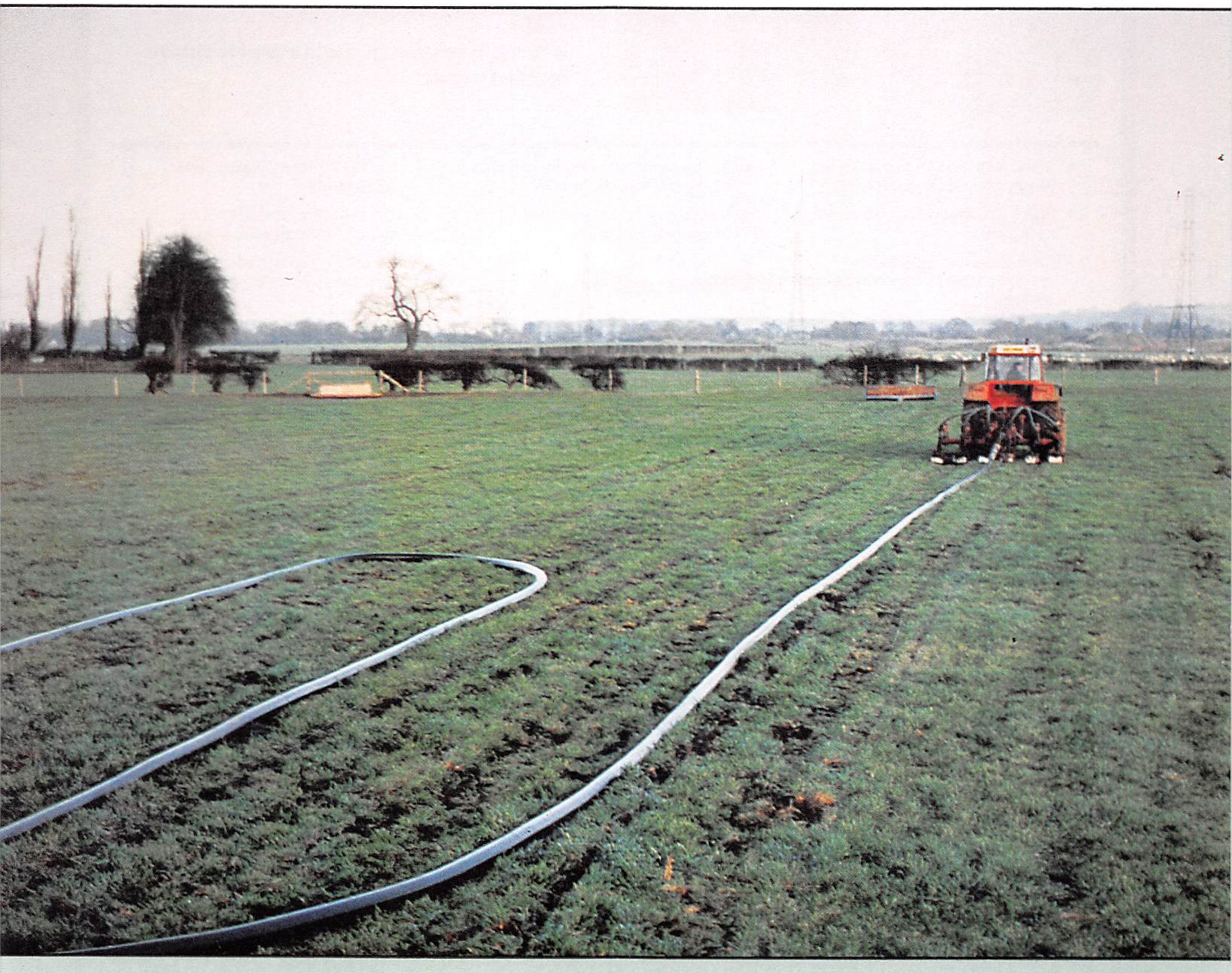
The Agricultural Engineer

Incorporating Soil and water

Volume 45 Number 2

Summer 1990



Slurry injection – systems compared

AE 45 (2)

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THE AGRICULTURAL ENGINEER incorporating Soil & Water is published quarterly by the Institution of Agricultural Engineers, West End Road, Silsoe, Bedford MK45 4DU. Tel: (0525) 61096.

Price £7.00 per copy, annual subscription £27 (post free in UK).

Front cover: Umbilical hose slurry injection *(photo* – Silsoe College, Cranfield Institute of Technology, Silsoe)

Journal and Proceedings

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ISSN 0308-5732

The Institution of Agricultural Engineers

Data for predicting the design crop loads on the walls of on-floor grain stores

P Moran

WALLDES is a computer program based on Coulomb's wedge theory which accurately predicts loads on the retaining walls of on-floor grain stores. The problems of presenting the design data produced by WALLDES in a succinct form are addressed. A typical set of design data based on properties of granular materials as given BS 5502: Part 22: 1987 are presented. Brief guidance is given on how design loads can be influenced by grain-to-wall friction, over-pressure on air tunnels and settlement of the contained materials.

Many theories have been proposed for predicting the lateral pressure which granular materials impose on a retaining wall, each differing as to the assumptions and results. The Theory of Conjugate Pressures (Rankine, 1885) and the Theory of Maximum Wedge (Coulomb, 1776) have both been extended by later workers to provide solutions which are normally considered to include all the independent variables and thus to be perfectly general. Formulæ based on wedge theory (Cain, 1904) are often given in text books and design manuals.

However, the solutions available are not perfectly general. They assume that the surface of the retained material is of infinite extent, but the surface, particularly in a grain store, is of finite extent which can terminate at a ridge or at a plateau (Fig 1). In these cases the magnitude of the active pressure on the wall is between that when the surface is level and that when the surface slopes upwards, perhaps to infinity, at the angle of repose. Furthermore, these solutions usually ignore phenomena arising from dilatancy of granular materials. Experiments (Jenkin, 1931) showed that dilatancy can have an important influence upon the force on the back of a retaining wall which has a positive batter, *i.e.* slopes away from the grain mass.

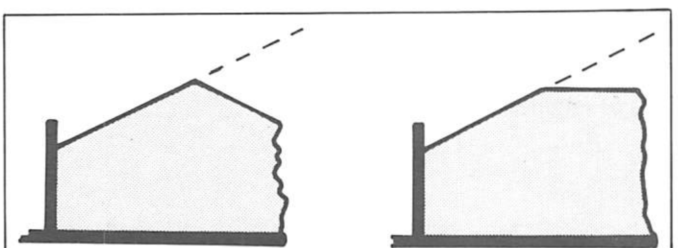

Fig 1. Walls retaining grain surcharged to a definite extent.

Empirical expressions are sometimes given, for vertical walls only, in design guides. In one designers' handbook the total pressure on the wall is increased above that for a level surface by an amount proportional to the mean increase in the head of material (Reynolds and Steedman, 1981). Møller (1983) derived such expressions from his experimental work. The total pressure is assumed to act at one third of the way up the wall. Mathematically accurate solutions for vertical walls based on classical theories are not impossible when the material surface is of definite extent or changes slope. Although analytical approaches to a solution which involve differentiating complex expressions soon get out of hand, it is possible to use Coulomb's theory and a simple graphical technique to provide individual solutions (Moran and Westgate, 1984). Unfortunately, if the back of a retaining wall has a positive batter as indicated by angle ϵ in Fig 2, a solution could be subject to Jenkin's Revised Wedge Theory and thus too complex for simple graphical techniques.

In Coulomb's Theory it is assumed that the resultant force on the wall is due to a wedge of material which tends to slip on an inclined plane of rupture within the mass of material itself. Two limiting states exist, termed "active" and "passive". In the active case the wall is deemed to move away from the wedge so that the grain must actively support itself. In the passive case the wall is deemed to move into the grain mass which presents a passive obstacle to motion. The active state imposes the least force on the wall.

Comparisons of measured and calculated static forces on the walls of full-size on-floor grain stores (Moran and Westgate, 1984, 1984a; Moran and Glass, 1986) have indicated that for practical purposes design loads can be predicted by methods which assume that the grain is in the active state. These comparisons have also indicated that the sides of main air tunnels between adjacent storage floors, when deflected into an existing heap of grain by filling against a previously uncovered side, are subjected to pressures which can be significantly higher than active pressures. However, these pressures were very much less than would be obtained in a fully passive condition where active pressures can be multiplied by about 6 for agricultural grains. Since these tunnel wall pressures were not fully "passive" and, therefore, cannot be

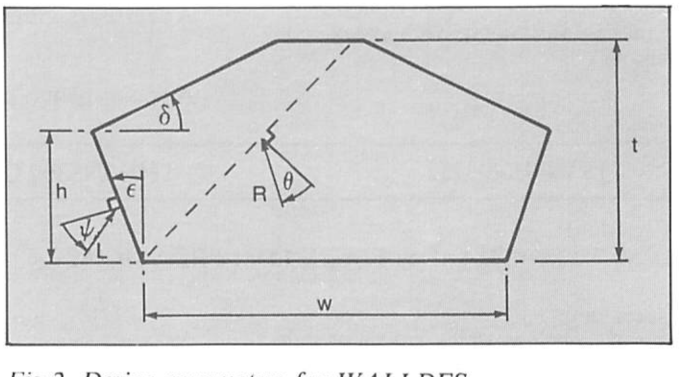

Fig 2. Design parameters for WALLDES.

Peter Moran is in the Welfare Science Division at the AFRC Institute of Engineering Research, Silsoe. (refereed paper)

List of symbols	
h	depth of grain at the wall
t	maximum depth of grain in the store
p	width of crest on wall profile
q	width of valley on wall profile
w	width of the store at floor level
H	horizontal force on the wall per unit length
K	active pressure coefficient
L	total force on the wall per unit length
R	reaction from plane of rupture per unit length
V	vertical (frictional) force on the wall per unit length
W	weight of grain wedge per unit length
γ	specific weight of grain
δ	angle of repose
ϵ	angle of wall batter
θ	angle of shear resistance
μ	coefficient of grain-to-wall friction (flat surface)
μ_d	coefficient of grain-to-wall friction for predicting design loads
ψ	angle of grain-to-wall friction

readily predicted by analytical methods, a practical solution must be sought.

A program (WALLDES) has been written which enables the graphical method of predicting the forces on a retaining wall according to Coulomb's Wedge Theory to be simulated on a BBC micro-computer. A recent paper (Moran, 1988) gives details of the theories which provided the mathematical models for the program. It also describes how the program has been used to quantify the errors due to the use of classical formulæ in the design of typical on-floor grain stores.

The computer program WALLDES makes it possible to take more parameters into account (Fig 2) than has previously been possible when predicting the loads on retaining walls for granular materials by classical formulæ. The program also considers the phenomenon of dilation within the granular material and modifies the simple Coulomb's wedge solution procedures in accordance with Jenkin's revised wedge theory when dilation is affecting wall loads. Predictions using WALLDES have shown that existing formulae may significantly over-estimate design loads for agricultural grain stores. An added feature of WALLDES is that it is able to estimate the position of the centre of pressure of the retained grain mass on a wall.

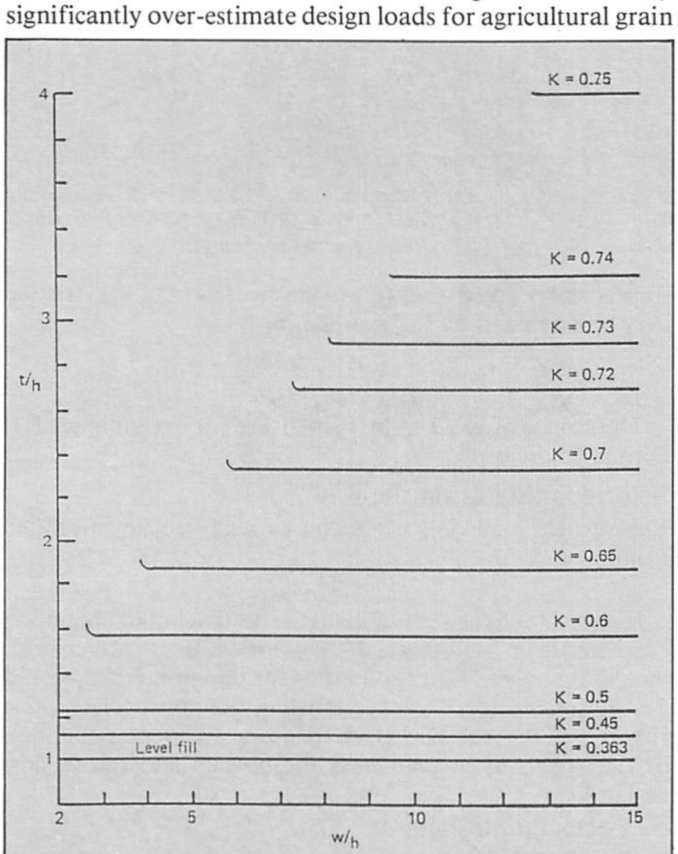

Fig 3. Pressure coefficients (K) for grain stores with vertical retaining walls of smooth galvanised steel (μ = 0.2) containing grain with angles of repose and shearing resistance of 25°.

Presenting data useful to the designer

Although WALLDES is based on classical earth pressure theories, it is not possible to present its solutions as a single formula or as a set of formulæ. One possible means of presenting the data derived from the program suggested in earlier papers (Moran, 1986 and 1988) is as a nomogram such as that shown (Fig 3). In this nomogram the width (w) and the maximum depth (t) are rendered dimensionless as w/h and t/h respectively. The horizontal force per unit length on the back of the retaining wall (H) is given by the expression:

$$H = \frac{h^2}{2} K.$$

At the time of writing the earlier paper on WALLDES, it seemed possible that a set of such nomograms would be a practical method of providing data for designers. However, the number of combinations of angle of repose and angle of shear resistance in the latest Code of Practice BS 5502 (British Standards Institution 1987), when permuted with the range of grain to wall friction values which must be catered for in design has imposed the need to find a more succinct form of data presentation.

This paper addresses the problem of reducing the design data available from WALLDES to a form which is useful to the designer.

K values – the active pressure coefficient

In the nomogram (Fig 3) the curves join equal levels of K as t/h and w/h vary. The positions and shape of each curve depends upon the four angular design parameters (Fig 2) and also upon whether or not the wedge of grain supported by the wall and the failure plane is considered to be bounded by the longitudinal plane of symmetry along the centre of the store, *i.e.* symmetrical wedges supported by opposing walls (Fig 4). For a given set of angular parameters, the K curve eventually becomes a straight line running parallel to the w/h axis. When the wedge is not bounded by the centre plane of the grain store, which is a conservative approximation leading to safe design, the curve straightens out at relatively low values of w/h (Fig 3).

The reason for this phenomenon is quite simple to explain by an inspection of Fig 2. Here, the wedge of grain supported by the wall is of such a shape that it does not change despite increases in width w. Hence, K remains at a constant value.

The construction of K value tables

In most practical cases, the designer deals with a store where the overall height of grain is limited and the width is several times the height of the wall. It can be seen from Fig 3 that in these cases the value of K can be considered as being virtually

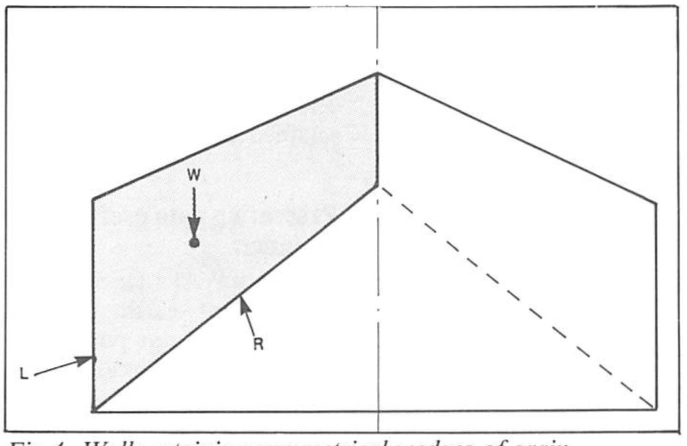

Fig 4. Walls retaining symmetrical wedges of grain.

independent of w/h. Hence, the data from several nomograms can be combined as a family of simple curves (Fig 5). For given values of t/h and μ a designer can determine the value of K needed to predict the design load on a wall. For values of t/h and μ not shown directly, a simple interpolation is possible. The grain to wall friction angle ψ cannot exceed the angle of shear resistance θ of the grain. Hence the coefficient of grain to wall friction μ is limited to tan θ.

However, there is a much simpler approach which avoids the requirement for the designer to estimate K values from scale graduations. The same families of data can be presented in tabular form (Table 1). This table has been prepared for a combination of angle of repose and angle of shearing resistance given in Table 7 of BS5502: Part 22: 1987 (British Standards Institution 1987). As described in the author's earlier papers the values have been calculated using recognised earth pressure theories. Thus the method satisfies the requirements of BS5502.

A set of seven data tables for the full range of angles of repose and angles of shearing resistance given in Table 7 of BS5502: Part 22: 1987 have been published elsewhere (Moran, 1988a).

In calculating an overturning moment or bending moment for a wall the centre of pressure can safely be assumed to be at a height of 0.35 h.

Table 1 Pressure coefficients (K) for grain stores with vertical retaining walls containing grain with angle of shearing resistance 25° and angle of repose 25°.

t/h	*Coefficient of grain-to-wall friction,* μ_d			
	0.1	*0.15*	*0.20*	*0.466*
1.0	0.363	0.346	0.331	0.322
1.2	0.481	0.460	0.441	0.430
1.4	0.556	0.535	0.516	0.505
1.6	0.606	0.587	0.569	0.557
1.8	0.641	0.623	0.606	0.596
2.0	0.667	0.650	0.634	0.625
2.2	0.686	0.671	0.656	0.647
2.4	0.701	0.687	0.674	0.665
2.6	0.713	0.700	0.687	0.680
2.8	0.723	0.711	0.699	0.692
3.0	0.731	0.720	0.709	0.702
3.2	0.738	0.727	0.717	0.711
3.4	0.744	0.734	0.724	0.718
3.6	0.749	0.739	0.730	0.724
3.8	0.753	0.744	0.737	0.730
4.0	0.757	0.749	0.741	0.736

Design loads

— Loads normal to the wall

Table 1 covers the range of wall friction coefficients which are indicated by literature to apply to agricultural grains (ACILG, 1981). The highest wall friction coefficient is limited to the tangent of the angle of shearing resistance (tan θ) of the grain. In calculating the normal loads on a wall, the designer must not over-estimate the coefficient of wall friction since this leads to under design. This is particularly important for corrugated steel or trapezoidal profile wall materials.

With corrugated steel, where the crests and valleys are parallel to the ground, the author suggests that the coefficient of wall friction μ_d used to predict the normal wall loading should be assumed to be no more than 0.9 tan θ. For trapezoidal profiled walls (Fig 6) the coefficient of wall friction may be estimated by the expression:

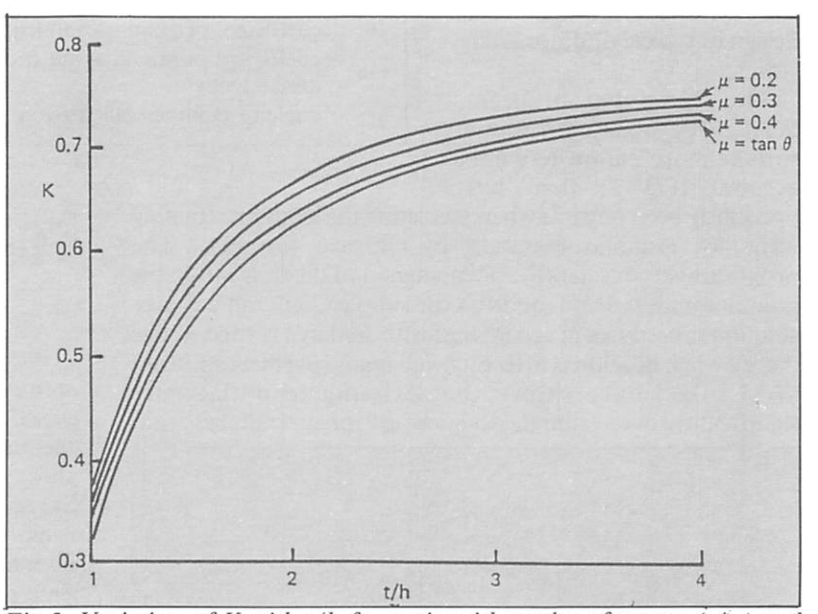

Fig 5. Variation of K with t/h for grain with angles of repose (δ) and shearing resistance (θ) of 25° surcharged to a plateau.

$$\mu_d = \frac{p\,\mu + q\,\tan\theta}{p + q}.$$

The values of K given in Table 1 are for design loads (H) normal to the wall.

– Friction loads on the wall

The vertical loads (V) per metre of wall can be calculated from:

$$V = H\,\mu_d.$$

In calculating the vertical load, the design should not underestimate the value of μ_d. If the vertical loads are critical, then the value of H for this part of the design exercise should be determined from the tables using the appropriate value for μ_d. It may be necessary to use a different estimation of the μ_d value in predicting the normal and the vertical design loads.

— Loads on air ducts

Code of Practice BS5502 draws attention to the special design requirements for air ducts in on-floor grain stores. It is essential that in designing an air duct that may be subjected to loading on one side and then on both sides that an overpressure factor of 1.3 should be applied to the loads calculated using tabulated data from WALLDES. Readers who require an explanation of this special requirement may refer to an earlier paper on design loads for retaining walls (Moran, 1988).

