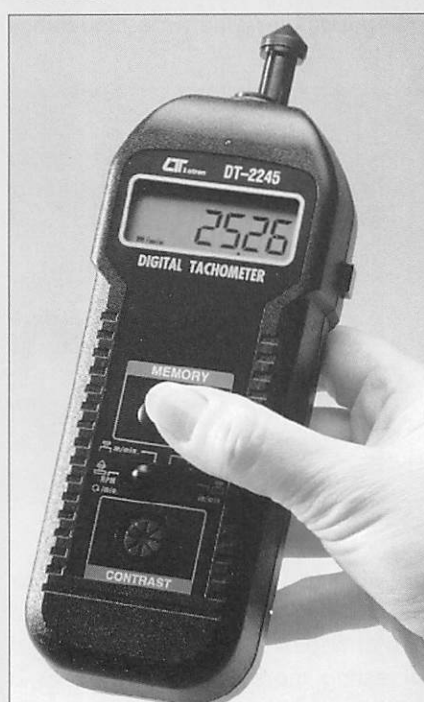
The Model DT-2245 is a new low cost contact type hand held tachometer specifically designed for the accurate measurement of both rotational and linear speeds with a single instrument.

The unit utilises a circuit design involving the use of a single exclusive LSI chip, resulting in a low cost but very accurate instrument. Readings are presented on a liquid crystal display with 7 mm high characters. The measuring range is 5 - 99,999 rpm to an accuracy of ± 1 rpm. Both metric and imperial linear speeds can be measured up to 3289 ft/min or 999.9 m/min.

Power is derived from four AA size alkaline batteries, giving an operating life in excess of 24 months in normal use.

Housed in a strong durable ABS plastic case, and supplied with all operating accessories, the DT-2245 is a robust long life tool for all general purpose speed measuring requirements throughout industry and commerce.

Contact: **Mr P D White, Graham & White Instruments Ltd, 135 Hatfield road, St Albans AL1 4LZ. Tel: 01727 861110.**



'Indestructible' high pressure washer from Checo

- Pressure washer 'burn-out' becomes a thing of the past.
- Revolutionary 'cool running pump'rewrites the rulebook.
- At last, a machine that can cope with abuse and misuse.

Ask anyone who has ever used a high pressure washer and knows how long it will last if you accidentally leave it running on bypass or, even worse, running dry (without water to cool the pump). They'll say the machine will last 10 to 15 minutes maximum before seals burn out and cause the pistons to overheat and crack. This damage incurs substantial repair costs and up to 3 days in 'down time' while repairs are carried out.

The new Checo PROSHOT has already run for an incredible 32 consecutive hours on bypass and over 3 hours on 'dry' during a rigorous 6 day test programme.

The revolutionary pressure washer has an advanced new design which allows it to stand upright for easy storage. It has an integral plastic detergent tank and is powerful, portable and lightweight. Electrically driven and delivering to 160 bar, it's components all meet stringent British Safety Standards. However, the key reason for high levels of interest in the PROSHOT from right across the industrial spectrum is the incredible durability which saves on repair and maintenance costs.

Contact: **Philip Lund, Checo Ltd, New Kensington Court, Hallam Fields Road West, Ilkeston, Derbyshire DE7 4BL. Tel: 0115 9307217.**

New 10 metre wide Claas tedder

The new Claas Volto 1050H tedder has a working width of 10 metres, putting it amongst the widest machines available for this type of work. For contractors, this means being able to keep ahead of a self-propelled forager harvesting more than 40 hectares a day.

Attached to the tractor via the lower linkage, this trailed machine has a Claas patented folding system and a centre pair of wheels, fitted with 20.5 x 8-10 tyres, that double as transport wheels. Raised and lowered hydraulically into transport and work positions, these dual function wheels eliminate the need for dedicated transport wheels and the additional weight disadvantages that they bring. The three wheels on either side of the centre pair are fitted with 16 x 6.50 super flotation tyres. Folded, the machine is 2.97 m wide and 2.90 m high. A low centre of gravity makes it easy to handle on the road.

The height of the rotors is set by adjusting a contour following wheel fitted close to the attachment points. With the tractor's hydraulics in floating operation, the machine matches itself to ground contours independently of the tractor.

The 1050 differs from other models in the Volto range as each of the 8 rotors is fitted with 7 tine arms that give a more even spread of material. All models, however, will feature stronger tine arms with wall thickness increased by 25%, and 5 coil tines with the diameter increased from 9.5 mm to 11 mm.

The price of the Volto 1050H is £13,250.

Contact: **Roger Marshall, Sales Promotion Manager, Claas U.K. Ltd, Saxham Business Park, Bury St Edmunds, Suffolk 1P28 6QZ. Tel: 01284 763100.**

GEM launches the Emerald self-propelled sprayer

GEM Sprayers has launched a new self propelled sprayer - the Emerald - and with it a new light bright livery that will now be included right across the GEM range through to the millenium. The Emerald, sharing the same high quality specification and build as its larger stablemate, the award-winning Sapphire, is aimed at the medium sized farmer or contractor.

