The Agricultural Engineer

Incorporating Soil and water

Volume 48 Number 3 Autumn 1993

Better by Design
Convention Papers

AE 48 (3)

BUSH SOIL PENETROMETER SP 1000

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WITH INTEGRAL DATA STORAGE

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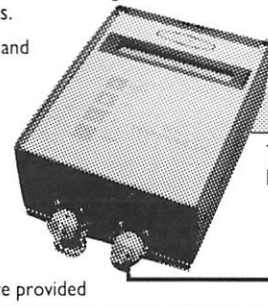

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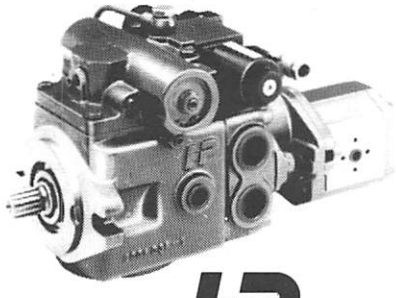

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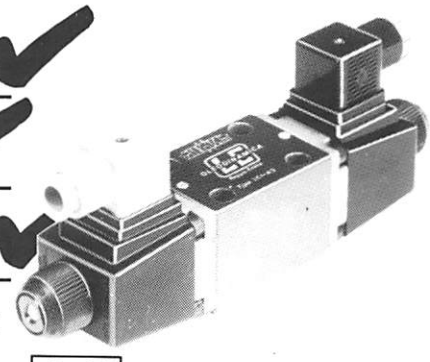

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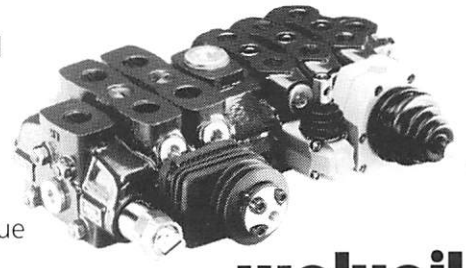

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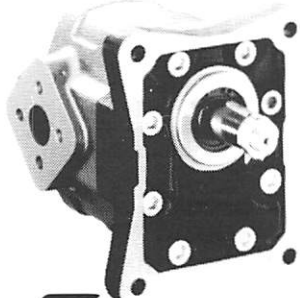

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The Agricultural Engineer

Incorporating Soil and water

Journal and Proceedings

Volume 48 No.3, Autumn 1993

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Front cover: The prototype straw wafering machine developed at Silsoe Research Institute. Swath density is critical – see page 72.

Regular Features

CONTENTS

COMMENT

Allan Langley

My association with the Journal Editorial Panel goes back to the Spring 1987 issue when Jim Pascal took over from Brian Witney as Honorary Editor. Both Jim and his successor, Barry Sheppard, put in a power of work in maintaining the Journal's quality content. Layout improvements by Geoff Baldwin have resulted in a more user-friendly publication. My hope is that I can continue in the same vein as my colleagues.

Acquiring a regular supply of suitable articles and papers for the Journal has been a problem in the past. The Annual Convention, the Branch and Specialist Group meetings and conferences are all potential sources of copy, which via the Journal, can be disseminated to a wider audience. A wealth of information also lies latent in you, the members. Please contact me if you have knowledge of, or would like to submit, an article which would be suitable for publication in the Journal.

Within this issue you will find a questionnaire aimed to gauge members' attitudes to many aspects of the Institution's activities. YOUR opinion is important. The Institution's direction over the next few years will be guided by the responses received. Please take a few minutes NOW to fill in the questionnaire and return it to the Secretary in the reply-paid envelope.

In order to widen the readership interest, this issue includes an article on farm buildings. It is hoped that this will become a regular feature of the Journal.

Allan Langley, Honorary Editor

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The Institution of Agricultural Engineers

The old leather strap is back in fashion

New wetstone grinder complete with leather honing wheel gives razor sharp edge to cutting tools.

The Tormek SuperGrind 1204 is the name of a new, compact wetstone grinder currently being introduced by the Swedish firm Tormek. The grinder is fitted as standard with a honing wheel made from real leather which, when used in conjunction with Tormek's own honing compound, gives a highly polished, razor sharp cutting edge.