— Loading due to parameter changes and settlement

In practice, angles of repose and of shearing resistance may vary appreciably from quoted values due to the method of heaping and due to variation in the condition or post storage treatment of the grain. Designers should pay special attention,

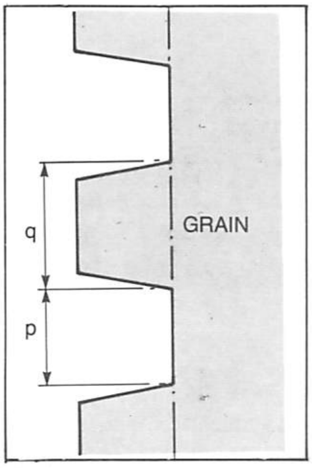

Fig 6. Parameters for calculating the friction coefficient on a trapezoidal wall.

particularly when w/h values are large, to the possible effects of these and other parametric changes which may give rise to increased wall loadings.

For example, grain which has been dried within the store increases bulk density, decreases its angles of repose and shearing resistance, and also decreases its grain to wall friction. All these changes tend to increase the loading on the wall.

In a store where the w/h ratio is high the change in the angle of repose and the subsequent movement of the grain may also give rise to a significant increase in the depth of grain at the wall. Since the load on the wall is a function of h^2 this can significantly increase the loading at the wall.

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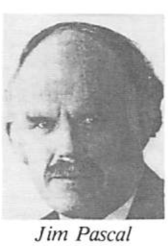
Change of Editor



Jim Pascal

Jim Pascal's activities in the Institution should not have gone unnoticed by any Member who has scanned the pages of *Agricultural Engineer* over the past few years. He has been participating on the Editorial Panel since 1982 as a member, deputy editor and, finally, as editor over the past 3 years. During this extended period, he was involved in re-establishing the production of the 10 year author and subject indices in 1983, followed by annual indices thereafter.

Jim has also played an important role in two major design changes to the layout and content of the Journal. He provided the first entry on the new Higher Certificate in Agricultural Engineering launched by SCOTEC (now SCOTVEC) at Elmwood College where we introduced Ag Eng Items under my editorship in 1983. More recently, the Panel conducted a survey of the membership to determine the 'shape' of the Institution 'flagship' in the future. Whilst the response to that questionnaire was disappointing, our 'new look' Journal with colour cover and wide ranging contents is a credit to the Honorary Editor and his team, ably assisted by our Production Editor and Advertisement Manager. It is encouraging to see the trend towards greater advertising copy in parallel with a broadening of the subject interest areas.

Barry Sheppard

Of course, the Editorial duties were only one demanding aspect of Jim's commitment to the Institution. Having just completed his 2 year term of office as Chairman of Scottish Branch (after a long career as Branch Secretary, resulting in a Branch Meritorious Service Award), he is still embroiled in both Branch and Council activities.

In thanking Jim for his major contribution to furthering the aims of the Institution, may I also take the opportunity of welcoming Barry Sheppard as our new Honorary Editor and extend our best wishes for a continuation of high quality and presentation in the future issues of the Journal.

B D Witney, Immediate Past President

On-farm grading and cleaning of potatoes and onions – techniques and equipment to improve returns

C F H Bishop

Consumers are becoming increasingly particular of the "quality" (often evaluated on appearance alone) of food purchased. Surveys carried out by supermarkets chains and marketing organisations indicate that quality has a higher priority than price. There are few indications that this trend will not continue and therefore supermarkets will increasingly dictate quality levels of produce to growers and other suppliers.

As an indication only, one of the large cooperatives supplying the prepack and other quality outlets had an average sale price for potatoes in the 87/88 season of £113.42/t compared with the mean wholesale market price of £74.52/t for the same period. Although much of this difference can be put down to marketing and profit margins, it is an indication of the added value that can be put on the humble spud.

Whilst it may seem that activities on the farm may be restricted to a form of pre-grading, this will need to be done to higher standards in order to refrain from sending anything to the packers or processors that has to be rejected. However, before considering the treatment of the product for market, it is worth recalling the old dictum "rubbish in, rubbish out". No system of cleaning and grading can do more than present the available product in the best possible light. A quality product cannot be made out of poor material.

The four main areas that need to be considered in on-farm grading and cleaning are:

- cleaning
- handling
- size classification
- inspection.

In all cases where a high quality product is required all four operations are essential (Bishop and Maunder, 1980) and the grading and cleaning of produce must be considered as part of a total system. The avoidance of damage is of paramount importance and must be borne in mind at all times.

Cleaning

The cleaning of produce can be split into two parts: the removal of trash, stones and clods and cleaning the surface of the product. In all cases the first part is required but it is this second part which will be necessary for a higher priced quality market.

— Potatoes

From Table 1 it can be seen that there is a definite preference for a soil free potato although not necessarily a washed potato (Statham, 1986). The majority of producers will not have the throughput to justify the cost of a washing plant which must include an absorption sponge roller surplus water disposal (often the major expense).

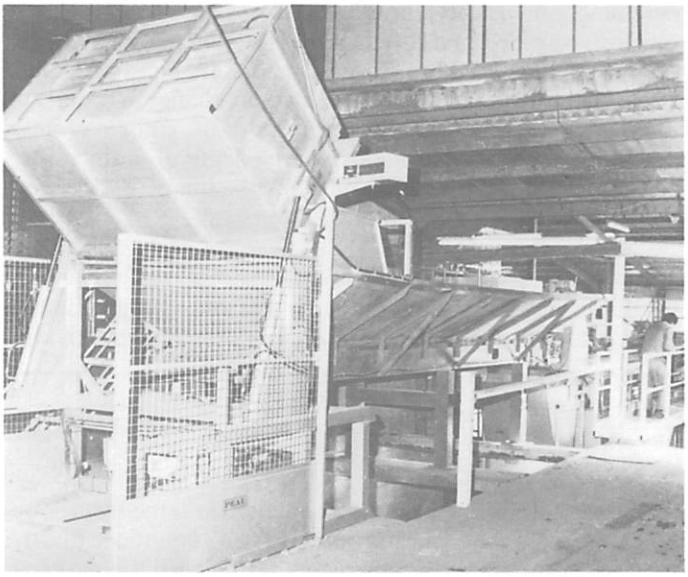


Fig 1. Box tippler fitted with weigh cells in base for collection and storage of input data (Peal).

The removal of soil without washing is by dry brushing. A dry brusher has the axis of the brushes at right angles to the direction of flow of crop and the action of the brushes on the crop surface removes the soil. Over a period of time the brushes may become clogged with soil which will reduce their cleaning efficiency. With some systems the brush rollers are in units which can be removed and replaced with spare units, thus avoiding line hold-ups. On any line, a by-pass of the dry brusher is necessary for excessively dirty or wet crop as, if there is moisture present clogging and smearing will occur.

There are various sizes of dry brushers, from 0.5m to 2.0m in width and from 1.5m to 6.0m in length with different types of brushes to suit individual soil types. In some cases the dry brusher can be used to provide a polishing action. It must be remembered, however, that any cleaning action will result in disease, defects or damage being more clearly exhibited.

— Onions

There are two most common mechanisms for topping onions, after drying or storage. These are the helical roller and the fan and vibrating screen.

Table 1. Cleanliness preference

		Source of purchase				
Cleanliness preference	*Total*	*Green grocer*	*Super market*	*Grocer*	*Farm/ FS*	*Other*
Washed	24	17	54	21	10	20
Unwashed/no soil	52	59	27	53	64	57
Unwashed some soil	14	16	9	12	17	16
No preference	8	7	9	12	8	5

Report on a Survey of consumer attitudes and behaviour 81/82. Published by PMB.

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The helical roller topper is composed of pairs of steel rollers, fixed in parallel and running longitudinally down an adjustable slope of 15-20°. The rollers are approximately 38mm in diameter and one roller in each pair has a course pitch helix of steel strip welded to it. As the onions pass down the machine the rotating rollers trap the tops and remove them with the helix. The cut is not clean and if the necks are wet or damp the centre of the onion can be drawn out. The machines can be obtained in a wide range of sizes.

The fan topper is a more expensive machine – producing a better standard of topping with less damage. For best results the onions should be pre-graded into sizes to allow the onions to pass over two different sizes of vibrating screen. Beneath the screen one or more propellor fans draw down the tops by the passage of air and cut them with the knife-edged fan blades. Negligible skinning is caused with this type.

Handling

There are four basic causes of damage: pressure, impact, cutting and friction. Damage by pressure is not typical on a grading line. Cutting should also not be a problem, as if cut wounds are found it is normally a relatively easy task to protect sharp edges. Impact and friction are the two most important causes of damage on a grading line. One method of pinpointing impact damage is by using the SCAE electronic potato which records the impact "history" over a grading line.

The most common reasons why potatoes fail to meet the grade is mechanical damage and despite many campaigns on damage awareness, it is still prevalent. Any drops should be kept to a minimum and the surface onto which the crop falls must be well protected.

Table 2. Probability of severe damage

Potato variety	*Drop height (onto flat surface) – mm*			
	for 50% damage		*for 10% damage*	
	1973	*1974*	*1973*	*1974*
Pentland Dell	1300	581	774	272
Maris Piper	1115	616	617	377
Record	869	807	732	415
Desiree	831	543	348	280

As can be seen from Table 2 the change in impact tolerance between one year and the next year can be very large. Grading lines must therefore be checked every year. The effect of temperatures can also affect impact damage. As an example, a cold potato at 4°C had a 77% chance of splitting when dropped 1100mm as opposed to a potato at 8°C which had a 38% probability of splitting (McRae *et al,* 1976).

One of the most common problems is when pallet boxes, front end loaders or trailers are tipping onto a line. Pallet box unloaders which tip boxes gently are becoming more common. Many have a two box facility so that one can be tipping while the other is replaced (Fig 1).

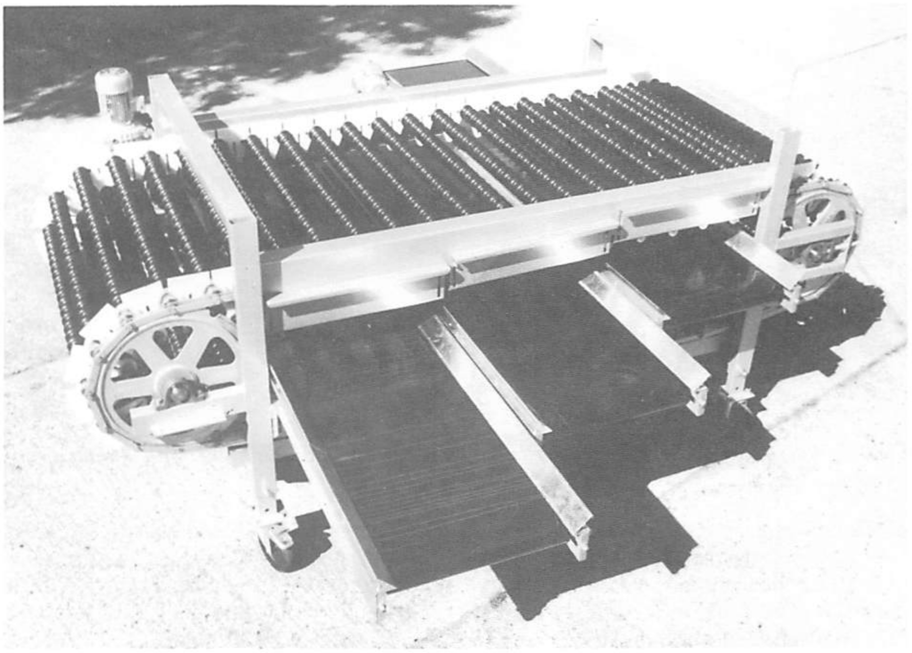

Fig 2. Expanding roller sizer (Downs).

Frictional damage is an area which has received limited attention in the past as it only causes scuffing. However, surface scuffing results in partial skinning of either the potato or onion, allowing diseases to spread more easily and reducing the attractive appearance and therefore the value of the crop. Some work at Writtle College which is still in the initial stages has highlighted the belt speed onto which potatoes are dropped, as being a major source of this damage. This problem is further exacerbated if the tuber is rotating in the opposite direction to the belt, giving an increased effective contact velocity. This frictional damage can be reduced by using lower belt speeds and/or rotating the tuber in the same direction as the belt.

Sizing

The most important consideration after the appearance of the product is the size. There are mandatory riddle sizes, but increasingly the market requires a number or more clearly defined size ranges. Equipment to provide this is becoming more common. Four methods of sizing used in the industry at present are:-

- fixed aperture
- varying aperture
- weight
- vision systems.

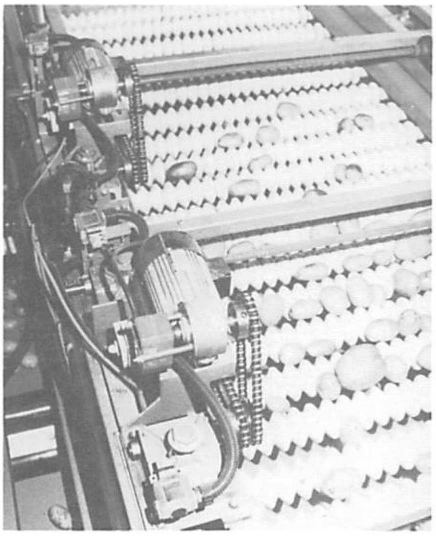

Fig 3. Close up of electronic adjustment motor for expanding roller sizer (Peal).

The most common method for sizing potatoes which is also popular for onions is the fixed aperture riddle type of grader where the crop is fed onto a series of sieves or riddles with increasing size of square hole. Traditionally the product is bounced down the riddles with the potential for damage, particularly if the bounces or agitation is too great. With careful management this problem can be overcome. Some fixed aperture graders of the step type, grade out the large produce first. This reduces the possibility of damage caused by the large produce having to traverse the whole line, jostling smaller produce on the way.

A further problem with the riddle or endless screen type of grader is that it only operates in two dimensions and, if the crop does not approximate to a sphere, as with many varieties of potatoes, there can be large variations of weight (30% is not uncommon) falling through the same hole. Onions which are more spherical do not suffer from such large variations.

A varying aperture grader (Figs 2 and 3) has the advantage over a fixed aperture grader in that it can give different sizes as required. Typically for both onions and potatoes roller graders are the most common with compactness being one of their advantages. The product passes over sets of rollers which have their axes at right angles to the crop flow and the aperture between the rollers gradually increases until the crop

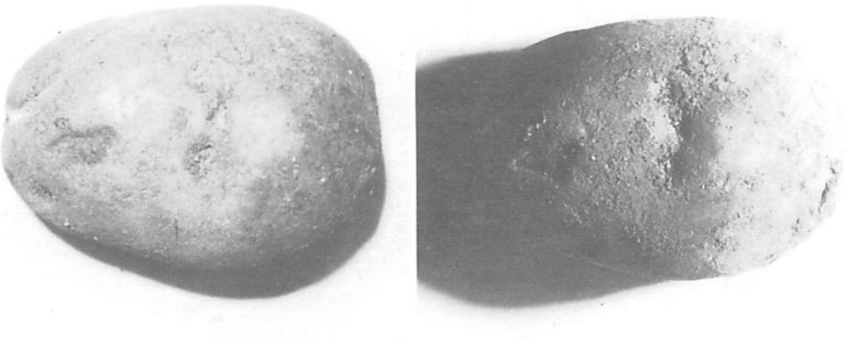

Fig 4. Potato under 500 lux: at left, with illumination from above; at right, with illumination from one side.

drops between the rollers. It is worth considering how often the size classification will have to be changed, as the ease of varying the distance between rollers differs with the different makes of machine.

Weight grading particularly of baking potatoes is becoming more common. It gives inherently better sizing accuracy, as an increase of 30% by weight and therefore volume in a sphere gives only a 10% increase in dimensions. The singulation of the crop is still quite a high cost operation and therefore more appropriate to large scale installations.

Electronic sizing is by looking at the shape of the product, from which a computer program calculates the weight.

Inspection

If produce is going to be graded to a high standard there are three basic areas which must always be considered: operator training, illumination levels and presentation of produce to operators. In many cases around 30% of produce can be out of grade on lines which the farmer thought was adequate. All operators must undergo some form of training so as to know what is acceptable and what should be rejected. Operators should also be aware of the quality requirements. Supervisors must fully understand the market requirements.

The actual illumination level is very important and is an area which is often given cursory consideration on many farms. The illumination level should be at least 500 lux and preferably 750-1000 lux with no shadow on the inspection table (Figs 4 and 5 show a potato under 500 lux illumination with and without shadow) and as uniform a level of illumination as possible. Natural light should be avoided as its quality is constantly changing. The operators should also be protected from any glare and the table itself should be in a neutral colour of low reflectance. The background lighting should be kept at a much lower level such as 100 lux.

The presentation of the produce on the roller table to the operators needs careful consideration and the following factors should be borne in mind:-

- The maximum quantity of produce that each operator should have to inspect is 300 tubers or onions per minute. This is about 1.5 tonne per hour. For high quality inspection half this figure is probably a better guide.
- The speed at which the product passes the operator should be steplessly variable but if not, the speed should be 5-6m/minute.
- The rotating speed of the product should be in the range 1.5-4.5 revolutions per 300mm of forward travel.
- If operators are stationed on either side of the table it is easier to see defects.
- Operators should not have to reach more than 450mm.

Vision systems

The use of vision systems is growing fast in many areas of industry including agriculture. The flexibility of such systems is constantly increasing and they are capable of both sizing and quality grading. Although such equipment tends to be more appropriate for the large, often cooperative, packhouse it is worth being aware of its capabilities.

Electronic selectors (Fig 5) work on the following principle. A standard colour television is made up of tiny phosphor dots which, when excited, glow either red, green or blue. Every colour that we see on the screen is made up of a combination of these colours. The selector logic includes a store which has a location for every possible combination. When produce is shown to a television camera blemishes which cause changes in colour can therefore be identified. Small spots of colours, which make up a blemish may be scattered about all over the surface of the product (russet or scurf) and this may be acceptable. What distinguishes a blemish is an area where there is a concentration of these colours and the computer program can be written to recognise acceptable and non-acceptable areas.

The selector has to recognise 262,144 different colours and typically the screen is split into 150,000 elements, called pixels, therefore for every frame each pixel is compared with 262,144 colours and the frame changes 25 times a second. Even by computer standards this is quite a lot to do and only recently have the processors and memory chips been developed that are fast enough to make this possible. This is one reason why electronic selectors are not yet common.

Conclusions

There are no real secrets to high quality grading and cleaning. Care is needed at every stage to achieve the best possible result. Constant vigilance is required to ensure that standards do not drop and it is essential that everyone involved in the task is adequately trained and understands the objectives.

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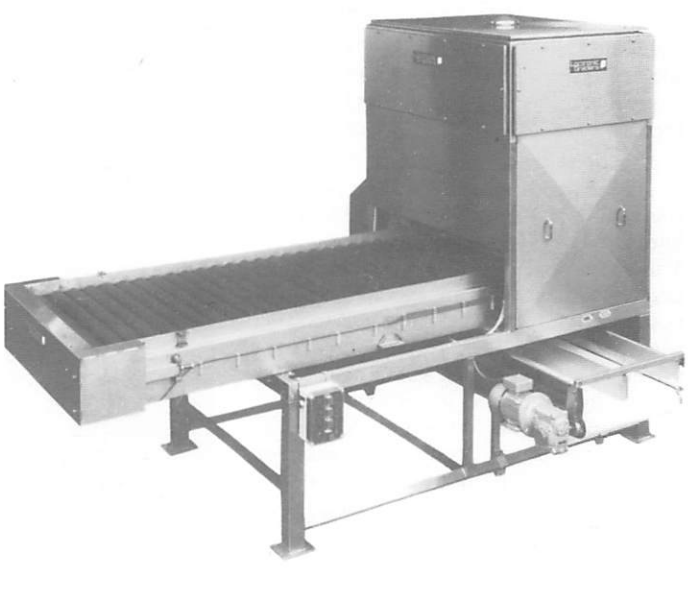


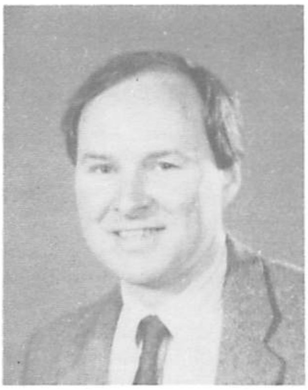
Fig 5. Electronic selector (Loctronic Graders).

Specification and design of a facility for research into milking systems for small ruminants

by T T Mottram, D L O Smith

The growth of the alternative enterprises of sheep and goat milking has led to an identification of new research areas. To enable research to be undertaken on the interface between the animal and the milking system a research facility has been developed by Silsoe College and the Royal Veterinary College. The milking parlour has the capability for instrumenting milk yield, flow, conductivity and temperature on the individual teats of each animal. The milking parlour is also equipped with automatic cluster removal equipment, controlled manually or by computer, allowing a range of work on the effect of over milking on mastitis.

T T Mottram



D L O Smith

There is general agreement among research personnel working in the field of milking systems, that little is known about the milking process and the complex relationships between the many factors involved. Most work is concentrated, correctly, on the bovine dairy sector, as this is by far the largest sector of the dairy industry.

However, improving our understanding of the process of milking in goats and sheep will yield results that will lead not only to improvements for that sector but to a greater understanding of the milking process of the cow. This will come about through determining those elements which are common between species and those which are specific. For example, the maximum rate of flow of milk per teat appears to be similar for all species, thus there is a common factor within the udder which controls the maximum rate of flow of milk.