The machine is equipped with a 2000 litre spray tank and has boom widths up to 24 metres. Power is derived from a 76 kW liquid-cooled Deutz engine, driving a three-speed hydrostatic transmission system with front and rear axle independent torque selection for hill climbing and optimum traction. It has permanent four-wheel drive.

Selectable four-wheel steering can be switched to two-wheel option for road work. Maximum road speed is 38 km/h. In the field, re-alignment is automatic after headland turns in four-wheel steer.

GEM has introduced hydro-pneumatic suspension for optimum operator comfort and performance in the field and on the road. Easily adjustable, sliding axles give track adjustment from 1.5 to 1.8 m as standard and other width options are available. Ground clearance on standard tyres is a useful 800 mm. The clean underbelly profile can be further enhanced with an optional belly sheet. Wider, low-profile and flotation tyres can be fitted.

The new concept chassis design - unique to GEM - is stepped down between the axles to provide a low-slung main sprayer tank. This dramatically reduces the machine's centre of gravity, giving superb stability on hills.

The new boom design retains all the suspension and rugged performance characteristics of the proven 24 m gullwing boom but is considerably lighter. Hydraulic tilt for hillside correction and hydraulic folding to 12 metres is standard on all boom widths from 18 - 24 metres. All boom functions are hydraulically operated from the cab. Boom folding is flat and horizontal alongside the cab, giving unimpeded access and excellent all-round visibility on the road.

The new 2000 litre tank has an integral 200 litre clean water tank, its wide, low profile design contributing to the machine's stability and further enhanced by internal baffles. The tank is designed to drain even on steep slopes and visibility to the rear over the tank is excellent.

Optimum 50/50 weight distribution has been achieved in virtually all operating conditions, whether the booms are open or closed and the tank is empty or full. Positioning the tank centrally between the axles ensures that there is little influence on weight distribution as the tank empties. Positioning the cab forward of the front axle and the booms close behind the rear axle further contribute to the desired result.

The new cab, on anti-vibration mountings to isolate the operator from rough field conditions, has been designed for optimum operator efficiency and comfort. Large, tinted, anti-glare glass in the front and sides give virtually unrestricted vision. Full air-conditioning with forced air carbon filtration, fully adjustable, sprung, high-back seat with arm rest, lap seat belt, adjustable height and tilt steering column, complete the operator comforts. The well-insulated cab ensures a quiet working environment.

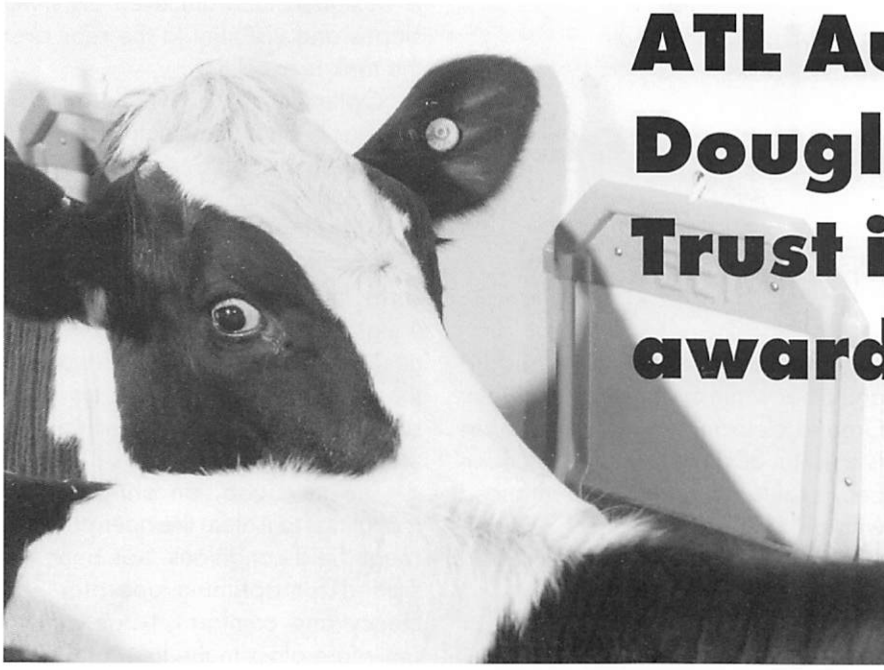
Ergonomic instrument layout with GEM-TRONIC auto dose control and GEM INFOMETER are features of the vehicle systems management.

The sprayer pack has safety features which include fully integrated clean water rinsing system, stainless steel chemical induction hopper with flushing and container rinsing, protective clothing storage and clean water hand/eye rinsing.

The de-mount system is quick, easy and safe to use, offering a load platform for disc spreaders and air drills.

The Emerald, which has undergone rigorous field testing, is priced from £47,100 with an 18 metre boom.

Contact: **Mike Would, GEM Sprayers Ltd, Station Road, North Hykeham, Lincoln LN6 9AA. Tel: 01522 500909.**



ATL Auto-ID wins Douglas Bomford Trust innovation award

When the cows line up for milking, the data embedded in the each ear tag transponder individually identifies the animal. The elegant electronics in the interface behind the identification system led to the affordable, accurate parlour control unit that won the award.