The Tormek SuperGrind is supplied complete with grinding jig for chisels and plane irons, angle meter, honing paste and the new handbook 'Whetstone grinding of edge tools'.

Information from G M Brown, 8 Ladbroke Park, Millers Road, Warwick CV34 5AE. Tel: 0926 493389; Fax: 0925 491 357.

Massey Ferguson buys into combine maker

Massey Ferguson is the largest single shareholder in a new company which has been formed to acquire the whole of the assets of Danish combine maker, Dronningborg Maskinfabrik A/S.

This move to take wider control of the major source of its European-made machines will secure future supplies of the highly successful range, which has been steadily increasing MF's share of the combine market in recent years, both here and in Europe.

The new company will be known as DM Industries A/S. MF is subscribing about one third of the share capital, and it will be represented on the board of directors. The rest of the equity is being contributed by major Danish institutional investors.

SIMBA cultivation systems

Equipment manufacturer, SIMBA, has commissioned ADAS to report on two of their main cultivation products.

In one report, ADAS looks at the costs of operating the SIMBA 'Top-Tilth' cultivator. The report includes sets of tables examining all costs and comparing them against power harrows.

For the other report, ADAS carried out a user survey to evaluate the performance of SIMBA disc and press rolls/landpackers in a wet season compared to previous dry seasons. The user experiences, comments and costs are all broken down in the report.

Further information from Guy Leversha, SIMBA International Ltd, Woodbridge Road, Sleaford, Lincs NG34 7EW (Tel: 0529 304654).

Exporting to the USA

Shelbourne Reynolds Engineering Ltd estimates that 50 percent of its turnover is now North America bound. The company, started by Keith Shelbourne in 1972 with just two people, now employs over 100 people with a market mainly centred on producing equipment for handling wheat.

Apart from North America, Shelbourne also sells to over 30 other countries, an achievement which recently won the company a Queen's Award for Exports.

Pesticides in the bag

Some companies are now packing their product in measured dose bags which are simply dropped into the sprayer on the farm.

The bag, made from a polyvinyl alcohol film, dissolves completely, allowing the contents to disperse. The film is non-toxic and bio-degradable.

Aquafilm Ltd has perfected a technique for blowing the film on traditional extrusion equipment, significantly reducing manufacturing costs and allowing a far greater degree of tailoring to meet specific requirements.

Used for pesticide packaging, Aquafilm eliminates the need for handling of potentially hazardous products and also the problems of disposing of contaminated packaging.

"We find that Health and Safety inspectors like the idea of pesticides packaged in measured sachets because of the hazard of contamination", explains Aquafilm Director, Martin Osborne.

Aquafilm Ltd, Unit 229 Ikon Estate, Droitwich Road, Hartlebury, Worcs DY10 4EU. Tel: 0299 251335; Fax: 0299 251601.

Wootton 3500 gallon slurry tanker

Wootton have introduced a new, top-of-the-range, 3500 gallon (16,000 litres) slurry tanker with full high speed running gear.

Standard specification of the new Professional 3500 includes three-leaf parabolic springs, new Michelin 445/65 x 22.5 XZA radials, York Tec commercial axles and dual air/hydraulic brakes with a load sensing valve on the two-line air system.

The tank is built with the patented Grandage weight transfer system (a central baffle with a critically dimensioned aperture)which prevents surging and maintains weight on the drawbar. When liquid in the rear tank falls below the aperture, air passes into the front tank allowing a controlled release of liquid to the rear. Slurry is thus automatically held in the front tank, nearest the drawbar, until it is required for spreading.

Wootton Trailers are at Ancaster, Grantham, Lincs NG32 3PL. Tel: 0400 30568.