Funding for research into goat and sheep milking has become available as the Ministry of Agriculture has identified "alternative enterprises" as a growth area with specific problems within UK agriculture. Silsoe College has been conducting research and development in goat milking systems and the Royal Veterinary College has been researching mastitis in sheep. These two institutions have identified the need for a unit dedicated to research in the area of small ruminant milking systems and have committed funds and personnel to its establishment.

The unit, located at the Royal Veterinary College, Department of Animal Husbandry, Boltons Park, Potters Bar, Hertfordshire, comprises a flock of 50 milk sheep and a milking parlour designed for research. The milking parlour was designed and installed by R. J. Fullwood & Bland in collaboration with Silsoe College.

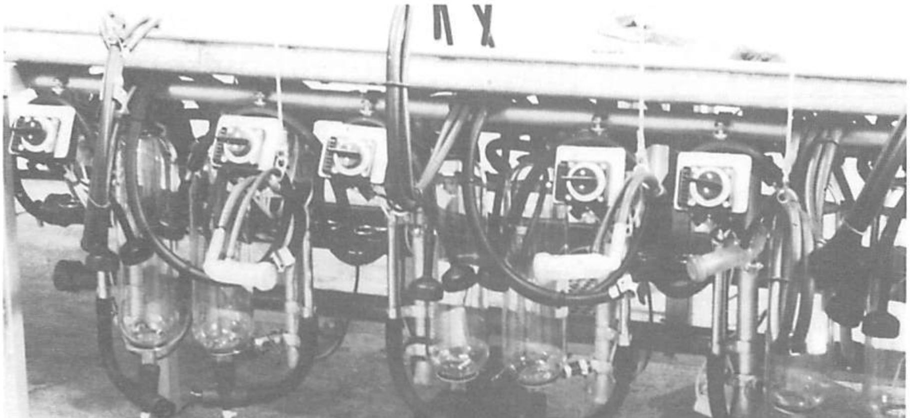


Fig 1. The milking system has a four-litre jar for measuring individual teat milk flows and yields.

Toby Mottram was formerly a Research Officer at Silsoe College and is now a Senior Scientific Officer at the Milking and Mastitis Centre, Compton. David Smith, formerly a Lecturer in Agricultural Engineering at Silsoe College, is now Project Leader, Food Engineering, in the Process Engineering Division at AFRC Engineering, Silsoe.

Design requirements of the milking parlour

The principal function of the milking parlour is to remove the milk from the animals with the minimum labour input. In addition, the milking parlour should be able to:-

- measure the milk yield from each animal,
- measure the milk flow from each animal,
- measure the milk flow from each teat of an animal,
- control the removal of the milking cluster to give predetermined under or over milking for mastitis studies,
- allow the individual feeding of animals within test groups.

Platform design to resist corrosion and prevent vibration

The milking parlour is a six-stall, cascading-yoke simple platform with six milking jars. Each recorder jar has a combination valve which allows manual, semi-automatic and fully automatic cluster removal. The four-litre capacity recorder jars can be used in a conventional format or in pairs to receive the milk from individual teats (Fig 1). The recorder jars release milk into a 40mm diameter pipeline which runs to a stainless steel receiver jar. Milk is pumped from the receiver jar, through a filter and a heat exchanger to a 280 litre chilled storage vat. The milking system is cleaned after milking by the acidified boiling water method.

The construction of the platform is novel in that care has been taken to separate the alloy chequer plate from the steel box frame base to prevent the galvanic effects which lead to rapid corrosion of these materials in conventional parlours. The alloy plate is secured to the steel by stainless steel bolts screwed into rubber rawl anchors and the plate is separated from the steel by strips of plastic. The platform is separated from the

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Agricultural Engineering and the Environment

The EC Club of Advanced Engineering for Agriculture held its first Technical Review in March at the CEMAGREF laboratory in Rennes, France, with research specialists from nine EC countries meeting to discuss some of the ways in which research projects in their discipline can contribute towards the protection of the environment.

Investigating ways of preventing pollution

Two Workshops were organised, one dealing with ways of preventing pollution by agrochemicals used in arable crop production, and the other with pollution by agricultural byproducts and residues, including livestock wastes. One or two appropriate specialists from almost all EC countries were invited to attend each Workshop. Nine countries sent participants.

Establishing priorities for research

The primary aim of the Workshops was to establish European Community priorities for research on these topics, and to facilitate, through discussion, collaboration between research organisations throughout the Community. This collaboration, already well developed in many instances, is essential if research funding from schemes run by the European Commission in Brussels is to be sought.

The Club Chairman is Professor John Matthews of AFRC Engineering, Silsoe, and the Workshops were chaired by Dr Francis Sevila of CEMAGREF, France (for agrochemicals) and Dr Voorburg of IMAG, the Netherlands (for byproducts and residues).

Discussion to determine overall EC priorities was structured around sub-topics for each Workshop:

For agrochemicals these included methods of reducing application rates, and of improving the efficiency of application; non-chemical methods of pest control; and the flow of chemical pollutants into soil and ground water.

For agricultural byproducts the sub-topics covered the handling, storage, treatment and disposal of livestock wastes, treatment of other pollutants and effluents (such as those from silage), and alternative uses for wastes and byproducts such as straw.

Reports to be presented to Brussels Directorates

The final reports from the Workshops are now being prepared for presentation to officials at various Brussels Directorates. The reports give the priority areas for research:

- To minimise the environmental effect of **agrochemicals,** it was felt that standardised test methods for machine performance, including methods of assessing machine contamination, were essential.

Studies to improve the effectiveness of applications should include research on information technology and on systems for localised targeting (*e.g.* patch spraying). The basic science underlying the transport and mode of action of agrochemicals must be studied, including the physics of spray transport which could provide designs to minimise drift, and models to describe the distribution of pesticides and fertilisers in the soil.

Finally, physical methods for controlling insect pests and weeds should be sought.

- The priority areas identified for research on **agricultural byproducts** were the utilisation of livestock wastes on the farm, the processing of livestock wastes, and the reduction of airborne emissions from farm buildings.

Recommended projects include the development of improved storage and land spreading technology, solving the problems of on-farm water management, and the analysis and modelling of soil-wastes interactions. Processing techniques to produce standardised fertilisers from surplus livestock wastes should be sought.

Make a note of the date!

Institution of Agricultural Engineers

Second International Conference

2-5 Sept 1991 – Robinson College, Cambridge

Engineering the Rural Environment

continued from previous page

instrumentation support to prevent any vibration from the animal movements affecting the electronics below.

Research on physiology of mammary gland

The parlour is primarily designed for research work on the physiology of the mammary gland and has been arranged so that three animals may be milked simultaneously with the flow of milk from each teat being taken to a separate jar. This arrangement allows twinned tests on the difference in milk flows between teats on the same animal to be undertaken and also allows conductivity, compositional, and bacteriological tests to be carried out with ease on the entire sample of milk from an individual teat.

At each milking point there is a switch, with signal lines leading to a remote junction box, which can be used for a variety of functions, such as starting timers and counters or actuating sampling devices. Fig 2 shows the tracked feed dispenser unit which allows individual feeding of experimental animals.

The first planned experiment will use the switches to signal the start of milking for an "expert" automatic cluster removal system. Each recorder jar is supported by a cantilever bracket fitted with a four-arm strain gauge bridge to measure the yield of milk in the jar.

The yield signal is taken to a computer (PC) in the adjoining viewing area, so that datalogging can be carried out without interference to the milking process. Initially, the identity of the animal is to be recorded manually, however, it is intended that in future the animal identity will be entered by the operator in the milking parlour at a waterproof keypad, and animal data will be logged directly to a record for each animal in the flock.

Facility available to research workers and students

The first batch of sheep was milked from April to July 1989, and lambed again in January 1990. A second autumn-lambing flock is being established to maximise use of the facility throughout the year. In the future a group of goats may be added to the establishment.

The facility is available for research workers and students wishing to undertake research in the areas of machine milking development, sheep mastitis and milk composition detection.

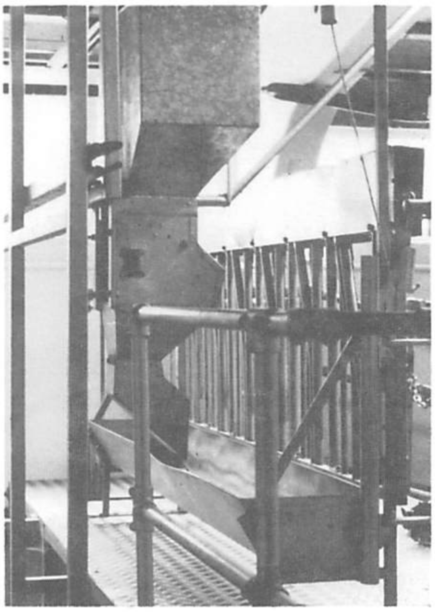

Fig 2. The tracked feed dispenser unit to allow individual feeding of experimental animals in the milking parlour.

Acknowledgement

This work has been possible due to the generosity and co-operation of R. J. Fullwood & Bland, Ellesmere, Shropshire, who provided the equipment and installed the milking system.

Comparison of umbilical hose and conventional tanker-mounted slurry injection systems

R J Godwin, N L Warner, M J Hann

In this study the authors show several significant advantages for the umbilical hose system for slurry injection. Power requirement can be 25 to 50 percent less whilst there can be a doubling of the work rate. There is less odour nuisance and less risk of damage to soil and crop.

The injection of both agricultural and municipal wastes is becoming increasingly popular as a technique which can eliminate much of the environmental problems of odour and ammonia emissions (Phillips *et al,* 1988), and the problem of surface run-off normally associated with conventional surface spreading.

Conventional injection equipment, where the injector tines are mounted behind the slurry tanker, Fig 1, requires large, high powered tractors for efficient operation. The heavy loads involved, both from the tractor and tanker, result in soil and crop damage (Warner *et al,* 1988), particularly under wet soil conditions, as a result of high levels of soil compaction and tractor wheelslip.

These problems can, in principle, be reduced by the adoption of a lighter umbilical hose injection system, Fig 4, where the injector tines are mounted directly on to the tractor, and slurry is supplied via a flexible pipeline from either a tanker on the field headland, or direct from the slurry store via an irrigation pipeline.

In order to evaluate more precisely the benefits of the umbilical injection system, a series of comparative trials has been conducted to assess the performance of an umbilical system, and to compare the results with those of a tanker-mounted injection system and conventional surface application techniques operating under the same conditions.

Umbilical system – less power and lower fuel consumption

Measurements were made of the draught force requirements and tractor fuel consumption of both umbilical and tanker injection systems when operating in stubble, on a sandy loam soil at 5% moisture content,

Professor Dick Godwin (left) and Mike Hann (right) are at the Department of Engineering for Agriculture, Silsoe College, Cranfield Institute of Technology, Silsoe, Bedford. Nigel Warner (centre), formerly at the Department of Engineering, Silsoe College, is now at the Department of Agricultural Engineering and Farm Mechanisation, Royal Agricultural College, Cirencester, Glos.

Fig 1. Conventional tanker-mounted injection equipment.

and powered by a 75kW four-wheel drive tractor.

Table 1 shows that draught force reductions of approximately 50% are apparent when operating an umbilical injection system, compared to those for the fully laden tanker injector. The figures show that, despite the total forces for the empty tanker system being slightly less than those for the umbilical injector, the forces acting on the injector tines are marginally greater, due to the compaction of the soil, by the tanker, ahead of the tines. A greater increase in injector tine forces is apparent with the fully laden tanker, due to the increased compaction resulting from the heavier machine.

Subsequent measurements of the drag forces acting on the umbilical hose under a range of conditions has shown that when used on either grassland or bare cultivated soil, the forces are approximately 40 N/m and 50 N/m respectively, compared to the 18.5 N/m recorded on stubble. However, even allowing for the greatly increased forces on the pipeline, the total force on the complete system would still be at least 15% less than those on the tanker system, assuming the forces acting on the tanker injector

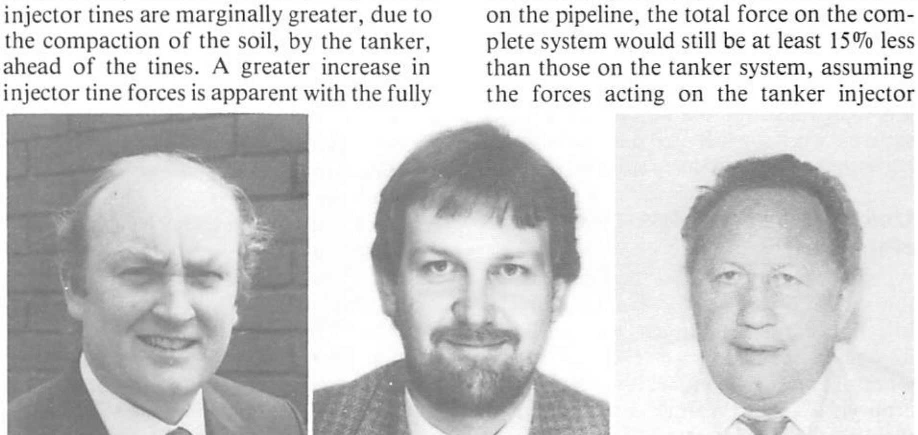

Table 1. Draught forces and power requirements of tanker-mounted and umbilical hose injection systems operating in stubble on a sandy loam soil.

	Complete system		*Injection tines only*		*Tanker rolling resistance*		*Drag on 100 m umbilical hose*	
	Draught force kN	*Power req. kW*	*Draught force kN*	*Power req. kW*	*Draught force kN*	*Power req. kW*	*Draught force kN*	*Power req. kW*
Tanker system – full, wt 49 kN	9.41	84	5.62	50	3.79	34	–	–
Tanker system – empty, wt 13 kN	4.38	39	3.39	30	0.99	9	–	–
Umbilical system	4.88	44	3.03	27	–	–	1.85	17

remain the same.

The tractor power requirements for each of the slurry application systems, operating at a speed of 2.5 km/hr, can be calculated from the draught forces, using the formula of Hunt (1976), where:-

$$\text{Power(kW)} = \text{Drawbar pull (kN)} \times \text{speed (km/h)} \times 3.6$$

The results, as shown in Table 1, show the need for tractors in excess of 80kW for tanker injectors, compared to 45kW for umbilical injection. When the increased drag forces on the hose are considered, then power requirements for umbilical injection increase to approximately 60 kW, still 25% less than for tanker injection. In contrast, conventional surface application systems only require tractors of 34kW, being the power required to overcome the rolling resistance of the tanker.

Measurements of fuel consumption were obtained using a 75kW tractor for all application systems. The tractor size was chosen as one which could operate all application systems and which exhibited fuel efficiency figures similar to those of both smaller and larger tractors from the same manufacturer.

The results given in Table 2 show that the umbilical system will reduce fuel consumption by 30% and 20% for the surface application and injection systems respectively. However, the umbilical system requires a second tractor to operate the supply pump. The fuel consumption figures for this tractor are also given in Table 2, when the pump is situated either in the field, or at the slurry store, where the slurry is pumped via an underground irrigation pipeline to the umbilical hose.

The total fuel consumption of the umbilical hose application system, whether surface applying or injecting slurry, is still less than those for the tanker application systems, when the fuel used during transport between the field and slurry store is included.

Umbilical system – less soil and crop damage

As will be reported in a forthcoming paper, the operation of heavy tanker-mounted injection equipment under wet soil conditions, can lead to high levels of tractor wheelslip and soil compaction, resulting in crop yield losses (Warner *et al,* 1988) and the need for costly remedial soil treatment. However, the removal of the tanker from the machine system, and the use of an umbilical hose, could potentially reduce the above problems and lead to a more effective operation.

The results presented in Fig 2 show mean wheelrut depth for a range of injection equipment operating on two soil types, related to drop-cone penetration (Godwin *et al,* 1990) which is a measure of soil shear strength.

The results show that wheelrut depths resulting from umbilical injection are 50% less than those produced by equivalent tanker-mounted equipment. Further reductions in rut depth can be achieved by equipping the tractor with low ground pressure tyres.

Similar results were obtained by Smith (1985) when predicting the wheeling damage caused by a range of agricultural machinery.

The reduced damage of the umbilical system is confirmed by the results of a study into the grassland damage resulting from injection by different machine systems (Warner *et al,* 1988), the results of which are given in Fig 3. It can be seen that using tanker injectors, yield losses within wheelings ranging from 35% to 70% of an unwheeled control can result. This compares to losses of between 14% to 40% for a conventional tyred umbilical injector, and between 12% and 20% when low ground pressure tyres are fitted.

However, due to the much larger contact width of the low ground pressure tyres, yield losses across the total plot (Fig 3, right) are similar for both umbilical injection systems, amounting to between 6% and 18% of the control plot. This compares with total losses for the tanker injection system of 13% to 30% of the control, leading to an actual yield benefit of approximately 0.6t/ha in favour of the umbilical injection system, equating to a revenue of approximately

Table 2. Fuel consumption (litres/hr) for a 75 kW tractor when surface spreading or injecting slurry by both tanker mounted and umbilical application systems.

	Fuel consumption (litres/hr)				
	Tanker systems		*Umbilical systems*		
	Field operation	*Transport*	*Field operation*	*Supply pump in field*	*Supply pump at store*
Surface application	24.5	9.7	16.9	5.0	11.6
•Injection	25.7	9.7	21.0	5.0	11.6

£36/ha when assuming a value of £60/tonne for dry matter.

The results in Fig 3 also enable the effects of compaction alone to be estimated, by extrapolating the lines back to zero slip. This shows losses of 0.3t/ha resulting from umbilical injection, increasing to 0.7t/ha when using tanker-mounted equipment, again confirming the benefit of the lightweight umbilical injection system for reducing soil and crop damage.

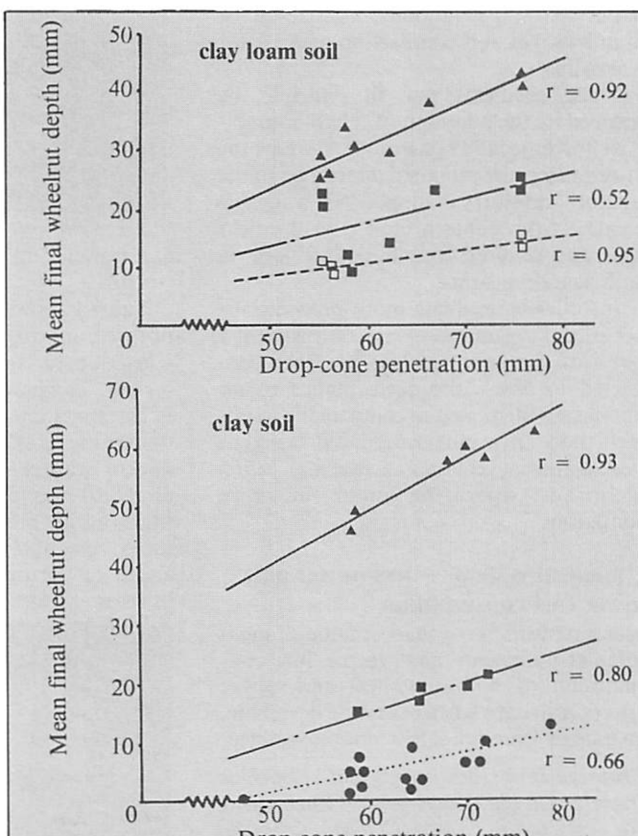

Fig 2. Relationship between drop cone penetration and mean wheelrut depth.

▲ *conventional tyred tractor and tanker-mounted injector,*
■ *conventional tyred tractor and umbilical injector,*
□ *low ground pressure tyred tractor and umbilical/injector*
● *Land-Rover.*

Improved machine trafficability leads to lower slurry storage requirement

The ability to predict the potential damage resulting from machinery traffic and whether the damage is acceptable or not, is an important aspect in the planning of machinery operations such as slurry spreading as it can enable variables such as storage period to be estimated more accurately for individual farm situations.

Research over three winter periods enabled the number of lost work days, due to wet conditions; to be determined for:-

(i) conventional tyred tanker-mounted system,
(ii) conventional tyred umbilical system, and
(iii) low ground pressure umbilical system utilising either low ground pressure tyres or dual wheels fitted to the tractor.

The period of the study enabled lost work days in a **dry** (1988/9), **average** (1986/7) and **wet** (1987/8) winter period to be determined.

A non-working day was assumed to be one where damage to the soil and crop caused by the passage of the machine was considered too great for farmers to accept, assessed by monitoring wheelslip and wheel-rut depth for each machine. The damage was correlated with a shear strength assessment device (Godwin *et al*, 1990) which enabled the potential damage to be determined on days when machinery operations were not conducted.

An estimate of the number of lost days was also determined from weather data, following the work of Smith (1977). In this case, it was assumed that tanker-mounted equipment would be unable to operate on days when the soil was above field capacity, *i.e.* there was excess of water in the soil, and on any subsequent day when the excess water was greater than half the daily drainage losses. It was assumed that the value of daily drainage would amount to 3.0mm for clay soils, increasing to 5.0mm for sandy soils.

Fig 4. Umbilical injection equipment.

The conventional tyred umbilical system, however, was assumed to be capable of operating at soil moisture contents above field capacity, up to periods when the excess water exceeded 7.5mm, plus subsequent days when the excess water exceeded an amount equal to half the sum of the daily drainage plus 7.5mm. A similar assumption was used for the low ground pressure umbilical system but operating up to a value of excess water equal to 15mm.

Estimated figures for the number of lost working days, together with actual values measured from field operations, are shown in Table 3, for both clay and sandy soils for the three winter periods considered. A good correlation was found between the predicted and actual work days lost (Fig 5). It was therefore decided to utilise the weather data to estimate total lost work days for the period of the study, and to account for the soils, machine systems and years when it was not possible to conduct field measurements. Fig 6 shows the estimated number of lost working days for each of the machine systems over the three winter periods plotted against rainfall return period (Schwab *et al*, 1981).