At the Institution of Agricultural Engineers Annual Convention on 13 May, the winners of the **Douglas Bomford Trust Silver Jubilee Innovation Award** were announced by Dr Mary Harris, Director General of the 'Year of Engineering Success' (YES). The YES campaign is a nationwide initiative to promote the importance and success of engineering. She said that the winners of the £10,000 first prize, ATL Agricultural Technology Limited of Kirtling, Newmarket, "were advancing cattle recognition technology at a cost that would be within the reach of the majority of dairy farmers. This is an award that would have appealed to the progressive thinking of Douglas Bomford himself."

Runners-up receiving £1000 prizes were *Farmrite Fabrications* of Kirkbymoorside for the Balebuggy, a simple, reliable and inexpensive fully self-loading and unloading round bale trailer for use with ATV's, and *Rotorflush Filters* of Dorchester for a robust self-cleaning filter for use in dirty water disposal systems.

The Balebuggy

Farmrite Fabrications are particularly known for subsoilers and countryside maintenance equipment. The Balebuggy is used mostly with ATV's but works equally well with any 4x4 vehicle. It handles wrapped silage bales without damage, is very quick and reliable in operation, and does not require any electrical or hydraulic power. It is a clever design which will find a market on many grassland forms. The Balebuggy towbar pivots at the trailer end to allow the platform to tilt vertically. Reversing the tilted platform against the bale on the ground, the bale is gripped by the arm. The ATV then moves forward with the Balebuggy wheels braked initially to pull the trailer into the horizontal transport position.

Balebuggy fitted with optional wrapped bale gripper and lights

The towbar is secured automatically in the towing position and away you go. Clearing a field fast with better ATV stability on cross slopes because of the wider wheelbase of the Balebuggy "puts the fun back into farming".

Rotorflush filter

The novel filter from Rotorflush Filters was developed by a dairy farmer to overcome problems with his own dirty water system. The filter is robust, reliable, self cleaning, and essentially maintenance-free. The action is based on recirculating some of the filtered water through rotating rubber nozzles. It offers the prospect of dirty water systems without expensive settlement tanks.

For more information on the products developed by the award winner and by the runners-up, contact:

- **Robin Sadler, ATL Agricultural Technology Limited,** Place Farm, Kirtling, Newmarket, CB8 9PA. Tel: 01638 731212. Fax: 01638 731174.
- **Jim Hosford, Rotorflush Filters,** Broompound, Moreton, Dorchester, DT2 8RL, tel/fax: 01929 462464.
- **A K Jackson, Farmrite Fabrications,** Kirby Mills Industrial Estate, Kirkbymoorside, York YO6 6NR, tel/fax: 01751 431250,

Automatic identification and parlour controls

ATL Agricultural Technology Limited are designers of electronic dairy feeding and automatic identification equipment. The Automatic ID System for cattle is based on the ATL Meridian Micro Control and the patented ATL Multiple Antenna system. It is a breakthrough in affordable accurate cow identification linked to rapid feeding and milk recording in the parlour. It can also be linked to a new out-of-parlour feeder and the Yoke-L controlled forage feeding barrier.

The ATL equipment is based on the well-established Texas Instruments Registration and Identification System (TIRIS). This employs a transmitter/receiver ("reader"), operating on long-wave radio frequency to energise a passive transponder which is electronically imprinted with a unique code. The transponders each have a tiny directional antenna to acquire their power from a magnetic field generated by the same antenna that receives the transmitted signal. As the transponders require no batteries, they are sufficiently small and lightweight to fit into eartags for livestock tracking but the high cost of one reader per antenna meant that equipping even a modest milking parlour was prohibitively expensive. A more economic possibility was to use only one antenna in the entry passage to the milking parlour, identifying each animal as the cows walked towards a number of milking points. In practice, however, the order in which the cows pass along the entry passage is not necessarily the order in which they occupy the milking stalls. This posed a design problem with no simple, inexpensive solution.

A DABS system installed in a new parlour. The antennae which power and read the ear tags are secured to the wall at each stall. Each manger pan is protected by a stall rail with the cows standing obliquely to the wall - herringbone fashion - for both milking and feeding. The high protein cake is discharged into the pans through the circular ports in the wall. The amount of feed delivered to each cow is determined by the ATL parlour control which also directs the operation of the Auto-ID system.

When ATL devised the DABS - *Dynamic Antenna Balancing and Selection* - system, automatic identification of cows became available at a greatly reduced cost. The antenna design makes it possible to register the identities of all the cows at a set of milking points. The DABS interface cleverly balances each antenna to the reader so quickly and effectively that the switch from one antenna to another is completely 'seamless'. In principle, it involves quite simple means of matching the impedance of each antenna to the reader, so that all antennae interface with the reader in exactly the same way, regardless of the distance from the reader. This makes it straightforward for the reader to register the identity of each animal at each stall, sequentially, at a rate of approximately a tenth of a second per reading.

Scanning a milking parlour is fast and efficient; the farmer no longer has to key-punch cow numbers; less time in the parlour means more time involved with the herd's wellbeing, more time for farm management and a better return on investment.

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