Closed transfer system for pesticides

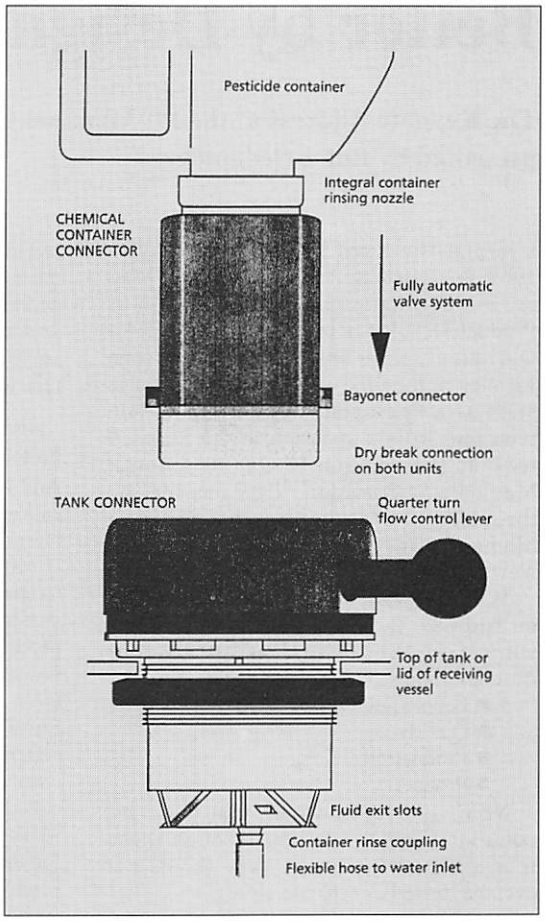
The CHEMLOCK chemical transfer system offers a completely sealed, controlled transfer of liquid. The system comprises two independently valved containers ñ one which screws onto the chemical container and one which fits onto the spray tank, induction bowl or chemical injection system.

The containers fit together and a controlled transfer of liquid is achieved by pulling the control lever clockwise through a quarter turn. Acting as a measuring lever, this quarter turn allows part or full packs of chemical to be used.

On disconnection, the system achieves a totally dry break protecting the operator from contamination. CHEMLOCK also features full container rinsing.

Details: Lurmark Ltd, Longstanton, Cambs, CB4 5DDS (Tel: 0954 260097; Fax: 0954 260245).

The CHEMLOCK container connector with integral rinsing nozzle replaces the transit cap on the container and is attached prior to chemical transfer. The container seal is retained intact until liquid is dispensed. A matching tank connector is fitted into the head of the receiving vessel.



Duckhams are back

After absence of almost a decade, Duckhams Oils are back in the agricultural market. A range of 40 products will be available – from engine oils to specialist products.

The Humidicoil

The Humidicoil store cooler is a radically new type of high humidity air cooler from Thermal Engineering Systems Ltd (Devon EX15 3AJ. Tel: 0884 840216).

Using an indirect cooling system which employs glycol, the Humidicoil gives powerful cooling rates – 25 percent greater, say the manufacturers, than obtainable with a conventional refrigeration system using similar sized coils. The large surface area and the porous packing to the rear of the coil give very high humidity cold air off the coil. TES point out that designing the Humidicoil involved a redesign of coil geometry but the result was a self-regulating evaporative cooler attached to the rear of the cooling coil, whereas normally, such a humidifier is an expensive add-on in cold stores.

Prices start at £600 for the smallest unit. Applications, to date, include storage of potatoes, meat maturing rooms, shop flower stores, cheese maturing rooms and the general cooling of fruit and vegetables.

The Humidicoil has earned TES a SMART award.

Deaths increase from overhead power line accidents

Five people died in accidents involving overhead power lines during 1992/93 – two more than in the previous year.

As part of a co-ordinated effort aimed to reduce fatalities and major injuries, the Health and Safety Executive has launched a new video entitled 'Shock Horror' which reconstructs the typical sorts of events leading to accidents. Its message is hard hitting and dramatic.

Further details from:- CFL Vision, PO Box 35, Wetherby, West Yorkshire LS23 7EX. (Tel: 0937 541010).

Looking for leaks

A staggering 25% of mains water is lost through leakage every year at a cost of £1488m per annum. A new electronic device, now offered by Bradley Products (Tel: 0648 42333) is capable of detecting all billable leaks from a dripping tap to a pipe burst.

Known as the Aquasense, the device senses a leak and activates an alarm or can be programmed to cut off the water supply. Flow rate, time and volume variables are monitored – not only double checking for leakage but triple checking. This determines whether flow changes are the result of normal water usage or of leakage, emitting audio or visual alarms when a leak has been detected.