The results indicate that the ADAS recommended storage period of 140 days will give sufficient capacity to avoid overflow when operating a tanker-mounted injection system on clay soils, with a volume of winter rainfall which could be expected every one hundred years.

However, for the same return period, the use of umbilical hose equipment mounted

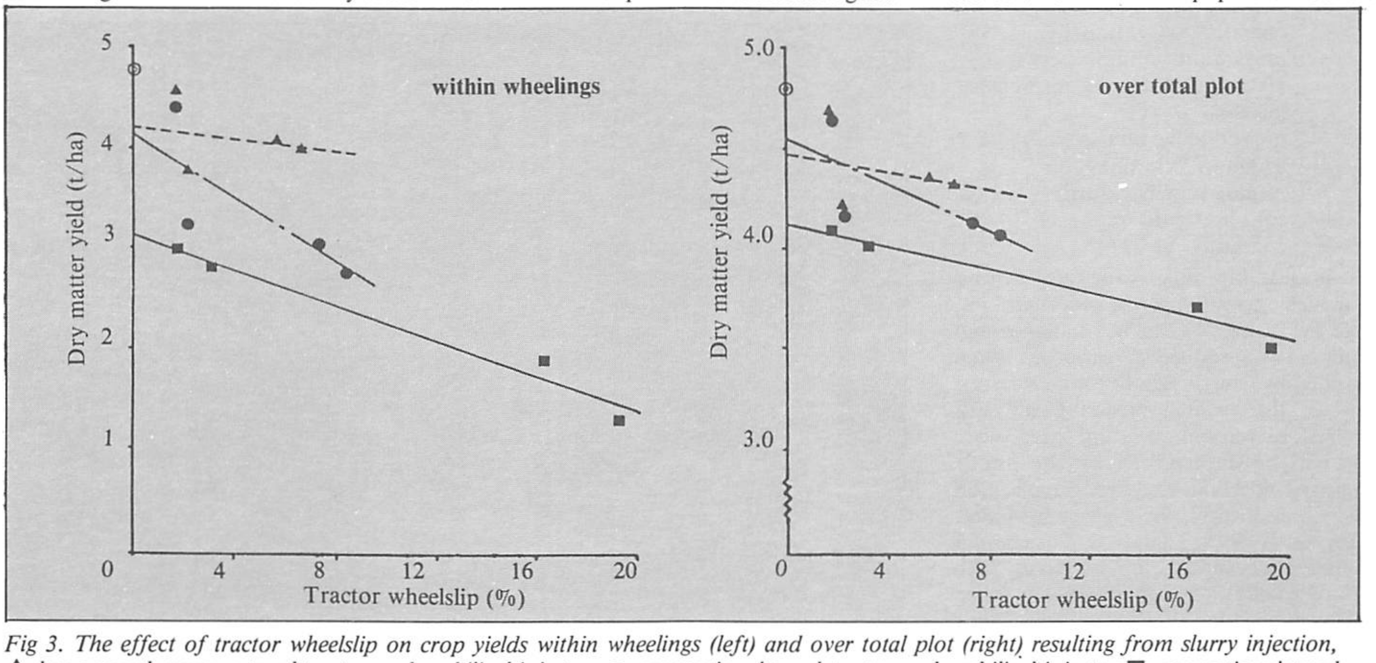

Fig 3. The effect of tractor wheelslip on crop yields within wheelings (left) and over total plot (right) resulting from slurry injection, ▲ low ground pressure tyred tractor and umbilical injector; ● conventional tyred tractor and umbilical injector ■ conventional tyred tractor and tanker-mounted injector, ◎ unwheeled control.

Table 3. Comparison of the number of actual lost working days from machinery operations with estimated lost working days from weather data for various machine systems on two soil types over three winter periods (1st October to 31st March).

Machinery operation	*Soil type*	*Lost working days*					
		1986-87		*1987-88*		*1988-89*	
		Act	*Est*	*Act*	*Est*	*Act*	*Est*
Conventional tyred tractor	clay	24	25	70	70	–	12
and tanker injector	sand	–	8	37	42	–	6
(excess water > 0mm)							
Conventional tyred tractor	clay	7	2	33	36	–	4
and umbilical injector	sand	–	0	9	13	–	2
(excess water > 7.5mm)							
Lgp/dual wheeled tractor	clay	0	0	10	18	0	2
and umbilical injector	sand	0	0	0	4	0	0
(excess water > 15mm)							

on tractor with conventional tyres would enable storage periods to be reduced to 90 days, due to the improved trafficability and reduced damage from the lighter machine.

Further reductions in storage could be obtained if low ground pressure tyres were fitted to the tractor. This, however, could increase the risk of leaching under cold, wet conditions, when crop growth is at a minimum. Consequently, a minimum storage period of 90 days should be adhered to, enabling slurry to be stored until early in the new year, reducing the risk of leaching, and enabling the nutrients to be applied at a time when crop growth starts as spring temperatures increase.

Significant improvement in machine capacity with umbilical system

The work rate of all agricultural machine systems can be estimated using the formula developed by Hunt (1979) which gives:

$$C = SWLEw/(k_1L + DSWLEw + k_2St)$$

where:

- C = effective machine capacity (ha/hr)
- S = operating speed (km/hr)
- W = rated width of implement (m)
- Ew = effective width of implement (decimal of w)
- D = unproductive time (hr/ha)
- L = length of field (m)
- t = turning time (sec/turn)
- k_1 = constant = 10
- k_2 = constant = 2.7778

It is clear that high work rates depend upon high operating speeds, wide machines, large fields, quick turns at headlands and minimum unproductive periods. When considering slurry application systems, however, the machine spreading width will be fixed, as will the operating speed, since this will be determined by the pump capacity, and the required application rate. Consequently, for a given field size, quick turns at headlands and minimum unproductive periods are required. Such periods include the transportation and filling of tankers and the setting up and dismantling of umbilical pipelines.

Table 4 summarises the spreading times for various slurry applications systems operating in a 10ha field, 500m from the slurry store, the information being gathered from detailed time and motion studies of a range of machine systems in operation.

The results show the significant improvement in machine capacity achieved by the umbilical system, due entirely to the much reduced unproductive times involved.

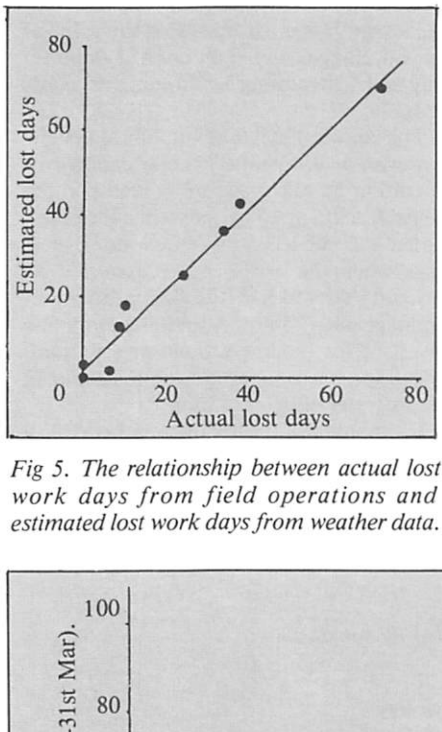

Fig 5. The relationship between actual lost work days from field operations and estimated lost work days from weather data.

In the case of the tanker-mounted equipment, a greater proportion of the total time for each load is unproductive, involving the filling of the tanker at the store, and transport to and from the field. However, with the umbilical system, once the pipeline has been set up, there is no more unproductive time until the field operation has ceased, and the pipeline needs to be moved, giving rise to machine capacities of greater than twice those of equivalent tanker-mounted systems.

The effect of transport distance, field size and slurry tanker size on machine capacity are presented in Fig 7. The results show that transport distance has a slightly greater effect on the machine capacity of tanker systems comparted to umbilicals, although both reduce by approximately 0.08 ha/hr for every 1km increase in distance.

Field size, however, has little effect when using tanker equipment for fields greater than 2 ha in size, but does have a significant effect on umbilical systems for fields of less than 10 ha, although the performance is still significantly better than tanker equipment. However, for very small fields, *i.e.* less than 2 ha, then the use of umbilical equipment would appear unsuitable owing to the greater proportion of time involved in setting up and dismantling of the umbilical hose.

Increasing slurry tanker size can also affect machine performance with a 50% increase in machine capacity from 0.2 to 0.3ha/hr, apparent when tanker size is increased from 5m³ to 10m³. Smaller increases occur as tanker size increases further, with a machine capacity of 0.4 ha/hr achieved with tankers of 20m³ capacity. However, at this size, very much larger tractors would be required for stability,

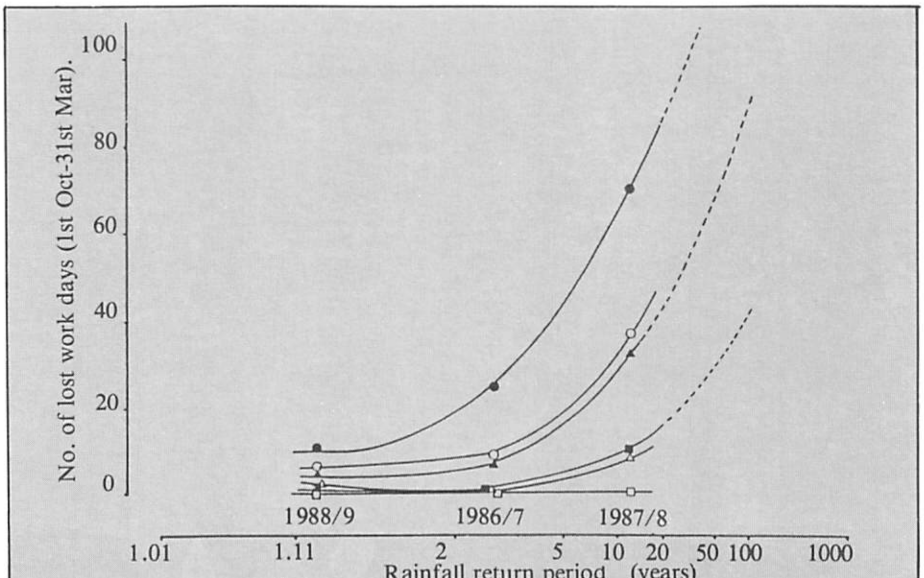

Fig 6. Relationship between number of lost winter work days and rainfall return period. (●○) conventional tyred tractor and tanker injector, (▲△) conventional tyred tractor and umbilical injector, and (■□) low ground pressure/dual wheeled tractor and umbilical injector. Operating in a clay soil (closed symbols) and a sandy loam soil (open symbols).

Table 4. Comparison of slurry application times for tanker and umbilical injection equipment with conventional surface application, operating in a 10 ha field situated 500 m from slurry store.

Operation	*Conventional splash-plate tanker*	*Tanker-mounted injector*	*Umbilical hose injector*
Field application time/ha (mins)	48	61	61
Turning time/ha (mins)	–	7	12
Transport to and from field – (mins/load)	9	9	–
Filling time at store (mins/load)	12	12	–
Number of loads per hectare	7	7	–
Set up umbilical pipeline (mins)	–	–	35
Dismantle umbilical pipeline (mins)	–	–	40
Time to cover 1 ha	195 mins	215 mins	148 mins
Time to cover 10 ha field	32h 30mins (1950 mins)	35h 50mins (2150 mins)	13h 25mins (805 mins)
Machine capacity	0.35 ha/hr	0.28 ha/hr	0.75 ha/hr

resulting in a 20% increase in operating costs.

Cost of slurry disposal

The cost of injecting slurry by both tanker-mounted and umbilical hose equipment can be estimated for any given livestock system, when the details of slurry production and machine performance are known.

Comparing the two injection systems for a mixed livestock enterprise of 1500 pigs and 100 dairy cattle, producing a total of 10 m^3 pig and 6 m^3 cattle slurry per day, shows a cost reduction of approximately 55 p/m^3 or 10% in favour of the umbilical hose injection system. This amounts to an annual saving of over £3,000 by using the umbilical system, as a result of the increased machine capacity reducing the variable input costs, such as fuel and labour requirements. The ability to reduce storage capacity and tractor power requirements also reduces the initial capital expenditure, and hence fixed costs.

Comparing the costs of injection with conventional surface application shows costs increasing by 20% for umbilical injection, and up to 35% for tanker-mounted injectors. However, the injection operation significantly reduces the odour produced from slurry spreading (Phillips *et al,* 1988), enabling slurry to be applied to fields previously barred to surface application due to the proximity of housing. Such fields are often close to the slurry storage area, and so savings in transport costs can be made.

Full details of the costs of alternative slurry treatment and spreading systems for controlling odour are given in Warner *et al,* 1990.

Conclusions

- Umbilical injection equipment requires 25% to 50% less power than tanker injectors, depending upon soil and crop conditions. This is due to the increased draught forces on the injector tines resulting from increased soil compaction caused by the tanker ahead of the tines.
- Fuel consumption by umbilical systems is generally 20% to 30% less than tanker systems during field operation. The umbilical system requires a second tractor for the supply pump but the fuel usage of this tractor is balanced by the fuel used during transport for the tanker system.
- Umbilical injection can lead to a greater than 50% reduction in wheelrut damage, compared to tanker-mounted injectors, when operating under wet soil conditions.
- Early spring injection can lead to a 20% loss of yield, due to wheelings, when using umbilical equipment. However, this contrasts with a 30% yield reduction when using tankers.
- Umbilical equipment can operate for a much longer period throughout the winter, compared to tankers, due to the reduced weight on the field. Further benefits can be achieved when low ground-pressure tyres are used.
- Slurry storage periods of 140 days, recommended by ADAS, can be significantly reduced when operating umbilical injection equipment. However, a 90 day minimum storage period should be adhered to for environmental reasons.
- Umbilical injection systems can achieve work rates greater than twice those of equivalent tanker injectors, providing fields are greater than 10 ha in size.
- Tanker injection equipment is to be preferred when field sizes are less than 2ha due to the higher proportion of unproductive time involved in setting up and dismantling umbilical pipelines.
- The cost of umbilical injection is generally 10-15% less than tanker injection, reflecting the higher work rates and the ability to reduce storage and tractor power requirements.
- Injection is generally 20% more expensive than conventional surface applications but significant reductions in odour can be achieved often enabling spreading to be conducted in fields close to the slurry source.

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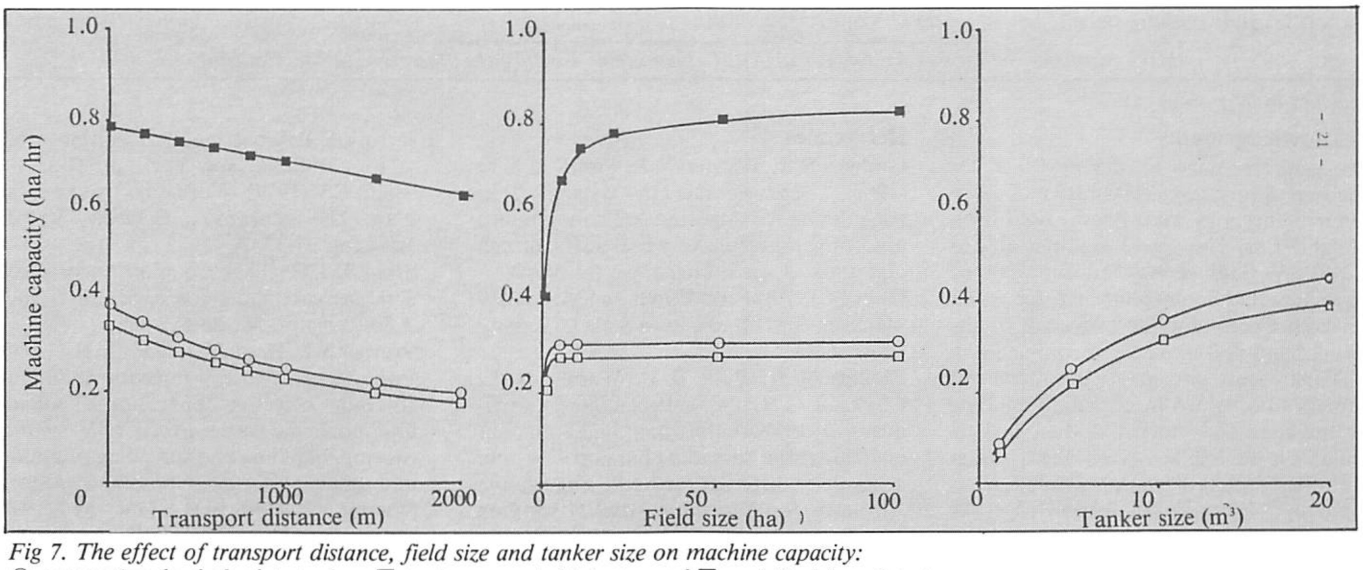

Fig 7. The effect of transport distance, field size and tanker size on machine capacity:
○ *conventional splash-plate tanker;* □ *tanker-mounted injector and* ■ *umbilical hose injector.*

STANDARDS

Review of recent British Standards

by M D P Matthews

BS6913 : Part 1 : 1989 (ISO 4510-1:1987) **Operation and maintenance of earth-moving machinery. Part I Guide to common maintenance and adjustment service calls** (7 pages)

This British Standard is a guide to the tools commonly used for carrying out on-site maintenance and routine adjustments on earth-moving machinery. A table is also provided showing the tools required for 38 different servicing tasks.

BS6916 : Part II : 1989 **Chain saws. Part II. Specification for general design, performance, safety and construction requirements for internal combustion engined machines** (6 pages)

Throughout this Standard the technical terms used follow the definitions provided by BS6916 : Part 1. This British Standard requires the general design of chain saws to minimise the hazards to operators and bystanders. Provision of two handles, a stopping device which does not require sustained effort, and all other controls are specified in relation to an operator using protective gloves. The need for a guide bar cover is specified when the saw is out of use. Chain brake operation and performance and maximum rotational kick-back angle is specified. Aspects of the design to protect the operator in the event of chain breakage or derailment is included. The balance of the machine, the design and strength of the handles and the front handguard are detailed along with the design and operating features of the clutch and the throttle control, including the throttle trigger lock-out and a lock for cold starting. The positioning of the exhaust is specified in relation to heat and fumes. Maximum levels of noise and vibration are specified and the use of fail-safe vibration isolators is stressed. Recommendations are made regarding manual/automatic oiling, fuel and oiltank filler sizes and the ignition circuit. Markings are specified to be legible, contrasting to the background, permanent and well positioned using symbols specified by other British Standards. A minimum of six markings are required. Technical data must be available on request but an operator's manual and user's instructions are recommended. Eighteen items are listed as the minimum to be covered by the user's instructions. The provision of tools for principal adjustments and maintenance is recommended.

BSAU50 : Part 1 : Section 3 (ISO 4250-1:1988) **Tyres and wheels. Section 3. Off-the-road tyres**
Sub-section 3.1 : 1989 Specification for narrow and wide base tyre designations and dimensions (7 pages)

This Standard specifies the way tyres are designated in terms of the tyre size and constructional code and the index of tyre strength. Other optional markings are specified as preferred direction of rotation, tubeless tyres, service code and rim type. Tables of dimensions are provided for narrow and wide base tyres and for narrow base tyres mounted on 15° rim contours. Corresponding tables are provided for the dimensions of the wheel rims. A recommendation for the spacing of dual wheels is provided and the method of measurement of tyre dimensions is summarised.

Sub-section 3.2 : 1989 Specification for narrow and wide base tyre loads and inflation pressures (10 pages)

This section gives working definitions of masses and load cycles and sets out tyre loads and reference inflation pressures for narrow and wide base off-road tyres. The masses defined are the maximum load, the operating mass, the optional equipment mass, mass of special modifications, payload, tyre ballast and field modifications. Operating conditions are also defined in terms of maximum speed, the earth-moving haulage cycle, loader cycle, load carry cycle, dozer (tractor) cycle, grader cycle, creep and drive away. Six tables cover the loading and inflation pressures covering diagonal ply and radial tyres, short hauls at a reference speed of 50 km/h, slow speed service at 10 km/h for narrow based and wide based tyres. Users are recommended to consult with manufacturers of tyres over conditions outside those specified in the tables and with wheel and rim manufacturers over strength in intended service conditions.

BS7006 : 1989 (ISO 8912-1986) **Trailed agricultural rollers** (3 pages)

The characteristics of roller coupling devices and the section width dimensions are specified for rollers used on soil. With reference to ISO 500 and ISO 4254/1, both relating to agricultural tractors and machinery, the coupling halves, *i.e.* ring and clevis, are specified with regard to size, articulation, pitch height and positioning. Examples are given of methods of hitching 3- or 5-section rollers for work or transport.

further reviews, page 56

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Acknowledgements

The authors wish to acknowledge the financial support of the Ministry of Agriculture, Fisheries and Food, Ford New Holland Ltd, Undergear Equipment Ltd and BKW Engineering Ltd for loan of machinery and equipment, and the Water Research Centre for the provision of the draught and fuel monitoring equipment.

Thanks must also go to the numerous farmers who helped in obtaining the data for the time and motion studies, in particular Chris Holt at Severn Trent Water Authority's Stoke Bardolph Estate.

Finally, we wish to acknowledge the technical support given by David Atcheson and David Blackburn throughout the period of this study.

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The role of irrigation in Czechoslovak agricultural development

J. Bodnár and L. Janský explain the importance of irrigation in Czechoslovakia. They point out that irrigation is helping to establish better balanced systems of agriculture and is showing big improvements in yields of many crops. Sprinkler irrigation predominates and has already achieved a high level of automation. Emphasis now is on economy in use of water and power and on promoting the most efficient management of irrigation installations.

J Bodnár

L Janský

Czechoslovakia's territory, looked upon as Europe's heart, lies in the area of the Central European transient climate.

In the areas where maritime air masses are dominant, the winters and summers are moderate with sufficient precipitation. Elsewhere, the dominant effect is from the continental air masses; winters are cooler and summers are warmer; there is less cloudiness and a longer duration of sunshine; rainfall is more irregular and there can be occasional drought.

It is Bohemia, the western part of Czechoslovakia, which has the more moderate climate, and Slovakia, the eastern part of the country, which has the greater variation in climate and the greater need for irrigation. The most rainless area in Slovakia is the Danubian lowland with annual precipitation of only 400-600mm.

From the point of view of cropping suitability, Czechoslovakia has been divided into three basic climatic areas. These are:-

the warm area – in this area the more demanding thermophilous plants (tobacco, maize, vegetables) thrive well

the moderately warm area – the areas for profitable winter wheat and sugar beet cultivation

the cool area – thermal conditions in this area are not favourable for cultivation of the more demanding cereals.

Dr Jan Bodnár is Director of the National Land Reclamation Centre in Bratislava and Member of the Czechoslovak National Committee of International Commission on Irrigation and Drainage.

Dr Libor Janský is National Land Reclamation Centre Specialist, Bratislava and Member of the Czechoslovak National Committee of ICID. He was Czechoslovak Visiting Scholar at University of Oxford in 1989.

The demarcation of these areas, coinciding with the main irrigation areas (especially the warm area) is presented by several authors (Bodnár J *et al,* 1986; Havliček V *et al,* 1986; Holý M *et al,* 1976).

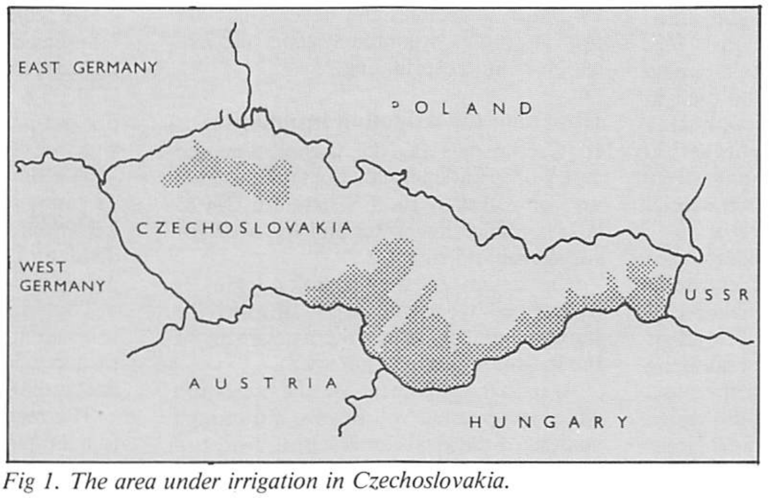

Fig 1. The area under irrigation in Czechoslovakia.

Benefits of irrigation

The amount of irrigation required is determined by many factors (Holý M *et al,* 1976) but especially climatic ones, in the course of the growing season from April to September. Experience gained from agricultural production over the last ten years shows that even with high economic inputs into the soil, water continues to be one of the limiting factors of agricultural production.

At present it is the most fertile soils which show the most effect of water deficits. In Czechoslovakia's important production areas the moisture deficit of agricultural crops varies within the range of 1500-2500 m^3/ha in the growing season.

The major benefits of irrigation lie in replenishing the deficit of soil water; in optimising the water regime of cultivated crops and in eliminating the effects of the non-uniform distribution of natural precipitations.

However, irrigation has a broader effect on the intensification and stabilisation of agricultural production. Bodnár J *et al,* 1986 identify the following advantages:

- allowing effective concentration and specialisation of important branches of the vegetable industry and fruit farming.
- creating conditions for continuously achieving high fodder yields thus stabilising animal production.
- facilitating soil cultivation and preparation in periods of drought – with consequent cost benefits.
- allowing changes in agricultural systems to give two harvests a year, or three harvests in two years.
- extending season of green forage for cattle from early spring to late autumn, thus assisting in establishing a balance between animal and plant production.
- creating higher organic matter production in the soil in the form of plant residues or as direct plant production for green manuring, thus increasing the humus content of the soil and maintaining and improving yield potential.
- generally being highly effective in improving the economics of production.

In addition to the optimisation of the moisture conditions of plants and soil, irrigation may also be utilised for other purposes: –

- the application of inorganic and organic fertilisers to plants and soil.
- air conditioning, frost-control and protective purposes.

Open pumping station – Dyjákovice

Hose reel irrigators predominate

At the present time the design and manufacturing programme for irrigation is based on irrigation by sprinkling. Development is aimed at attaining maximum economy in water and power consumption together with a high level of mechanisation and automation of the work in the field.

For the future it is forecast that, up to 1995, hose reel irrigators will be used in 60 percent of the irrigated areas, with large scale irrigation machines in a further 30 percent and various other special systems (such as drip and point and other special systems) in the remaining 10 percent.

The established large and medium area irrigation installations with underground pressure distribution of water, inclusive of pumping stations, involve a high level of engineering knowledge. Irrigation pumping stations are fully automated. In the past, typical pumping station output varied between 5-40 l/s but during 1955-60 large-area irrigation systems were constructed in which the capacity of pumping stations reached as much as 600 l/s. At present pumping stations are being designed and constructed to supply areas of 5000 up to 10,000 ha, with capacities of as much as 2500 l/s and more.

For other irrigation facilities (portable units, etc) pump capacities range from 14 to 535 l/s. A development in hose reel irrigators has been the change to turbo drive from the earlier piston drive and, since 1978, large scale pivot irrigation machines of the Fregat type made in the USSR have also been used.

A marked advance in irrigation engineering is now witnessed by the Czechoslovak electrified large scale SIGMATIC pivot irrigation machine, available in various modifications. This irrigator offers central control with complete automation. Depending on the arm length it can irrigate an area of 8-50 ha, and gives an output of 20-50 l/s at a hydrant pressure of 300-700 kPa. High quality and uniform application rates are also provided by the new HRON and PZ-PALAVA-type high performance hose-reel irrigators.

Recently, specialised types of irrigation have started to be widely used – stationary irrigation systems for irrigation of orchards, vineyards, vegetables and hops. These are drip and point irrigation systems and irrigation by microsprinkling.

Designing the irrigation installation

In Czechoslovakia, the preparation and design of irrigation installations and facilities are controlled by the CS standard ON 83 0635 – Irrigation water and the need for supplemental irrigation.

The design of the irrigation plant is determined by various factors of which the starting point is clearly the assessment of the irrigation water requirement.

A proper assessment of the irrigation water requirement will involve a thorough analysis of the local climatic, soil, field and other conditions.

The determination of irrigation water demand begins with the premise that the soil moisture must be kept within optimal limits by supplemental irrigation. The parameters covering the design of the irrigation plant are thus: –

- irrigation water requirement – m^3/ha
  - in an "average" year
  - in a "standard" dry year
- timing and rate of application of the irrigation water – m^3/ha
- critical supply rate – l/sec/ha
- regular supply rate – l/sec/ha.

The **irrigation water requirement** is defined as the quantity of water needed to be supplied, during the growing season of the crop, per unit of area, to replenish the natural water content in the soil and to compensate for all water loss, except for water loss in the supply system.

An **"average" year** is characterised by the arithmetic mean of monthly precipitations through the growing season over a twenty year period. A **"standard" dry year** is defined by the so called standard precipitation fixed for the growing season. This standard precipitation is a variable quantity depending on the climatic and cultivation conditions of the area in question.

Determination of water provision and precipitation through the growing season in a "standard" dry year Z_z depending on water requirement of agricultural crops V_c is based on a theoretical transgression curve of precipitation fixed for growing season Z_v (Fig 2). Z_1 means the limit of precipitation provision, Z_2 is a limit of water provision with p % transgression probability.

The **timing and application rate** of the irrigation requirement is represented by the behaviour of the assumed demands by individual crops for the irrigation water provisions during the growing season.

The **critical supply rate** is that required to maintain a functional moisture regime in a critical rainless period for the most demanding crop within the crop rotation.

The **regular supply rate** is that required to maintain the functional moisture regime of all crops in the irrigated area within a long-term average.

Utilisation of irrigation

Up to the present, irrigation installations

Seasonal transferrable pumping station.

covering 462,000 ṽ ha have been built in Czechoslovakia. This represents 6.8% of the agricultural area and 9.6% of arable land. Slovakia has an essentially higher proportion of irrigation, in view of her climatic conditions, namely 13.5% of agricultural area and 22.0% of arable land. Within Slovakia, irrigation structures are concentrated into the West Slovakian region which has the highest proportion in irrigation, namely 24.5% of agricultural area and 29.0% of arable land.

Irrigation represents an important intensifying agent and stabilising factor in the Czechoslovak agricultural system.

If, under irrigation, phyto-production rises by 1.75 tonnes per ha in a year, the total annual phyto-production increase amounts to 0.8 million tonnes annual. This increase, however, is attained only if irrigation is correctly applied. Correct application has sometimes been a problem, especially in the early years.

The utilisation of irrigation works is affected by a complex of economic, engineering and social factors. It goes beyond the scope of this article to analyse them in detail.

To begin with, in Czechoslovakia the first large-scale irrigation systems were embarked upon only in the nineteen-seventies. Irrigation had no tradition and it is only from seeing the benefits in top agricultural enterprises that there has been a gradual spread in adoption of irrigation elsewhere throughout the country. Now there are regions where irrigation is thoroughly utilised and where the agricultural enterprises exchange knowledge and experience with one another and cooperate closely with irrigation research. Nevertheless, there are similarly other regions where there are still reservations about utilising irrigation.

A similar situation is also to be seen with the irrigation of individual crops. The first crops to be irrigated are those that best respond to moisture, such as vegetables, forage crops and maize. Only later is irrigation used on other crops, such as densely sown cereals, intermediate crops, etc. This delay in achieving full utilisation can no doubt be overcome as more training and instruction is provided, particularly in the early days of installation of new irrigation plant. Instructions for managing irrigation systems are available from research establishments.

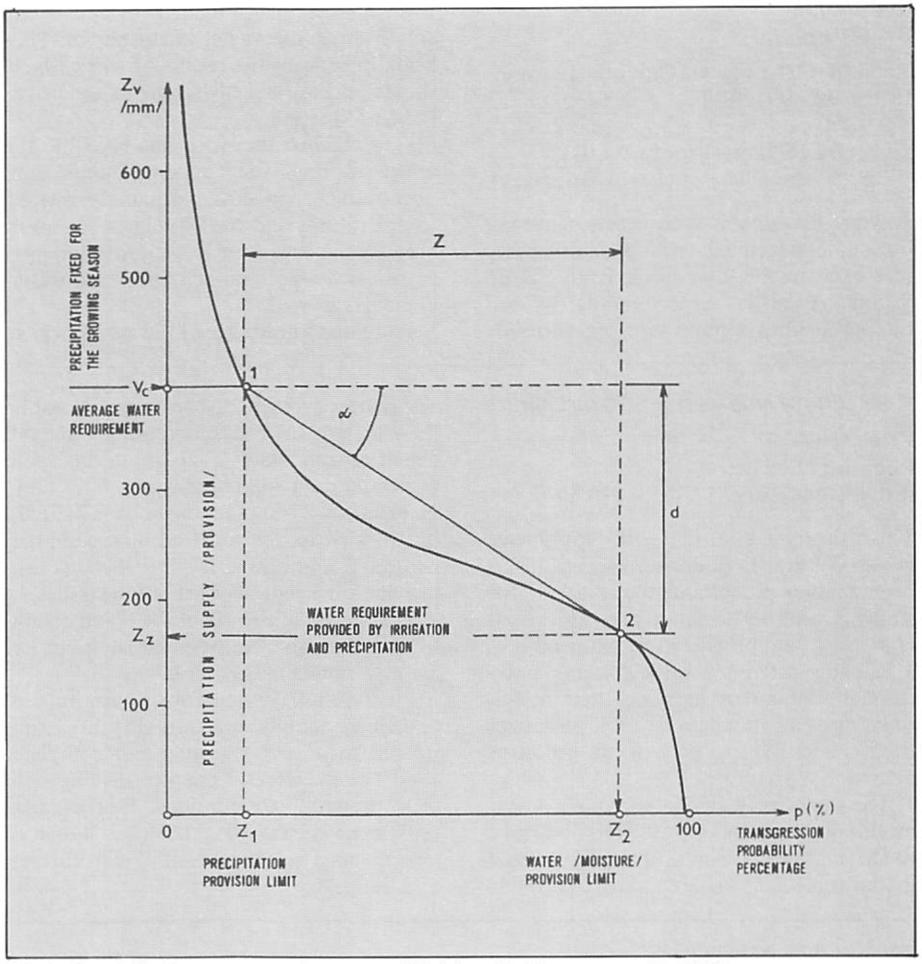

Fig 2. Precipitation transgression curve (Heinige V, Klementova E, 1990).

Assessment indicators of irrigation use

An important issue is the development of indicators for objective assessment of the utilisation of irrigation systems.

Data on the irrigated area and the water supplied provide basic information on the utilisation of irrigation. Readings are checked weekly, monthly and also for the growing season as a whole on the basis not only of enterprises, districts, regions and the Republic but also according to the areal utilisation of the irrigation installation – that is, the percentage of the area actually irrigated compared to the area covered by the installation. Also calculated is the volume of irrigation water supplied per unit of area.

According to Čislák *et al*, 1988, the real utilisation of irrigation up to 1970 did not exceed 59% and 573 up to 1000m³ of water were supplied to 1 ha. In the years 1981-1985 the areal utilisation of irrigation in Czechoslovakia varied from 70.4% to 86.5% (in Slovakia 91.7%) and 709 up to 1182m³ of water were supplied per hectare. There has been a further rise in 1986 in the level of irrigation utilisation in Slovakia – to 95.2% areally and 1120m³ water supplied per ha.

The areal utilisation of irrigation and the amount of water supplied are, however, only general indicators. Additional indicators are therefore required to assess the specific utilisation of irrigation, such as, for example, the number of applications, irrigated intermediate crops, presowing irrigation, water supplied according to the particular crops, etc. This refinement in assessment indicators, however, still does not give an objective picture concerning the need for supplemental irrigation and the degree of its utilisation.

In 1987, therefore, a programme was set up to evaluate irrigation utilisation in terms of the humidity requirements of plants. From this indicator, an 87.8% coverage of the moisture deficit was achieved on average in 1987 for Slovakia (Moravík S, 1988). For the main irrigated crops (vegetables, maize, perennial fodder crops and densely sown cereals) humidity requirements were satisfied by up to 90%. These results testify to the increased quality of irrigation utilisation.

It is essential to obtain the necessary data to ensure that the moisture deficit is satisfied. Hence, the method of irrigation control – irrigation scheduling – has been combined with the assessment of irrigation utilisation.

Irrigation scheduling is provided on two levels:- in accordance with the basic data, forecasts are made for the Republic as a whole and also for certain specific agricultural enterprises. The specific agricultural enterprises are those where irrigation forms a particular element of their farming practice along with an advanced level of irrigation management – meaning that they are capable of carrying out irrigation scheduling and irrigation assessment in great detail and very exactly within their economic district and on the basis of actually measured meteorological data and actual crop sequences.

The program for computer application has been provided from irrigation research.

State involvement

The question often asked is why State Authorities are concerned about the utilisation of irrigation. This is primarily due to the fact that investments into irrigation

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Soil biology
by M Wood

Publisher: The Blackie Publishing Group
ISBN: 0-216-91782-4 £23.00 (hardback)
0-216-91786-7 (pbk) £10.95 (paperback)

Anyone like myself with a major interest in soil management, will be particularly interested in this new book from Martin Wood. A better understanding of soil biology is always important but currently this interest is stimulated by increased concern to conserve natural resources. This book introduces the results of work which should improve soil environments and hence food production.

It is claimed the work has been mostly aimed at final year undergraduates and postgraduate students particularly related to agriculture and the biological sciences. However, I suggest it is a useful reference work for a whole range of soil and water engineers as well.

Increased knowledge of the way in which organisms modify and develop soil, interact with plant roots, as well as the environment in which they live and how it may be modified to encourage positive activity are important to improved soil management.

With these thoughts in mind I can recommend this work as a well presented, easy to read reference. I was particularly impressed with the use of illustrations and figures to augment the text. There is also a carefully prepared reference list for those wishing to broaden their reading.

MJH

Agricultural engineering soil mechanics
by E. McKyes

Publisher: Elsevier
ISBN: 0-444-88080-1 Price £36.50

This is the tenth book in the "Developments in Agricultural Engineering" series. It has been written predominantly as a text for students aspiring to enter the profession. However, I am pleased to recommend it as a valuable reference work for any practitioner wishing to improve their understanding of the foundation of soil mechanics theory and its applications to problems related to agriculture.

The main difficulty in compiling a text on this diverse subject must be to do justice to all components. This problem shows itself in that some chapters are unable to provide adequate coverage of the topic. Notably these include the chapters dealing with soil classification, water flow to drains, soil protection and soil compaction. This may give the impression that the book is limited, but it must be remembered how wide the subject is and how difficult it becomes to provide sufficient depth to all the issues.

Despite these drawbacks it is important to dwell on the considerable number of positive points in the book.

Firstly, though some topics have limited coverage, equally many others are considered in a very rigorous and complete way. This includes the chapters dealing with soil strength, foundations (particularly settlement methodology), slope stability, lateral earth pressures and "soil cutting and tillage".

Secondly, the book is extremely well presented in a very readable style augmented with many excellent descriptive figures and diagrams. There are also problems set at the end of each chapter to help the learning process as well as an exhaustive list of references.

The introduction of geotextiles and the problems of soil freezing are refreshingly new and provide an insight into these less commonly covered areas.

One final small criticism is that the subject index is poor and does not match up to the quality of the rest of the work.

The book is an excellent effort to cover a very broad subject. It can be recommended to anyone with an interest in soil mechanics and its relationship to Agriculture.

MJH

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are until now shared with up to 85% from the State and only 15% by the agricultural enterprise. Hence the State monitors the overall utilisation of irrigation works by various economic tools and information.

On the other side, the agricultural enterprise is interested in achieving an optimum economic return from the investment, this being made possible by the irrigation scheduling of the actual system or the agricultural enterprise.

Irrigation increases yields

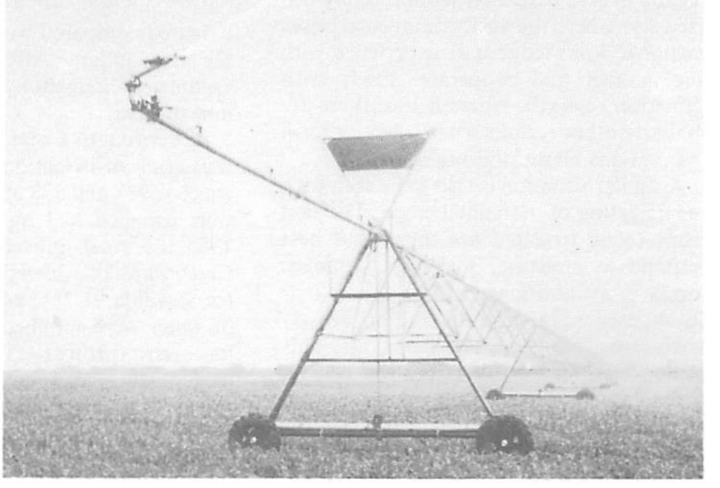
The most pronounced effect of irrigation, however, is seen in rising yields. Research has produced evidence that under experimental conditions irrigation increases crop yield – by 24.1% (winter wheat) up to 80% (perennial fodder crops), as compared to conditions without irrigation.

The positive effect of irrigation upon crop yields is also borne out by the results of a selected group of 36 agricultural enterprises. They furnish evidence of the increase in crops by irrigation from 12.4% (sugar beet) up to 35.5% (perennial fodder plants).

Results from other experiments are increases of 50% for intermediate crops, 30% for fruit bearing trees, 20% for vine and potatoes (early potatoes) and 10-18% for cereals and sugar beet.

Future trends

Clearly, irrigation is very important in Czechoslovakia agriculture and especially so during dry periods. The existing trends will continue but with increasing emphasis on economies of water and power in design and management and on the refinement of irrigation scheduling systems.



Large-scale centre pivot irrigator SIGMATIC.

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Drying and storing combinable crops (2nd edition)
by K. A. McLean

Publisher: Farming Press, Ipswich, 1989.
ISBN 0-85236-193-9 Price £19.95

There can be few members of the Institution, who have not encountered the first edition of Ken McLean's book, which appeared in 1980. At the time it was remarked as "filling an obvious gap in the farming library" and was commended for setting out, "in good practical terms, the means by which success ... can be achieved". These observations are equally applicable to the second edition, which is a slightly expanded version of its predecessor, updated to take account of research and development which has occurred in the last 10 years.

Some specific additions to the book include a short section dealing with the electrical loads imposed when fans are started and an expanded section on integrated fan/heater control, which goes on to discuss humidifiers and to make a comparison of relative humidity and fan control policies. Greater attention is paid to duct design and layout, special mention being made of the phenomenon of static pressure regain, and its implications.

There is a slightly expanded treatment of maximum safe drying temperatures and of the perhaps little-known practice of dryeration. The author, wisely, counsels caution if this example of technology transfer from USA is to be applied to British cereals – but he points out that it *has* been used successfully in UK and implies that it should not be ignored.