Aquasense can be easily installed with all normal supply systems from 15mm to 150mm (½" to 6"). The electronic control unit can be mounted up to 300 metres away from an in-line water meter.

Chubb alert on farm fires

Chubb Fire Ltd are warning farmers of the danger from fire. The latest Home Office figures show that fire brigades were called to more than 4000 fires in farm buildings, crops and in forests during 1991.

At the Royal Show this year, Chubb Fire personnel were carrying out dramatic fire fighting demonstrations showing that farm fires can be effectively tackled quickly with the right extinguisher. A pocket guide, 'Fire Protection on the Farm' available from Chubb, outlines the main risk areas, the correct extinguishers to use and the fire fighting equipment available – including control and warning alarms.

Chubb Fire Ltd are at Chubb House, Staines Road West, Sunbury on Thames, Middlesex TW16 7AR. Tel: 0932 785588, Fax: 0932 787729.

Better by Design

The Keynote Address at the 1993 Annual Convention presented by Bob Friedlander

I joined the Ford Motor Company in 1963 as a graduate engineer trainee. After my initial training, I applied for a job as Product Development Engineer at Tractor Operations, Basildon. There was no such vacancy at the time and I was persuaded to start as a Personnel Officer. Later on, returning from a staff job in the States, I took up the position of Quality Control Manager at Basildon. This has led me through a progression of jobs in Manufacturing to my present position at New Holland Ford, UK.

With this varied background, it will be no surprise, therefore, that I address this subject of 'Better by Design' by four different routes. These are:

- People and Organisation
- Quality
- Production
- Product

You will see, however, that there are common threads running through these four topics and, perhaps, they should not even be treated as separate issues.

People and Organisation

Nonetheless,I will start with 'People and Organisation' because it is by far the most important and is, inevitably, the strongest common thread running through the other three topics.If you do not get your People and you Organisation right, you will get nothing else right. and yet, is it not strange that, if you look inside any company or institution, the amount of time spent on this key issue is nowhere near to being in proportion to its importance.

People — the greatest asset...

It has only been in the last decade that western companies have come to the realisation that people are their greatest asset — not their machinery and plant. And it is only in the last decade that we have started to spend more time — still not enoughñ on our most important asset.

I will give you an example from my early days as Quality Control Manager. Every morning at 8.00am, the Plant Manager held a staff meeting. I soon discovered, painfully, that the Production Manager was never at fault. Why hadn't the Tractor Assembly Line made its schedule yesterday? Back came the predictable answer: "Maintenance had gone into the Paint Floor to do a ten-minute repair job and had taken an hour over it!" Why hadn't the Piston Line made its score? Another predictable answer: "QC had rejected everything in process for some meaningless dimensional error". We spent endless unprofitable hours delving into the specifics of what had taken Maintenance so long and what specifically had QC rejected on the piston.

... but the Organisation determines how they perform

And then one day we realised that the root cause of these problems lay in the Organisation. We had created barriers between Production, Maintenance and Quality Control simply through the way we had structured our Organisation. As a result, people were operating in separate camps – indeed, just to emphasise this separation even more, we had given people on the Shop Floor different coloured overalls, dependent on which function they were in.

So what did we do? We created what we called the Area Management concept. Area Managers were appointed to be responsible for the major production entities within the Plant – for Engines; Hydraulics; Tractor Assembly; etc. The Area Managers were given their own Maintenance, Quality Control, Material Handling and Production people, together with the responsibility for those functions. In effect, we made them mini Plant Managers. The change in the 8.00am Staff Meeting was dramatic, and so was the improvement in efficiency. Not only did production improve, but so did quality and maintenance.

Each responsible for his own

But that is not the end of this little story All we had done was to push the problem down one organisational layer. Now it was the Area Managers who were having to oversee battles between their Production, Maintenance, Material Handling and Quality Control Superintendents. It did not take the Area Managers long to realise that the whole issue needed to be shoved much further down the organisation.

So, how does it look today?

Well, now the Line Foreman is responsible for everything on his line – production, quality and maintenance. And, leading on from that, the production operators control their own quality – the 140 inspectors have gone. And guess what? Quality has improved, probably because people do like to take on more responsibility and do resent someone of a higher grade overchecking their work.