Moisture content measurement merits half a chapter and Ken McLean emphasises the inherent difficulties in determination of this important aspect of grain quality. The emphasis is nowhere more apparent than in his sub-heading "Inaccuracy during the determination of Grain Moisture Content".

The control of insect and mite pests – another important aspect of quality maintenance, particularly after an unusually warm summer – has again received due attention, with the introduction of a section on the detection of insect pests.

The reader has his attention drawn to aspects of legislation which relate to noise generation by typical drying plant. This, together with a final chapter on Safety Matters, provides a timely warning to those who may otherwise be tempted to neglect their social and legal obligations.

Overall, the book is good to handle, having a slightly larger page size than its predecessor, and it includes a wide range of attractive colour plates. Each chapter concludes with an appropriate selection of references.

A comprehensive index is the final component of this workmanlike publication.

BCS

An introduction to operational control rules using the 10-component method
by Allan Lambert

British Hydrological Society Occasional Paper No. 1

This publication, from the British Hydrological Society, will interest all those involved in water resource systems.

The guide has two objectives:-

i) to provide a basic framework and terminology,
ii) to encourage others to devise and use simple practical control rules.

The author outlines the ten general components required for a set of control rules and shows how these components are developed and combined to produce a control method for a particular problem.

The method has been used in some existing systems with considerable success, the results of which are presented in this paper. An aim is to develop the confidence and expertise of those wishing to use and understand the ten component method.

It is written in an easy to follow structured text accompanied by useful figures and diagrams. Although a very specialised document, it will be extremely useful to anyone involved in water resource development.

MJH

English Agriculture: An historical perspective
by David Grigg

Published by: Blackwell Oxford 1989
ISBN 0-631-16033-7 Price £32.50

There are many examples now in the literature of works highly critical of farming in Britain. These include criticism of the treatment of animals, the cost of supporting high farm prices and the absurdities of food surpluses. The environmental issues have also been regularly aired; the use of large machinery and improved drainage has removed hedgerows and much wild life habitat, excessive use of nitrogen has polluted water supplies. The main aim of this book is to provide a more balanced insight into farming in England and Wales in the 1980's.

The focus of the work is the wide variation of farming production giving an account of the agricultural geography of the regions as major change looks likely. However, this for me plays only a minor role in this excellent publication. The real merit of the work lies in the excellent way the author leads us through an historic account of our farming past. From this basis are the arguments made for the present patterns of farming.

The author suggests that the major changes have been carried out in the technological climate of the last quarter century. However, using a whole range of carefully presented statistics the causes and effects of agricultural change are charted for the last three centuries.

From this base the reasons for policies and strategies are presented. It is a fascinating approach and makes a very good read. Much more importantly it presents in a balanced way the issues we now face and how they came about. This perspective must then give a basis for an improved insight to future trends.

I can only recommend you to a book which may well improve your perspective of English Agriculture.

MJH

Farm machinery cost guide

Available from: Agro Business Consultants Ltd., Melton Mowbray, Leics.
ISBN 0-9514588-0-9 Price £30.00

This cost guide contains twelve sections dealing with machines as varied as tractors and food mixers. Indeed more than 300 items are considered.

The user will be able to calculate the cost per hour or per acre of each machine for a given price, annual working hours and work rate.

The method of calculating costs is presented and shows that the techniques used are commonly accepted techniques. As always the estimation of spares and repairs costs presents difficulties, the authors falling back on well tried methods and their own data base.

The quality of results very much depends on these estimates being reasonable, and readers need to appreciate this. For the rest, the book is a well set out ready reckoner of costs for a range of machines and the parameters discussed earlier.

It will be appreciated that these calculations could be carried out by anyone competent in computer use and basic economics. However, considerable time and effort would be needed to produce useful results – hence the underlying value of this guide book.

The authors' aim is to provide the practitioner with the ability to calculate machine costs to compare with alternative techniques such as contract or hire. They review the cost of machinery combinations to improve efficiency – in considering alternative purchases or in budgeting alternative enterprises.

It should be pointed out, of course, that the information will age. The authors have confronted this problem by providing variation tables for instance on purchase price and have produced the book as a loose leaf so that updating will be possible.

I found the information well presented, easy to access and use. Farmers, managers, consultants and agents could find this book a valuable tool.

MJH

Management systems to reduce impact of nitrates

Edited by: J C Germon
Publisher: Elsevier Applied Science Publishers Ltd, Barking, England.
Price £36.00

Supported by the Commission of the European Communities, this book includes papers presented on "Management systems to reduce impact of nitrates" organised within the framework of the Community Programme on Land and Water Use Management. The meeting, held in Brussels during September 1987, had the following aims:-

- to provide an overview of the different methods developed in EEC countries to limit and, if possible, to reduce nitrate pollution due to agriculture;
- to record the main steps of the nitrogen cycle by which it is possible to control nitrate availability in soil and to evaluate recent progress;
- to highlight areas needing more research in order to manage more efficiently the nitrogen cycle in agriculture.

To meet these aims the book presents progress from the seminar in five sections:-

i) Nitrogen balance in agricultural systems.
ii) Management of livestock effluents in order to reduce nitrate leaching.
iii) Agricultural practices to reduce nitrate leaching.
iv) Nitrogen availability in soil.
v) Optimisation of nitrogen fertilisation.

The work is in the form of scientific papers each complete with abstract, introduction, usually experimental method, discussions of results, conclusions and a full list of references. It is therefore very much a reference work and will be limited predominantly to others working in this field. There will also be interest in the work for students and academics with interests in the impact of nitrates. In this context the book will be a valuable addition to the literature as it contains work from all parts of Europe carried out by many of the best known and regarded scientists in the field. It represents the "state of the art" relating to the fate of nitrates.

One criticism is the conclusion and recommended section. Here, surely, was the opportunity to develop much of the excellent work represented in the book. However, although some points are well argued the method has not really been grasped and the conclusions are much less punchy, precise and forward thinking than expected.

The book is well presented and the index and references are excellent. As a reference on the topic of nitrate impact it is to be thoroughly recommended.

MJH

Environmental management in agriculture – European perspectives

Edited by: J. R. Park
Publisher: Belhaven Press
ISBN 1-85293-036-5 Price £25.00

Is there anyone left who is not aware of the environmental issues at present relating to agricultural production? If so, here is their chance to catch up with the latest on protection of the natural environment.

The book is based on a workshop "Agricultural management and environmental objectives" initiated by the European Commission, held at Bristol in July 1987.

The workshop concentrated on management of grassland, wetland and field margins, as well as monitoring of landscape and wildlife habitats.

The book provides a report of the proceedings and contains contributions from prominent scientists, agriculturalists, conservationists and some, dare I suggest, who might consider themselves Agricultural Engineers!

There are two introductory papers which set the scene. The first paper deals with efficiency of agriculture related to the environment and outlines all the major issues:- wildlife conservation, nitrate pollution, pesticides etc. The second reviews monitoring techniques.

The second part of the text reports from seven European nations, again setting out the major issues relating to changing agriculture and environmental conservation. Each of these papers is presented by an expert, or group of experts, from the named country, and is an informative, well presented and well researched contribution.

The contributors have been concise in their reports, making each piece rather more digestible.

The final component discusses current conservation issues in three crucially important ecological settings, namely field margins, grassland and wetland. Again, the experts contributing to these areas have done a very good job. They present their information in a very readable way and make suggestions, recommendations and conclusions which the reader may agree or disagree with, but, at least, will be happy that they have been well presented and reasonably argued.

I found this an interesting publication which presents a range of important issues in a very acceptable form. It should be of interest to anyone who cares for agriculture and conservation and really is keen to produce practical solutions.

MJH

Review of recent British Standards *continued from page 50*

BS4504 : Section 3.1 : 1989 **Circular flanges for pipes, valves and fittings (PN designated) Part 3, Steel, cast-iron and copper alloy flanges. Section 3.1 – Specification for steel flanges** (37 pages)

The manufacture of 11 types of PN designated circular steel flanges is covered by this Standard. The flanges dealt with are in the nominal size range DN10-DN4000 (30 sizes) and of nominal pressure rating PN 2.5, PN 6, PN 10, PN 16, PN 25 and PN 40. Illustrations are provided of the 11 coded flanges with a further eight types of flange facing. The pressure/temperature ratings of the flanges are specified in relation to their manufacture from ferritic austenitic or nickel steels or forged or cast steel. Particular requirements are included governing the use of ASTM materials. The requirements for bolting flanges on assembly and the repair of flanges are specified. The dimensions of the flanges, hubs, threads and bolt holes, including the relevant tolerances and facing finishes, are all specified. Eight items are recommended to be marked on the flange components. Appendices list information to be supplied by a purchaser with his order, notes on application and installation and recommendations for weld end preparations.

BS1660 : Part 4 : 1989 (ISO 297 : 1988) **Machine tapers, Part 4. Specification for spindle noses and tool shanks with self-release 7/24 tapers** (6 pages)

This Standard specifies the dimensions of 7/24 tapers for machine tool spindle noses and tool shanks and equipment for manual changing. (Dimensions for automatic changers are specified in ISO 7388-1.) It also specifies the external diameters of the collars for the tool shanks and the positioning of the front face of the collar with respect to the taper. The Standard provides for the adoption of metric or unified threads provided that the component is marked with the appropriate thread symbol. For all other dimensions the products are strictly interchangeable.

BS4742 : Part 7 : 1989 **Hydraulic equipment for agricultural machinery, Part 7. Specification for port connections for agricultural trailed vehicle hydraulic brake couplings** (3 pages)

Precise dimensions are specified for hydraulic brake couplings as specified by BS4742 : Part 4 : 1985.

Cultivation methods in Australia – an opportunity for British farmers to cut costs?

Ian Yule was awarded the Douglas Bomford Trust Travel Scholarship for 1987. He visited Australia to study methods available for tillage and to examine their possible application under UK conditions.

Work carried out before the tour (Verity A, 1986) had shown the potential of Australian equipment for soil structural improvement.

It was to follow up this work and to examine the wider use and economics of such equipment that I chose Australia as the destination for my Douglas Bomford travel scholarship.

Since the earliest years of settlement, farming in Australia has always been of an extensive nature and has relied on a cheap land resource. However, Australian soils are very low in many nutrients, particularly in levels of phosphate and humus content and these shortcomings have had a major effect in producing the present poor physical qualities and hard-setting nature of many of their topsoils. Added to this, in most cropping areas of Australia, total rainfall and rainfall distribution are less than ideal. It is important that the soils will accept and store rainfall in the root zone and, in addition that evaporation, drainage and runoff be minimised. It is particularly important to avoid compaction of the soil mass.

Compaction problems

Among Australian researchers it is generally assumed that root growth is severely restricted at penetrometer resistances of about 2 MPa. The pressures required to reduce root growth however may be quite small. In one series of experiments the root extension of barley plants was reduced by nearly 90% with 0.1 MPa pressure increase (Scott, Russell *et al*, 1979). A further factor which emerged from this work was that roots were unable to penetrate pores of a smaller diameter than the roots themselves, and in compacted soils were unable to exert sufficient force to open up the soil.

It is not only the use of tractors and other agricultural equipment that causes soil compaction. When soils are wet, animals can also cause damage. The pressures exerted by standing animals have been measured (Willat S T, Pullar D M, 1984): cow-192 KPa; sheep-83 KPa; and goat-60 KPa. These values were compared with values of 30-150 KPa exerted by a tractor. It is likely that a walking animal would exert even greater pressures, although obviously the area of impact is much less than that of a tractor. Increasing the stocking density of sheep has been shown to increase soil bulk density and to decrease hydraulic conductivity in the upper layers (0-6cm) of the soil (Reeves *et al*, 1984). The problem increased when the soils were wet.

Biological activity the key to soil improvement

In an attempt to reduce soil compaction, systems of minimum tillage have been developed. Further work in this area has resulted in the development of minimum tillage traffic systems.

Australian soil scientists now recognise that the key to soil improvement is through increased biological activity within the soil.

Management to improve structural stability and prevent clay dispersion of the sodic red brown earths centres on improving organic matter inputs, supplying calcium in the form of gypsum, minimising soil disturbance, minimising extremes of wetting and drying and preventing rapid wetting and water logging.

On a practical management level this means:-

a) Minimum tillage.
b) Controlled traffic.
c) Crop rotation with grain legumes.
d) Stubble retention, preferably on the soil surface.
e) The use of gypsum to aid soil amelioration.

Australian soil aerators

It was from an examination of the problems of compaction and minimum tillage in the UK (Yule, 1986) that interest was aroused at Durham College of Agriculture and Horticulture in the concept of "non-inversion" ploughs. These machines also come under the Australian name of "Soil Aerators". The first machine tested was the Wallace plough which seemed to fill a number of the requirements. It is claimed to:-

- fail the soil in tension.
- have a low power requirement.
- be usable as a direct drill.
- have proved its worth in terms of reducing compaction in grassland.

The trials at Durham were undertaken as a student project. In one series of experiments the Wallace plough site increased DM yield 42% over the control area. In other trials it either had no significant effect on yield or produced only a marginal improvement. Best results were obtained in permanent sward that had been heavily stocked and crops of hay and silage taken – in short, where there had been a number of agencies causing compaction.

The tines of the Wallace plough have an unconventional shape and are fitted with a "boot". The action of the boot is to create an air tunnel within the soil at about 20 cm depth, assuming that is the depth at which compaction is detected. The air tunnel is

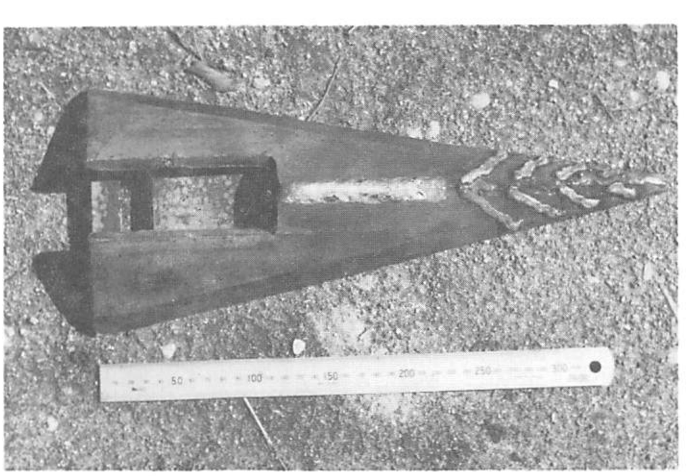

Fig 1. The 'boot' fitted to the tine of the Wallace plough.

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formed as the turf, first partially cut with the disc coulter before being eased up by the tine, resettles. The standard Wallace "boot" is illustrated in Fig 1.

The tool forms an environment within the soil where more air can circulate in the top layers of the soil. This is claimed to have a number of beneficial physical effects:-

- allowing aerobic conditions to exist within the soil, giving adequate oxygen supply for good plant growth.
- allowing greater dissipation of carbon dioxide from root respiration and decomposition of organic matter.
- improving drainage of the soil.

It was found that by treating the soil in autumn and not allowing recompaction to occur before winter, beneficial weathering effects could be gained. Soil structure improvements appeared to start at the air tunnels and gradually spread out, not only horizontally but deeper into the soil, beyond where the machine itself had reached. More root activity was evident, DM yield was increased and there was evidence that the uptake of minerals by the grass was improved. The ash content, which tends to rise with increased mineral content rose from an average of 11.15% to 11.44%. Phosphorus content was increased from 0.30% to 0.46%, magnesium content from 0.22% to 0.24% and potassium increased from 3.05% to 3.23%.

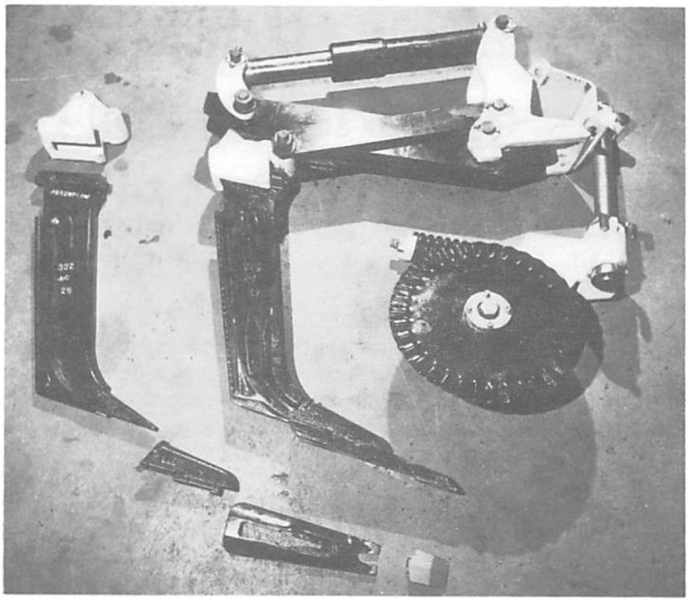

fig 2. Components and tine assembly of the 'Agroplow'.

Australian Experience

While in Australia, a number of sites were visited where the Wallace plough had been used. In most circumstances it was used in pasture either to relieve compaction within the pasture or for direct drilling cereals into pasture.

Other manufacturers were visited during the study tour, notably Agroplow of Wellington, NSW. The Agroplow design is significantly different to the Wallace plough. The tines, Fig 2, are of a more conventional shape, although they are designed mainly to lift the soil in order to encourage failure.

A considerable amount of work has been carried out by the extension services in both Victoria and NSW on the use of soil aerators both in pasture and cropping situations.

The soils most likely to respond to aeration are those which have a restricted layer in the root zone. Under cropping conditions the hard pan develops from continual cultivation of the top few centimetres of soil. The compacting pressures of livestock have already been stated and it is now recognised that hard pans can develop from years of stock movement.

The cost of the soil aeration equipment varies quite considerably and is related to the working depth of the machine. The Wallace plough operates at a depth of 10-20 cm and costs around A$2000-A$2500 (£870-£1086).

Machines which penetrate deeper such as the Agroplow cost from A$7000 (£3050).

Benefits for UK farmers

For UK farmers faced with the prospect of reducing commodity prices and the consequent need to cut tillage and establishment costs there appear to be a number of advantages to be gained from adopting a cultivation system based on the Wallace plough type of soil aerator:-

- Cheap method of cultivation.
- Only one pass is required rather than the usual four or five.
- Low power requirement. The seven leg Wallace plough for example can be pulled by a 40 kW tractor without difficulty.
- Low repair and maintenance costs. Wearing parts are quick to change.
- Tractor working on undisturbed soil giving greater workability and reduced soil damage.
- Machines designed to fail the soil in tension, giving better loosening and reduced compaction.
- Machine fitted with interchangeable tines to suit different conditions.
- Machine improves soil structure, allowing greater oxygen supply to the soil and dissipation of carbon dioxide.
- Reduced erosion potential and increased soil stability.

Against the foregoing advantages and benefits of using soil aerators in the UK some possible problem areas must also be considered:-

- One of the main problems with conventional direct drilling is weed control. This would require careful attention. Germination of weed seeds tends to be more sporadic than in seedbeds where conventional tillage has been employed, making an effective weed kill difficult to achieve.
- In Australia the machine is used to encourage a greater retention of moisture in the soil. This could become a problem in some areas of the UK at certain times of the year if the soil was aerated too much. It is important that there are no compacted areas below the depth of work which would restrict drainage. It was noted in experiments at Durham College of Agriculture and Horticulture that in order to gain the benefits from loosening grassland in the autumn, stock had to be kept off until spring in order not to recompact the soil. In an arable situation recompaction could be avoided by carrying out all subsequent operations from tramlines.

The direction of work is also important in relation to slopes. The machines should not be used up and down slopes as this encourages erosion. The suggested method would be at a slight angle to the contour to allow some soil water movement.

- The surface is left in a rough condition which is likely to cause contamination of ensiled grass by soil. A light roller may be required for surface levelling.
- The retention of crop residues may cause some crop hygiene problems by providing a bridge for disease and fungal infection into the subsequent crop.
- A more diverse rotation than presently exists on most arable farms would be required, with the inclusion of grassland, oilseeds and leguminous crops. This type of system would be best used in mixed farming situations.

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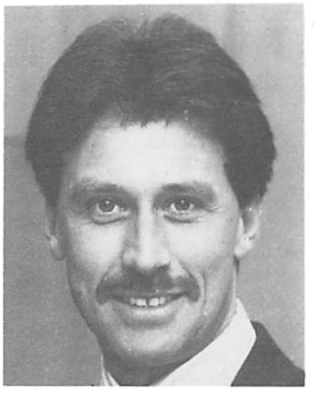
Farming and the environment – a legal view

by P. Burnley



"There has been a continuing and worrying increase in the number of pollution incidents due to accidents on farms, and poor storage of farm waste. The Government is determined to reverse this trend."

So said David Heathcote-Amory MP Parliamentary Under Secretary of State for Water, when he recently announced the start of consultations on Government proposals to reduce agricultural pollution of rivers.

In the same vein the Water Act 1989 which gave birth to a new regulatory body for water – the National Rivers Authority (NRA) – has also provided powers for the Secretary of State to make Regulations to control pollution from agriculture.

Historically, legal sanctions against farmers who cause pollution of rivers and waterways have been criticised as weak and inadequate. Convictions, until now, have been infrequent, fines have been low and have not, in general, reflected the severity of the pollution caused.

Figures compiled by the National Audit Office (NAO), Whitehall's principal financial monitor, show that of 4,141 pollution incidents in 1988, of which 940 were classified as serious, there were just 148 convictions for farm pollution offences in the same period.

Penalties for pollution likely to be more severe

That trend is set to be reversed by a combination of regulatory legislation, a readiness to prosecute polluters by the newly formed NRA and raised public awareness brought about, in part, by the media. There should be no doubts as to how rigorously the new law is being applied following the outcome of a recent case taken by the NRA against a farmer in Suffolk. Here a pig farmer is faced with a £27,000 claim for damages from the NRA after being convicted of polluting the Sapiston and Little Ouse rivers with slurry. After being fined £10,000 in the Crown Court the farmer may have to pay a further £38,000 to meet the legal costs of the case and the NRA investigation. So far it is the highest fine and compensation claim in a farm pollution incident. It will not be the last!

The fine against the farmer was high because the case was taken, at the NRA's request, to the Crown Court which can impose unlimited fines unlike the Magistrates Court which has a limit of £2,000 and has been accused of being too lenient in the past.

But what powers are given to the NRA by the new legislation? Well, to be honest, little more than was given to the predecessors of the NRA, the old Water Authorities, by the Control of Pollution Act 1974. What is different is **the way** in which it is now being applied. That, together with the removal of the important statutory defence to the farmer of compliance with the Code of Good Agricultural Practice, now means that farmers should take greater care and notice of the possible consequences of pollution than hitherto has been the case.

Offence is 'to cause' or 'knowingly permit'

Under the Water Act an individual commits an offence if he causes or knowingly permits any poisonous, noxious or polluting matter to enter a watercourse. The phrase "causes or knowingly permits" creates two separate offences, one "causing", the other "knowingly permitting". Whilst "knowingly permitting" is a simple enough concept it does require the prosecution to prove the Defendant acted with knowledge, intentionally or negligently.

"Causing" pollution on the other hand merits a different interpretation raising as it does the concept of "strict liability". Here the Defendant is guilty without the need for the prosecution to prove knowledge, intention or negligence on his behalf – indeed, the Defendant may have been aware of the pollution in the first place!

The leading case on "cause" is *Alphacell Ltd -v- Woodward (1972)* in the House of Lords. Here the Defendant prepared manila fibres for paper manufacture operating at a site close to a river. Effluent was piped into settling tanks and two pumps were provided which were designed to switch on automatically when effluent in the tanks reached a certain level. The sole object was to prevent the tanks overflowing into the river. However, on one occasion **both** pumps became obstructed by leaves and bracken as a result of which they failed to operate. Polluted water from the tanks then overflowed into the river. The Defendants were convicted of "causing" pollution to the river despite the Court's acceptance that the Defendants had not acted negligently and had taken all reasonable steps to make sure effluent did not escape. In short, it was an unforeseeable accident.

So why should they have been held to be guilty?

Lord Wilberforce summed up the view of the Court:-

"In my opinion, this is a clear case of causing the polluting water to enter the stream. The whole (manufacturing) operation which might lead to this result was an operation deliberately conducted by the (Company) and I fail to see how a defect in one stage of it, even if we assume that this happened without negligence, can enable them to say that they did not cause the pollution".

In layman terms the Defendants were deemed to be accountable for any pollution arising as a result of their manufacturing operations.

Thus the offence was held by the Court to be one of strict liability belonging in the words of Mr Justice Rice, "to that class of offences which could not be described as criminal but were rather acts prohibited by statute under a penalty". Explain that to a farmer who receives a "drubbing" in Court with attendant adverse publicity following a single isolated escape of accidental pollution!

On the other hand, as the Court accepted in the Alphacell case, if the effective cause of pollution was the intervening act of a third party, such as a trespasser, or an Act of God, the Defendant would, in all probability, be not guilty if effluent from his process was released into the river. Liability is strict not absolute.

Only defence is Act of God, or third party

The question obviously raised is whether the Alphacell case dealing as it did with manufacturing operations, could be applied to those involved in farming and agriculture.

A recent case in August of last year has answered the point. In *Southern Water Authority -v- Pegram (1989)*, the Defendants, father and son, ran a pig farm. Effluent from the pigs ran into tanks and was then transferred into a lagoon constructed by digging an oblong hole in the ground surrounded by earthworks. Unbeknown to the farmers a fissure 2 ft. deep had developed in the side of the lagoon.

Rain which fell on the buildings containing the pig unit discharged through a drain

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Paul Burnley is a member of the Environmental Law Team, Hepworth & Chadwick, Leeds.

The draft regulations

new installations be constructed with a design life of 20 years and the NRA, as statutory "watchdogs" notified of construction or reconstruction within 28 days of its completion;

installations be constructed at least 10m from any watercourse, ditch or open drain;

powers given to the NRA to service a notice requiring action to improve existing installations;

specified level of performance required from the installation to minimise the risk of water pollution;

proper maintenance and inspection of the installations to meet the performance standards at all times;

technical requirements for construction contained in the three schedules to the draft regulations. These include:-

- walls and base of an installation must be resistant to corrosion by silage and silage liquor;
- specified wall loadings for slurry installations;
- installation of two valves in series on any drain from a slurry tank;

fuel stores to be surrounded by impervious barriers.

which had become blocked by debris. Water bubbled up from the manhole and flowed downhill into the lagoon. When that filled up to the level of the fissure it overflowed and caused the pollution of the ditch and subsequently a stream.

The farmers did not know rainwater was flowing into the lagoon, nor that it was overflowing by reason of the fissure. They were charged by the Water Authority (as the NRA was not in being at that time) with causing polluted matter to enter the stream.

At first instance the Magistrates found that there was no guilty act in that the ingress of rainwater had been an intervening act breaking the chain of activities between the acts of the Defendants, as pig farmers, and the pollution of the water. It was the blocked drain, they considered, which effectively had "caused" the pollution.

On appeal by the Prosecution the High Court rejected this finding. The Court considered the principles laid down in the Alphacell case and found that there was nothing extraordinary about the amount of rain that had fallen and that secondly, there was no suggestion that the blocking of the drain had been caused by someone else, such as a trespasser. The case was thus remitted to the Magistrates with a direction to convict.

This case's importance lies in its application and development of the Alphacell case, particularly in its application to agriculture. In the Pegram case the Court examined whether the issues that can be raised in such cases, *e.g.* Act of God/or act of a third party, could be defences. On the facts of the case it was felt that they could not – the amount of rain was perfectly normal and no third party had caused the drain to be blocked.

Accordingly following the Alphacell principles the farmers were strictly liable as their operations involved the storage of material, pig slurry, likely to pollute if it escaped – as they could show no intervening acts of a third party or Act of God as being the operative cause of the escape they were strictly liable without the prosecution having to show any negligence or criminal intent.

The lesson to be learned by the farming community is that in the absence of an intervening Act of God or third party they will be strictly liable if effluent or waste "escapes" causing pollution. That is the law at the present time. Nor does the meaning of "accidental pollution" appear to have any part to play in environmental law other than to provide factors in mitigation. To that extent "strict liability" can be a most frustrating and annoying concept for the farmer.

Moreover there is little doubt that "cause" will be interpreted in the same way in the equivalent offence under the Water Act 1989. In practice, all that the prosecution need prove is that the effluent or waste emanated from the farm or its operations causing pollution of the stream or watercourse. The onus then switches to the farmer to show either intervening Acts of God or third party – no other defence is possible!

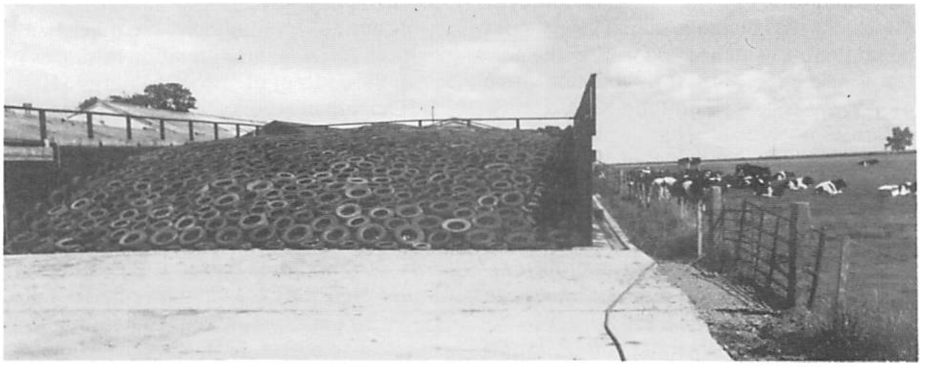
Draft regulations issued by D of E

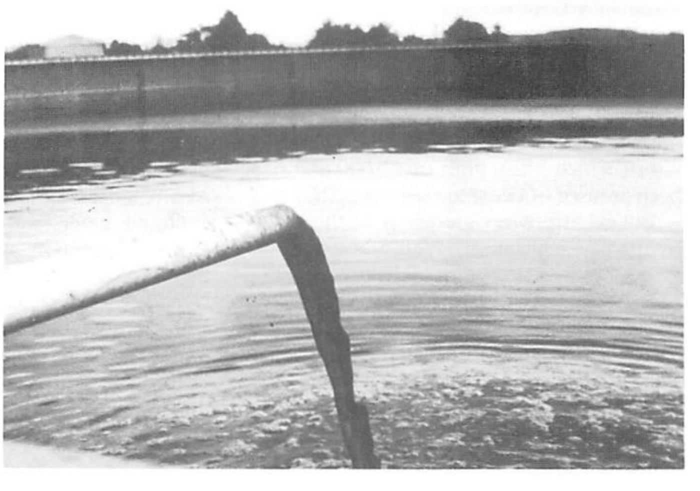
Finally, let me turn to the most recent proposals of the Government to reduce agricultural pollution of rivers. Draft regulations made under the Water Act have been issued by the Department of the Environment (D of E). Described as controls which will complement existing measures they are to set new standards for the construction of silage stores, slurry installations, reception pits and agricultural fuel oil stores.

Advice to farmers

Develop a rapport with the enforcing authorities – take their advice seriously and heed any warnings. If, after having worked with and taken the advice of the enforcing authority, there is an accidental escape of farm effluent or waste, so long as it is not a major pollution incident, the risk of a full blown prosecution in the Courts will usually be lessened.

To those farmers who already advocate and follow good agricultural practice in relation to their environment the law should present no difficulty. To those others – watch out!





Silage pits, slurry tanks, fuel stores — all affected by the draft regulations Photos: Centre for Rural Building, Aberdeen.

Putting pesticides in perspective

"There is an element of risk in every action or decision," says C. Hibbitt, "but the public's perception of the risk is sometimes quite different from the actual."

With every action or decision we take, there is an element of risk – but with the use of crop protection the risks are perceived as far greater than they really are.

Several years ago an American research study identified causes of deaths, with smoking, alcohol and motor accidents ranking very highly, while no deaths were recorded in connection with the use of pesticides (Table 1).

However, the same study showed that the public's perceptions were quite different. Pesticides were seen as being of high risk to human life, whilst actual high risk activities such as driving and swimming were seen as being relatively safe.

People seem to have an inbuilt fear of what they do not understand and of what is unfamiliar. To illustrate this point, when ploughs made from iron and steel were first introduced to farming, these metals were charged with poisoning the soil. Today, pesticides, one of the newer groups of chemicals, are seen as presenting a threat, both to health and to the environment. Pressure groups often help to sustain and bolster this opinion, and sadly the crop protection industry has failed thusfar to dispel many of the myths surrounding the use of pesticides.

Machinery is principle cause of farm accidents

Pesticides pose far less danger than other farming practices. Records show that farm machinery is the principal cause of accidents on the farm, and a recent three-year study showed that while there were deaths from machinery accidents, there was not a single fatality from using crop protection products (Table 2).

Chemicals are also widely used in the garden and although we are warned of their danger, they in fact pose very little risk if used in accordance with label instructions. Of 100,000 reported non-fatal accidents in the home in 1987, fewer than 2,000 occurred in the garden – and, once again, machines such as lawn mowers and hedgecutters were the main culprits. Based on the evidence of this research, we should be more concerned with the dangers of garden canes and flower pots than with garden-care products (Table 3).

'Crop protection no longer needed!'

There is a current theory that crop protection products serve little purpose and that, although they played a vital part in increasing yields when populations were booming, they are no longer needed because the western world has now created large food surpluses.

This, too, is an incorrect assumption. Earlier this year the world wheat stocks reached a record low of only 54 days. Up to 1,500 million people are hungry or undernourished. Even with the current use of pesticides, it is thought that 40 percent of the world's annual food production is lost each year from pests, diseases and weeds. Without crop protection products food shortages would occur on a massive scale. Put simply, the world could not feed itself without the help of crop protection products.

Table 1. Perception of risk

The facts			The perception	
	Cause	Number of deaths per year	College students	Women voters
1	Smoking	150,000	1 Nuclear power	1 Nuclear power
2	Alcoholic beverages	100,000	2 Handguns	2 Motor vehicles
3	Motor vehicles	50,000	3 Smoking	3 Handguns
4	Handguns	17,000	**4 Pesticides**	4 Smoking
5	Electric power	14,000	5 Motor vehicles	5 Motorcycles
6	Motorcycles	3,000	6 Motorcycles	6 Alcoholic beverages
7	Swimming	3,000	7 Alcoholic beverages	7 General aviation
8	Surgery	2,800	8 Police work	8 Police work
9	X-Rays	2,300	9 Contraceptives	**9 Pesticides**
10	Railroads	1,950	10 Fire fighting	10 Surgery
11	General aviation	1,300	11 Surgery	11 Fire fighting
12	Large construction	1,000	12 Food preservatives	12 Large construction
13	Bicycles	1,000	13 Spray cans	13 Hunting
14	Hunting	800	14 Large construction	14 Spray cans
15	Home appliances	200	15 General aviation	15 Mountain climbing
16	Fire fighting	195	16 Commercial aviation	16 Bicycles
17	Police work	160	17 X-Rays	17 Commercial aviation
18	Contraceptives	150	18 Hunting	18 Electric power
19	Commercial aviation	130	19 Electric power	19 Swimming
20	Nuclear power	100	20 Food colouring	20 Contraceptives
21	Mountain climbing	30	21 Antibiotics*	21 Skiing
22	Power mowers	24	22 Mountain climbing	22 X-Rays
23	Scholastic football	23	23 Railroads	23 Scholastic football
24	Skiing	18	24 Bicycles	24 Railroads
25	Vaccinations	10	25 Skiing	25 Food preservatives
26	Food colouring		26 Scholastic football	26 Food colouring
27	Food preservatives		27 Home appliances	27 Power mowers
28	**Pesticides**		28 Power mowers	28 Antibiotics*
29	Antibiotics*		29 Vaccinations	29 Home appliances
30	Spray cans		30 Swimming	30 Vaccinations

* Prescription antibiotics

Based on A.C. Upton Scientific American vol. 246

'Man-made' versus 'natural'

People believe that man-made 'synthetic' chemicals damage the environment – and once again there is an assumption that everything 'natural' or naturally occurring is acceptable and not harmful. But many naturally-occurring organisms, such as moulds and diseases on crops, are highly toxic.

For instance, one milligram of the toxin *Clostridium botulinum* is enough to kill 500 adult humans. No man-made agrochemical is anywhere near so toxic. Carrots, often praised as being 'good for you', contain the nerve poison Carotatoxin, Myristicin – an halucinogin, and Isoflavones, which have an oestrogenic effect similar to female hormones. The point is, of course, that large amounts of carrots would have to be consumed to cause a problem.

So, eating a good balanced diet poses no risk – and neither does eating food treated with approved crop protection products at recommended rates. Handled with care and applied discriminately, they present no

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Chris Hibbitt is Technical Manager, Rhône-Poulenc Agriculture.

Recommended roles and responsibilities for Engineers

The Engineering Council has issued a new edition of their policy statement "Standards and Routes to Registration" (SARTOR). J C Levy draws attention to a very significant new appendix now providing guidelines on employment which should work to the benefit of registrants and their employers.

The Engineering Council's policy statement 'Standards and Routes to Registration' (SARTOR), which was originally published in December 1984, defined the standards of education, training and experience for those wishing to register as Chartered Engineers (CEng), Incorporated Engineers (IEng) or Engineering Technicians (EngTech).

However, the 1984 edition was silent on the kind of posts which engineers qualified to these nationally accepted standards should occupy. Now that the standards of SARTOR have been generally accepted, it is this omission which the appendix to the new edition aims to remedy.

Entitled 'Recommended Roles and Responsibilities for Chartered Engineers, Incorporated Engineers and Engineering Technicians' the appendix sets out guidelines for work which should fall within the domain of qualified engineers. The table opposite gives details for CEng and IEng.

Professor J C Levy OBE PhD FEng is Director – Engineering Profession of The Engineering Council.

Engineers deal with engineering matters

Basically, the guide is intended to emphasise that engineering matters are best dealt with by those who are recognised nationally as engineers and who have been so judged, against rigorous published standards. This makes for all-round efficiency and instills public confidence where matters of safety are concerned – an increasing consideration today.

The lists given in the guide are not intended to be exhaustive, but to assist individual engineers and employers. It has to be recognised that in the immediate future not all the posts described will in fact be occupied by registrants, nor will all registrants necessarily occupy such posts. Equally, the education and training of engineers fits them to occupy a wide variety of posts, up to the very highest levels, outside engineering.

Copies available from: The Engineering Council, 10 Maltravers Street, London WC2R 3ER.

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Table 2. Fatal accidents and diseases in agriculture 1981-1984.

Cause	*No. of deaths*
Self-propelled machines	89
Field machinery	38
Falls	33
Falling objects	32
Animals	26
Drowning/Asphyxiation	24
Electrical equipment	15
Powered hand tools	10
Diseases	10
Others	9
Pesticides	0

(Agricultural black spot – a study of fatal accidents HSE 1986)

danger to man or animal.

It is wrong to draw a distinction favouring naturally-occurring chemicals in preference to synthetic chemicals. Professor Bruce Ames, Director of the Environmental Health Sciences Centre at the University of California, says that 99.99 percent of carcinogens found in food are natural or traditional chemicals, and not man-made synthetic ones.

The majority of natural chemicals have never been tested, but some of those that have, such as alcohol, esters and hydrocarbons, have been shown to be carcinogenic and mutagenic in tests.

Minute traces now measurable

One of the problems we have to come to terms with in these 'high technology' times is that we have an unreasonable fear that if we can detect something, no matter how small, it must pose a threat. Scientists helped by sophisticated equipment have become so expert at detection we can now find minute traces of chemical residue, even as little as one part per trillion. Put into perspective, that is the equivalent of one pinch of salt in 10,000 tonnes of potato chips, or the width of a single human hair in the distance around the world.

In the past greater quantities would have gone undetected – but the world was not necessarily less contaminated, in fact the contrary is probably true if we consider how much longer people live these days.

The presence of a chemical – whether natural or synthetic – at low levels is not crucial to human health. It is the dose which is important. For instance, two ounces of common salt can kill a child; we take a lethal dose of caffeine in about 100 cups of coffee.

With rigorous control systems monitoring the introduction of new pesticides, it is unlikely that salt or caffeine could ever be approved as pesticides. Even the active ingredients of some toothpastes and shampoos have a higher toxicity than many common pesticides.

Product development allows lower doses

The belief that we are using more and more crop protection products, which increasingly pollute the environment, is another misconception which does not stand up to scrutiny. In the last five years, the weight of active crop protection products sold in the UK has dropped by over 30 percent.

Now products are being introduced which do the work at lower doses. Products are being developed with more environmentally-friendly ingredients, lower dose rates and less persistence. These products also tend to be more specifically targeted to deal with particular pests, weeds or diseases.

Table 3. Accidents involving garden equipment, 1985.

Cause	*No. of accidents*
Lawn mower	299
Fork	239
Hedge trimmer	210
Deckchair/Sunbed	143
Spade	143
Secateurs	81
Wheelbarrow	74
Pole/Stick	61
Flower Pots	56
Insects/Animal poisoning	37
Weedkillers	9
Insecticides	6
Total non-fatal home accidents	100,179

(Home accident survey 1985 – DTI).

Most people have little difficulty in accepting the role played by modern medicines, which can carry some risks, but give tremendous benefits in controlling disease and serious illness. Similarly, we should acknowledge that crop protection products have a role to play in modern farming and our survival in the world.

Perhaps the final word should go to Max Perutz, Nobel Laureate in Chemistry and founder of the Medical Research Council Institute of Molecular Biology, Cambridge when he said, "In summary, I have now come to realise that my original views on the dangers of pollution by agrochemicals were formed by people who publicised their adverse effects and concealed their benefits.

"Provided they are handled with care and applied discriminately, they present no danger to man or animal, and they have multiplied the crops on which our lives depend."

Guidelines for Chartered Engineers and Incorporated Engineers

The Engineering Council recommends that posts involving one or more of the duties and responsibilities listed below should be occupied by those registered as Chartered Engineers or Incorporated Engineers.

Each list is arranged in an approximately descending order of responsibility level, though clearly the relative importance of the items may vary somewhat from one situation to another.

There is inevitably an overlap in duties between Chartered and Incorporated Engineers. *It is expected that Chartered Engineers would mainly be concerned with topics in the first part of each list, while Incorporated Engineers would mainly be concerned with those in the second part of each list.* Also, it is expected that Chartered Engineers would normally be concerned with a broader range of these activities than Incorporated Engineers. Activities in various lists may overlap. Quality assurance is a case in point.

Design
- Managerial responsibility for an engineering design function or group.
- Supervising preparation of designs.
- Engineering design outside the scope of established procedures, standards and codes of practice to a competitive level of cost, safety, quality and reliability.
- Promotion of advanced designs and design methods. Continual development of standards and codes internationally.
- Failure analysis and value engineering.
- Design work involving established procedures and the use of Engineering Standards and Codes of Practice to a competitive level of cost, safety, quality, reliability and appearance.