And how about skilled maintenance people doing production operations when they have run out of maintenance work – that concept is in process of implementation right now.

Remove barriers; build teamwork

What I have been talking about is 'Barriers' – the barriers created by ourselves, the management, that stop people behaving as a team.

– the Trades barrier

There was another small but, nonetheless significant, barrier amongst the hourly-paid workforce.

Until 1984, at Basildon, we had seven different grades within the skilled maintenance crews. The simple job of changing an electric motor on a machine involved at least three trades – obviously an Electrician, but then also a Machine Repairman to undo the bolts holding the motor in position with a Millwright to hoist the motor up; and probably one or two others that the unions could dream up a reason for.

Then, one day, in 1984, a skilled Shop Steward said to me on the Shop Floor, "Bob, you've often talked about the need to reduce the number of trades and eliminate demarcations. Do it now – I don't think you'll have a problem". We did – and we didn't! We ended up with two trades, the first Ford of Britain Plant to do so. They were Electrical and Mechanical.

– the Hourly/Salaried barrier

Now to the big one – the Hourly/Salaried Barrier. Until British industry rids itself of this demarcation we will not be making any quantum leaps.

How about this scenario?

In February, 1991, we had an extremely heavy snowfall that started at noon. I decided to shut the plant down at 3.00pm and let everyone try to get home at a reasonable hour. If we had stuck to the rules, Fred, a skilled man with an HND and 25 years service, would not have got paid for the last hours of his shift. His daughter, Wendy, on the other hand, a salaried secretary with two years service and no qualifications, would have.

Then, there is this one — Mark, a Production Operator, walked five miles through the snow the next day and was two hours late. Should I dock him the two hours when his Production Manager only got in at lunch time and would not see any difference in his pay cheque at the end of the month?

R M Friedlander is Commercial Operations Director, New Holland Ford, UK.

– rewards for experience

Here is another aspect of the same barrier.

The Salaried payment structure recognises service, experience and merit. Each grade has a payment range and after, say, twenty years of good service you could expect to be at the maximum of your range.

With the Hourly Paid we have no such system There is only one payment rate for each grade. So you could have worked on the Tractor Assembly Line for 20 years and be an excellent, experienced employee; and, yet, tomorrow we could hire a totally inexperienced 18 year old, off the street, and he would qualify immediately for the same pay as you. There is a system that we could make 'Better by Design' but still, I am ashamed to admit, have not done so.

– trust and responsibility

However, we have been doing some things at Basildon to help eliminate the Hourly/ Salaried barrier, albeit too slowly.

The most recent step in that direction was the elimination of clocking. Many predicted that it wouldn't work – there would be a proliferation of late starts and early quits. However, when you give people trust and responsibility, that doesn't happen – well certainly with 99% of them it doesn't. They are on the job on time and at the end of the shift we no longer have that 10 minute clock queue. There is no clock so there is no need to queue. So what do they do? They go on working until shift end.

But there are many more things we have to change to rid ourselves of this barrier. Hourly have to become Salaried and we shall all have to eat in the same dining room and park in the same car park.

– get people involved

And now to my last People topic – Employee involvement.

Someone, a long time ago said, "Tell me and I'll forget, show me and I'll remember, involve me and I'll understand".

We continually underestimate the power of involvement. We must all pursue it with passion for it is of immense importance to our future.

Involvement generates Teamwork and it was teamwork that, eventually, in 1989, resulted in Basildon becoming Ford Motor Company's first Manufacturing and Assembly Plant worldwide and their third Assembly Plant to win the prestigious Ford Q1 Award after four years of hard work. In the final week, when we were tested by a panel of judges from Ford's headquarters in Dearborn, Michigan, 120 separate quality presentations were made, of which 80 were by operators on the Shop Floor. That's involvement!

Quality

Until the mid-70's, the only people interested in quality were those in the Quality Control department. No-one else was and certainly not Production,who regarded it as an evil and not even a necessary one. Product Engineering appeared to be interested in Quality, but only because they could hide behind it when something went wrong in the field. I can hear now their immediate response: "It must have been away from print" The design of the component could never be the root cause of the failure.

Statistical process control

An excellent Manufacturing and Assembly tool to control quality is Statistical Process Control – SPC, for short.

General Douglas Macarthur recruited Dr Demming after the Second World War and took him to Japan to help rebuild the country into a manufacturing power. Demming took with him SPC — and much of Japan's present fame for top quality products is owed to Demming and SPC. His secret was, however, that he did not apply SPC through the Quality Control department: he applied it through the Production operators.

Within Ford in the mid-50's we were using SPC, but it was the QC inspectors who took the readings and plotted the charts. Tons of charts were produced and filed away in QC. No-one looked at them and no-one acted on the information they were providing. And so, by the beginning of the 60's, SPC was abandoned as being an unsuccessful Quality tool.

It was only in the 70's, when we all started wondering how the Japanese products could be so superior in quality, that we found one of the main reasons was SPC and the manner in which they were applying it.

At Basildon, we re-launched SPC in 1984, but this time we applied it though the Production operator.

We started in Engine Machining by taking 390 operators and putting them on a two-day training course. After we had got them working successfully with this 'new-to-them' technique, we took another 30 people in our hydraulic lift component machining area and trained them up. We were just getting Hydraulics launched when the Unions stepped in and demanded that we raise the grade of any production operator performing SPC from semi-skilled to skilled. We said " No!" The Unions brought in the District Official, who told the 30 people in Engine Machining to stop using SPC and they, in turn, told the District Official that he could 'shove off'. They were enjoying what they were doing and their jobs had suddenly become a lot more meaningful and interesting.

If you visit Basildon today, you will find SPC charts all over the place and a workforce that is controlling its own quality and is interested in quality.

Quality audits

Now to another quality subject — Audits. Every day at Basildon we conduct audits on two or three tractors, two or three engines and two or three hydraulic lifts. In other words,we audit the finished products we manufacture.

These quality audits are performed by Hourly Paid auditors who randomly select tractors after they have been OK'd for shipment; engines after they have successfully completed the dyno hot test; and hydraulic lifts after they have been through the lift test.

The audits are extremely intensive. For example, a tractor takes the auditor five hours to complete his check list.

Over the years we successfully drove the audit Demerits-per-Unit down to the point where we started to measure demerits not 'per-unit' but 'per-100'. And yet, we heard through the Service department that the dealer network still moaned that our Assembly quality was not good enough. Then we realised that, perhaps, we were not checking the right things.

– the customer's view

One of my Manufacturing Managers suggested we should create an Adopt a Dealer programme – to invite four or five dealers into the Plant every quarter for a couple of days to communicate with us. In other words, we should do something revolutionary — we should talk to the customer, somebody we seemed to have forgotten about.

What an eye opener it was.

For example, we suddenly learned that lack of blue paint on the underside of the tractor was important to the customer. We had long since talked ourselves out of this demerit being important and we had stopped counting it. After all, it was not as though the underside wasn't painted and would rust:- there was plenty of primer protecting the components. So why was blue paint total coverage so important when you hardly ever saw the underneath of the tractor? Then we were told. A tractor is delivered to a farmer usually on a flat bed trailer and what does he see first — the lack of blue paint coverage underneath.

Then we learned of the 'Windolene Kid'. One of our Adopted Dealers told us that he employed a young man almost full time, removing all our various in-process stickers from the front window of the cab. He was mad that we had never managed to fix it. Fix it? We did not even know that it was a problem. The next day we started attaching a plastic card to the radiator grille and affixing the stickers to that.

It is remarkable what happens when you begin talking to your customers and finding out what is important to them.

– quality of service

Blindly following the Audit system was not good enough. Customer input is needed to assess whether what we were doing was of significance or not.

We realised that the ultimate customer, the farmer's perception of us was not only dependent on how our products behaved in the field but, just as important, how our

dealers behaved in the field.

We launched our CSE — Customer Service Evaluation — questionnaire. Six months after a farmer has bought one of our products we send him a questionnaire that invites him to evaluate two things: the product and the dealer. Even though this is an extremely detailed questionnaire, we get a 40% return, which just goes to show how much our customers care. Our dealers, too, are even more aware of the important part they play in achieving customer satisfaction.

In the last two decades, the subject of Quality has become of far greater importance and this now has a far greater dimension to it than the picture of an inspector using a micrometer on some part. Indeed, the term Total Quality Excellence is now being used.