Research and Development
- Leading research and development effort in engineering resulting in the design, development and manufacture of products, equipment and processes to a competitive level of cost, safety, quality, reliability and appearance.
- Managing engineering research and development groups, planning and execution of research and development programmes, carrying out research and development assignments.
- Evaluation of test results and interpretation of data. Preparing reports and recommendations.

Engineering Practice
- The exercise of independent technical judgment and the application of engineering principles.
- Application of theoretical knowledge to the marketing, operation and maintenance of products and services.
- Development and application of new technologies.
- Monitoring progress on a world-wide basis, assimilation of such information and independent contributions to the development of engineering science and its applications.
- Work involving the need to understand and apply analytical and technical skills and judgment and the use of a range of equipment, techniques and methods for measurement, control, operation, fault diagnosis, maintenance and for protection of the environment.

Manufacture, Installation, Construction
- Managerial responsibility for a production, installation, construction or dismantling function.
- Organisation of cost effective manufacturing functions.
- The introduction of new and more efficient production techniques and of installation and construction concepts.
- Organisation of quality-driven manufacture, installation and construction functions.
- Day-to-day organisation and supervision of manufacturing, installation and construction functions from raw material input to finished product.

Operation and Maintenance
- Managerial responsibility for an operation or maintenance function or group.
- Providing specifications of operational maintainability standards to be achieved in design and production.
- Determining operational maintenance requirements in terms of tasks to be performed and time intervals between tasks.
- Managing the quality of the output of operational maintenance activities.
- Developing and specifying diagnostic techniques and procedures.
- Developing and specifying repair and rectification methods.
- Assessing the actual and expected effect on performance of deterioration in service.

Health, Safety, Reliability
- Making appropriate provision in engineering projects to ensure safety and the required standards of reliability, not only with employees and customers in mind but in the general public interest.
- Responsibility for health, safety, reliability in situations involving engineering plant, systems, processes or activities.
- Accident investigation.
- Supervision of inspection and test procedures.

  (NB: It should be noted that there do exist a few statutory or quasi-statutory provisions under this heading. For example the Quality Assessment Schedule to BS5750 Part 1 relating to civil and/or structural engineering led multi-disciplinary engineering project design states "For each project the control of the design and design related activities shall be the responsibility of a Project Director who shall be a Chartered Engineer qualified in the relevant discipline").

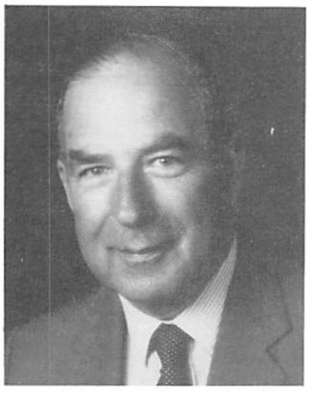
Management and Planning
- Overall company/commercial responsibility as a director with engineering knowledge.
- Longer range and strategic planning of engineering activities and functions.
- Management of the development and implementation of new technologies with estimation of the cost/benefit of the financial, social and political decisions taken.
- Pioneering of new engineering services and management methods.
- Effective direction of advanced existing technology involving high risk and capital intensive projects.
- Direct responsibility for the management or guidance of technical staff and other resources.
- Supervision of engineering staff and resources and the associated legal, financial and economic practice at a level commensurate with the scale of the activity and size of organisation within the constraints of the relevant environment.
- Short-range planning of engineering activities and functions.

Engineering Aspects of Marketing
- Management responsibility for a technical marketing function.
- Top-level customer and contract negotiations.
- Setting marketing objectives and policies.
- Territorial or market planning forecasts and targets.
- Management responsibility for the dissemination of accurate technical information.
- Customer technical advisory service.
- Market analysis, contract negotiations.
- Non-standard customer requirements.
- Sales operations, efficient market coverage.
- Preparing cost estimates and proposals.

Teaching, Training, Career Development
- Academic (teaching) responsibility for engineering courses and activities at first degree and postgraduate level.
- Career development for Chartered Engineers and Incorporated Engineers.
- Responsibility for training and the supervision of experience for those intending to become Chartered Engineers.
- Academic (teaching) responsibility for courses and activities up to BTEC/SCOTVEC Higher National level in engineering.
- Career development for Engineering Technicians.
- Responsibility for training and the supervision of experience for those intending to become Incorporated Engineers or Engineering Technicians.

NEWS AND VIEWS

Douglas Walker elected President of the Institution of Agricultural Engineers



At the Annual General Meeting of the Institution of Agricultural Engineers, held at NAC, Stoneleigh on the 9th May, 1990, Douglas M. Walker, Managing Director of John Deere Limited was elected President for the 1990-91 session.

Our new President can already look back on a long career in the farm machinery industry. After early years marketing and sales experience with David Brown Tractors he transferred in 1965 to John Deere in their newly established UK company. Within three years he was appointed Managing Director.

Douglas Walker's presidential address "The economics of agricultural machinery manufacture" will be reported in full in the next issue of the journal.

New 'Monitor system from Burkard Scientific

The new Monitor flexible data acquisition system for both segmented flow and flow injection analysis now available from Burkard Scientific of Uxbridge can simultaneously process up to 4 systems or 16 channels of analogue signal.

The Monitor system has been designed for use in laboratory research into water, soil and full liquid analysis with applications in water and waste monitoring, medical analysis, environmental control and industrial research.

Designed for use with IBM and compatible PCs the system can be linked to other standard database and spreadsheet software.

Burkard Scientific develops and manufactures a wide range of instrumentation such as flow analysers, both segmented and flow injection, used for analysis of water, effluents and soil. Burkard centrifuges are used widely with micrometer syringes/applicators, and spray towers used in entomology and agricultural research. They also supply a diverse range of products from pH control and measurement to tissue homogenisers. Brochure is available from: Burkard Scientific (Sales) Ltd, PO Box 55, Uxbridge, Middlesex UB8 2RT. Tel: 0895 30056.

Studies in agrochemical leaching

Soil and Water Management Specialist Group meeting

The meeting of the Soil and Water Management Specialist Group, 28th February, 1990 at the Field Drainage Experimental Unit (FDEU), Anstey Hall, Cambridge provided a valuable insight into varied work being conducted by the Unit into the many aspects of chemical leaching in agriculture.

The programme comprised a series of talks by FDEU staff supported by a number of displays. Although most of the work described is still at interim stages, the material offered opportunity for useful and wide ranging discussion.

Under the overall heading 'Drainage and soil water quality' the detailed programme was as follows:-

Introduction to the FDEU — D. A. Castle
The effect of farm management on agrochemical leaching — G. L. Harris
The leaching of pesticides in a heavy clay soil — R. Arrowsmith
Agrochemical leaching in a permeable soil — A. A. Thorburn
Agrochemical leaching from land in agricultural set-aside — S. C. Rose
Nitrate leaching from grassland — A. C. Armstrong
Agrochemical leaching from land under farm forestry — J. R. Williams

Some 34 members of the Specialist Group attended the meeting and a warm vote of thanks was accorded to Doug Castle and his staff at the FDEU for hosting such an interesting event on such a topical subject.

"The last straw"

– dealing with the straw you may not burn

In response to the proposed ban on straw burning ADAS is organising a demonstration and exhibition to be held 5th and 6th September 1990 at Bridgets EHF in Hampshire. ADAS believe this will be the only national working event covering this subject to be held this season.

"Whilst the straw burning ban has yet to become law there is, in the eyes of the general public, already an end to straw burning," states ADAS. Now is the time for farmers to consider the implications of the ban – on machinery purchases, on crop management and in seeking alternative uses for straw.

The ADAS event will include field demonstrations on methods of dealing with chopped straw, on methods of managing the long straw left by a stripper header and with the baling and handling of straw in the different bale forms now available. Exhibition displays will particularly feature alternative uses for straw and there will be overall emphasis on aspects of conservation and environment.

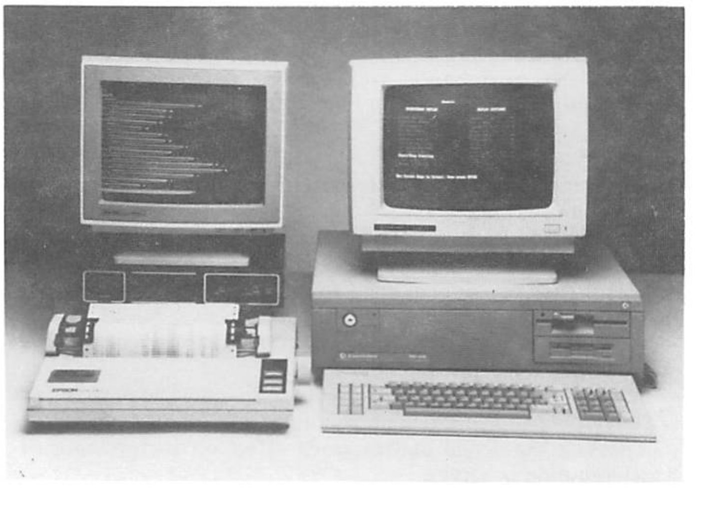
Natural inoculant improves silage quality

Biotal Limited have developed a silage inoculant which they say produces consistently good quality silage without the use of acid or formalin.

Super Sile Plus works by introducing large numbers of specially selected fast growing lactic acid-producing micro-organisms, which dominate the initial silage micro-organism population and accelerate the natural biological process that preserves forage crops for use as winter feed.

As well as introducing the selected lactic acid-producing bacteria, *Super Sile Plus* contains enzymes which produce additional soluble sugars, to ensure sufficient lactic acid can be produced. Only naturally-occurring bacteria are used, so the product is entirely safe and natural. It is more effective than acid in reducing the pH of the forage, but does not pose the same environmental problems.

Further details from: Biotal Ltd, 5 Chiltern Close, Cardiff CF4 5DL. Tel: 0222 766716.



New Monitor system from Burkard Scientific.

Amalgamated Plastics announce major expansion in stretchfilm production

Amalgamated Plastics Limited is expanding its production capacity of industrial and agricultural stretchfilms with the installation of a high output, DOLCI film blowing line. Total investment is around £1 million.

With a nameplate capacity of 4,500 tonnes per annum, the DOLCI production line has been fitted with a unique tack injection system, designed and commissioned by Amalgamated Plastics for accurately controlling the addition of high levels of tack required for its Silaflex™ agricultural round bale silage wrapping product.

"The new extrusion line is capable of producing stretchfilm up to 2.3 metres wide at 600 kilograms per hour and can run thinner film at up to 150 metres per minute.

Silaflex™, a UV stabilised mono layered blown film, is formulated from the highest quality octene-based raw materials and its adherence to both British and international standards ensures that every reel is quality assured in terms of strength, puncture and tear resistance, tack levels, length, weathering properties and UV protection.

Amalgamated Plastics, Cranborne Road, Potters Bar, Herts EN6 3JN. Tel: 0707 50771.

BBC TV's Tomorrow's World presenter Howard Stableford, demonstrates big bale silage wrapping using Silaflex™ in a sequence from the video 'A cut before the rest'.

Muck '91 set for April

Muck '91, the national farm waste management demonstration, will take place at the National Agricultural Centre, Stoneleigh, on 24th and 25th April, 1991.

The event will have a dual focus, dealing with the safe disposal of all kinds of farm effluent and with the profitable utilisation of those wastes such as slurry which contain valuable nutrients.

With environmental protection now being a major political issue and new legislation on the control of pollution imminent, the event will present both the industry and the farming community with an ideal opportunity to discuss latest innovations.

Groundwater contamination modelling

AEA Technology Harwell and Hydraulic Research Wallingford have joined forces to offer a comprehensive package of high technology services in the field of groundwater flow and contaminant migration modelling.

With new legislation and codes of practice there is a demand for increasingly accurate predictions and assessments of the impact of possible pollution. The new service can offer assistance on:-

- advice on problem definition
- field data collection and monitoring programmes
- site investigation
- computer modelling of pollution
- engineering interpretation of modelling results
- safety assessment reports.

New high specification bench pH meters

A range of high specification Hanna bench pH meters is now available from the Orme pH Centre based in Manchester. The range consists of six instruments, each of which can be battery or mains operated and are supplied complete with everything the operator needs to use, including electrodes, dust cover and full range of accessories. There is a two-year warranty period.

The Hanna model HI 8417 is a microprocessor based meter for reliability and accuracy, and has dual pH and temperature display. Measuring pH, millivolts and temperature this model has automatic or manual temperature compensation.

The Model HI 8418 offers a full data management system for pH, mV and temperature values, with memorised standard buffer values. There are four digital displays – temperature, pH, the sample number and the date. An integral printer enables permanent records to be kept. A variety of programs allows the operator to pre-select parameters such as audible pH alarm, print data with a pre-set interval until a determined time, or print data until a pre-set pH value is reached. The HI 8418 is priced at £412.00 and the HI 8417 at £262.00.

The Orme pH Centre can supply a wide range of pH measuring instruments throughout the UK. A team of qualified chemists and biochemists make up their in-house and field sales teams to provide technical advice, information and service back-up.

Orme pH Centre, PO Box3, Stakehill Industrial Park, Middleton, Manchester, M24 2RH. Tel: 061 653 4589

New Director of the AFRC Institute of Engineering Research (IER)

Dr B J Legg

The Agricultural and Food Research Council (AFRC) has announced the appointment of Dr Brian Legg to succeed Professor John Matthews, CBE, as Director of Engineering Research. Dr Legg will take up his appointment on 1 August 1990 on the retirement of Professor Matthews.

Dr Legg joined the staff of the former National Institute of Agricultural Engineering (now the AFRC Institute of Engineering Research) in 1983 as Head of the Horticultural Engineering Division. He is currently Deputy Director and Head of Process Engineering Division at IER.

Dr Legg was awarded the L.F. Richardson prize by the Royal Meteorological Society in 1978 and the Douglas Bomford Memorial prize by the Institute of Agricultural Engineers in 1989. He is a Fellow of the Royal Meteorological Society, the Institute of Physics and the Institution of Agricultural Engineers.

Sir Nigel Mobbs, new chairman of Groundwork

Groundwork, the fast-expanding environmental regeneration network, has appointed Sir Nigel Mobbs, Chairman and Chief Executive of Slough Estates plc, as its new national chairman.

"Sir Nigel's vast experience will be invaluable in furthering our partnerships with industry and the business community," said John Davidson, Chief Executive of Groundwork.

According to Groundwork there are some 100,000 acres of wasteland lying disused and derelict in Britain's towns and cities – the legacy of society's changing needs. The Groundwork approach is to draw together business, public sector and voluntary groups to work in partnership in restoring this damaged environment.

"Groundwork's approach has been seen to work extremely effectively. I intend to help it gain momentum," said Sir Nigel.

Botswana-based weather stations have satellite links

Four weather stations have been manufactured by the Didcot Instrument Company at Abingdon, Oxford, adapted with satellite links. The stations were commissioned by the Overseas Development Natural Resources Institute (ODNRI), and will be used to monitor climatic conditions in the most remote and hostile parts of Botswana.

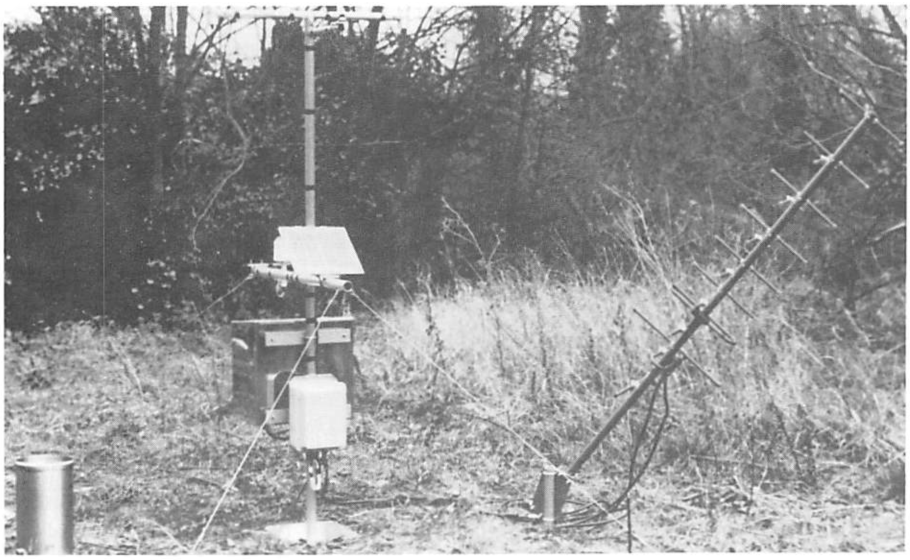
The weather stations chosen for this project are Didcot's standard Budget Automatic models, but they are unusual in having been specially adapted for usage with a satellite.

Each weather station is fitted with a data collection platform, manufactured by Space Technology Systems Ltd. As data on atmospheric parameters is collected by the mast, it is passed to the collection platform for transmission, at 3 – hourly intervals, to Meteosat – a geostationary satellite, permanently sited over Africa.

Information goes from the satellite to the European Space Operation Centre (ESOP) in Darmstadt, West Germany; which retransmits the data in a form that is freely available. After a certain time slot, however, Germany cannot retransmit, so it is vital that all stages of data transfer occur correctly, and in the exact temporal sequence.

ODNRI has provided the Meteorological Service of Botswana with a receiving system to capture the data from the satellite – a primary and secondary channel receiving unit, manufactured by Bradford University Research Ltd.

According to Dr Jim Williams, the head of the project at ODNRI, it is hoped eventually to have the system operating throughout the whole of Africa.



One of the budget weather stations manufactured by the Didcot Instrument Company for use in Botswana. The data collection platform is on the right.

'How to avoid contaminating water with pesticides'

The British Agrochemicals Association – the body represents the UK pesticides industry – has produced a useful leaflet detailing everyday practical measures to prevent water contamination during storage and use of pesticides.

Pointing out that any pesticide supplied, sold or used in the UK must first have received Ministry Approval, the leaflet stresses that users must then observe good working practices and handle and apply pesticides only as recommended on the labels.

In effect, the recommendations presented in the leaflet can be read as a list of the hazards to watch out for and avoid and the way in which 'accidents' can happen if proper thought has not been given to all aspects of the storage, mixing, application and disposal of pesticides. A good starting point under General Safety Precautions is to "keep detailed application and stock records".

The leaflet is a useful check list for all those concerned with pesticide application. Copies may be obtained from:-

British Agrochemicals Association, 4 Lincoln Court, Lincoln Road, Peterborough PE1 2RP.

Search no further ...

Nitech Limited have introduced a completely new range of extremely powerful and rugged hand-held **Search Lights** which are offered at very competitive prices.

Designed to operate directly from a 12v car cigar lighter socket, these units are approximately 5-6 times more powerful than a standard car headlamp and will project a beam for up to one mile. Despite their high power, their revolutionary design ensures a modest current consumption and they can be run for long periods directly from the car battery.

Nitech Ltd, Unit 26, Brunel Road, Churchfields Trading Estate, St Leonards-on-Sea, East Sussex TN38 9RT. Tel: 0424 52788.

New power washer for rapid cleaning

Increasing demand from several market sectors has prompted SIP (Holdings) Limited of Loughborough (Tel: 0509 503141) to launch a competitively priced, durable pressure washer – the Aqua 100.

Operating at up to 100 bar (1500 psi) this powerful new jet washer makes light work of cleaning vehicles, garden furniture, tools or machinery.

A range of optional accessories for a variety of uses from sandblasting to pipe cleaning makes the Aqua 100 one of the most versatile semi professional units available.

APPOINTMENTS

POSITION WANTED

BSc Agric MSc Agric (Agric Eng Speciality) AMIMechE PEng seeks a position in Consultancy, Research & Development, International Development, Management, Teaching or Technical Sales. In-depth international and technical experience including 20 years R&D in Agricultural Engineering in Europe and North America; 6 years in Industry in design, development, test and production; 5 years teaching and/or training; 5 years in Asia and Africa. Well read in electronic hardware with considerable hands-on experience in micro-computers and the principal programming languages. Some experience was concurrent and is, therefore, non-cumulative. All replies considered in confidence and will be answered. Willing to relocate. Available immediately.

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SALES

Offers invited for a range of Agricultural Engineering books, pamphlets, statistical returns dating variously from around 1900 to the 1940's early '50's. Write for list, enclosing SAE, to: Geoff Baldwin, 22 Edgerton Grove Road, Huddersfield HD1 5QX.

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Institution of Agricultural Engineers
Forestry Engineering Specialist Group

Harvester/Excavator Symposium

Thursday, 6th September, 1990
Newton Rigg College, Cumbria

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Which excavator?

How to decide?

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Institution of Agricultural Engineers
Soil and Water Specialist Group

Wednesday, 14th November (2.00pm-5.30pm)
Clement Stephenson Lecture Theatre
Faculty of Agriculture University of Newcastle upon Tyne

Session 1 – Soil Strength & Structure

Soil mechanics research
D R Hettiaratchi, University of Newcastle upon Tyne.

Controlled traffic research
D J Campbell, Scottish Centre for Agricultural Engineering

Effect of mineral working on soil physical properties
D Hewgill, ADAS

Session 2 – Soil-Water: Solute & Gas Movement

Land-use strategy and the environment
J R O'Callaghan, University of Newcastle upon Tyne

Nitrate leaching: state of the art
J K Syers, University of Newcastle upon Tyne

Gas movement in soil cores
B C Ball, Scottish Centre for Agricultural Engineering

The Douglas Bomford Trust

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Silsoe College, Thursday, 1st November 1990, 5.00 pm

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