Everyone in an organisation has to be aware of who is downstream of him, of who the customer is and what is important to him. Then, as if by magic, you start making these quantum leaps.

Production

Turning now to topic number three – Production. The 'Better by Design' concept applied here means curing problems by treating the root cause and not just the symptom.

– machining problems

To give an example; I had been appointed Area Manager of Engine Machining and Assembly and, within three hours of stepping into the job, the Block Line stopped. The machined sump face of the block was being heavily scored by the transfer rails between Op.20 and Op.30. I asked how long had this been going on and how long had Op.30 been shut down as a result. The answer was three weeks. Had anyone worked on the problem during that time?. The answer was "No". Why not? – because there were 6000 blocks in process in the line beyond Op.30 and the quality problems associated with running them through the line kept everyone very busy indeed.

My next question was why did we have 6000 blocks in process. The answer was that 6000 in process was the objective. A study had been conducted three years before by someone at Ford Headquarters in the States. He had concluded that due to the age and unreliability of the block line, 6000 blocks were needed to be in process at all times – JIC – a machine went down.

That is a glaring example of treating the symptom and not the cause. However, it was not the end of the story for, even worse, spurs had been built at a cost of £500,000 off the main line so that blocks could be loaded and unloaded between machines, and these gave almost as much trouble as the machines themselves.

Furthermore, the 6000 in process blocks contributed considerably to the poor performance of the line; they represented a melange of quality levels having been machined at different times with different machine settings so that the dimensional variations between them were significant. Inevitably, when you take a group of components such as this and try to process them through to, say, Op.80 you end up with enormous problems.

Finally, besides all that, the psychological effect on production and maintenance people resulting from having 6000 blocks in process was that, if a machine went down there was no need to fix it immediately. Why should you, you were protected by perhaps three weeks – a manana philosophy.

Today, Basildon has 250 blocks in process, the quantity that it takes to fill up the line. The loading and unloading spurs have all been ripped out. The machines are still the same old machines – but the results, in quality, in productivity and in machine up-time are vastly better than they were 14 years ago.

– supply problems

To give another example: decals were notorious for damaging our tractor 'OK off line' percentage.

We have some 250 decals for all sorts of purposes—model identification, instructions, safety warnings, etc, and, of course, in many different languages. (I was once challenged to find the obvious demerit on a tractor destined for Japan. I didn't. It was that the PTO warning decal was in Greek). However, there would always be one of the required decals missing.

This problem of decal availability started with the fact that we had sourced one third of them to a company in the States, one third to a company in Belgium and one third to a company in the UK.

The first sensible step we took was to source them all to the UK company which was only 15 miles from the Basildon Plant.

The second step was to take the job of scheduling and chasing decals away from the person who spent 120% of his day doing this and to tell the UK source he was totally responsible for keeping us supplied. We built 250 trays and we put a mark on each tray We told our UK supplier we had adopted the 'Marks and Spencer' system – whenever the decals in a tray fell below the mark we expected him to top it up. He now visits the Plant every day and does just that. The man who used to schedule and chase decals is doing another, more satisfying job.

– pay for quality not for mistakes

My last production example is one that we have not yet solved, but we need to — and I do not believe the problem is peculiar to my organisation but is common to many industries in the UK and elsewhere.

The problem is this. Our payment system penalises success and rewards failure.

I remember suggesting to our Conn rod Line that whenever a machine went down, as soon as it was up and running again, they should endeavour to catch back the lost production for the good of the Company and, in the long run, for the good of themselves. They answered quite honestly. They said that if they did that they would not get Saturday overtime at time and a half.

There are at least two issues here – we pay far too great a premium for overtime in the UK (and perhaps not enough in the base rate) and not many companies have a profit sharing scheme.

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Design' again heavily involves issues of People and Organisation and of customer awareness.

New product development

I am going to limit my discussion to the development of new products.

We found two major problems after we launched a new tractor range. First, it took far too long to get into the marketplace and second, when it did, it usually fell short of what the Customer, the farmer, wanted.

– find out customer requirements

We had forgotten to ask the customer what he wanted. Instead, we gave him what thought he should have wanted and then wondered why our arrogance got us into trouble.

The solution, of course is simple and five years ago we decided we should be revolutionary and take the daring step of consulting with these people who cause us so many problems – the customers.

For the Series 40, we established what we called 'customer clinics' (an inappropriate name, perhaps, as though these weird people need some form of treatment before they finally go off the rails). Anyway, regardless of the unfortunate name, these 'customer clinics' were a tremendous success. The farmers had plenty to say. We not only took note, but also took notice and implemented as much as we could of their demands. And when we finally launched, albeit a year late, they said, "finally you listened".

– get the product out on time

That brings me to the subject of Time to Market (TTM). It has always taken us far too long. With a structure powerfully organised on a functional basis, people climb into their respective organisational boxes and never venture out again. In that environment the following sequence of events would take place:

Product Planning would work on the concept of the new tractor for 18 months – wherever possible avoiding talking to any customers. They would then pass the concept on to Product Engineering who would immediately point out what they believed to be the fundamental weaknesses. Too late, the clock was ticking, Engineering had to accept it as is. Engineering then worked on it for three years, designing, building prototypes and testing. When Engineering had finished, they released their drawings to Manufacturing and Purchasing. This being the first time that these two organisations had had anything to do with the product programme, they screamed that half the parts had been designed with no account taken of the existing manufacturing processes. Too late, the clock was ticking even louder. More funds had to be requested to purchase new machines to suit the revised processes and the inevitable result was a request to delay the job.

– involve people in teamwork

What was the fundamental and vital ingredient lacking in this sad scenario? It was Teamwork. Some say it was Simultaneous Engineering but to me that is just another name for Teamwork. We only discovered this when we were half way through our Series 40 programme but, when we did discover it, what a difference it made.

The first step we took was to try to build as much of the second generation prototypes in the Plant as possible. Inevitably, that drove the Manufacturing, Purchasing and Engineering people together.

The next challenge was to build 140 pre-production vehicles nine months ahead of the full production launch and to do this on the line, while at the same time building current production.

We formed eight teams comprising a Design Engineer, a Process Engineer, a Quality Control Engineer, a Buyer and a Production Foreman. Each team had a section of the line for which they were responsible and each team was given authority to fix all problems identified. Their challenge was to fix every single problem raised by the operators, the road test drivers, the repairmen, the quality auditors, whoever.

It was stressed to these teams that what they might regard as a niggly, unimportant nuisance-type problem to a production operative had to be treated as extremely serious.It is just this kind of irritant type assembly problem that results in operators getting fed up and losing interest in doing their jobs correctly.

Some 1200 different problems were raised and 1100 had been fixed when we went into production nine months later.

The result? The best new model launch we have ever had.

LITERATURE

Two new books from Farming Press

A Full Pull: the sport of tractor pulling by Geoff Ashcroft

ISBN 0 85236 261 7 Price £14.95

This book describes this loud, dramatic sport which rests on the engineering skills of the tractor owners who modify their machines, some of which produce thousands of horsepower.

The tractor which pulls a rapidly increasing weight farthest over a measured track will win the class. There are a number of classes including some where the machines bear a close resemblance to their original tractors.

The sport is fully described by Geoff Ashcroft, from its start in the USA to the contemporary scene in Britain.

Fifty years of farm machinery: from starting handle to microchip by Brian Bell

ISBN 0 85236 263 3 Price approx. £20 (to be published in October)

The author is well known for his books on current machinery and farm workshops. This covers the history of farm machinery in Britain from the 1940's to today with considerable emphasis on the 50's and 60's. There is a short overview on tractors but the bulk of the book is devoted to other farm machinery.

A strong feature of the book is a description of a host of smaller British manufacturers, many of whom have long since disappeared from the agricultural scene. The book has approximately 350 pages, and includes 400 illustrations.

For orders and details of the above and their other new books, contact Farming Press Books, Wharfedale Road, Ipswich, IP1 4LG. (Tel: 0673 241122)

Health and Safety

The Health and Safety Executive has published a revised guidance on 'local exhaust ventilation' (LEV). This revises previous guidance in line with COSHH.

Sometimes, LEV systems are not fully effective due to inadequate design or because their function and use is not properly understood. This booklet describes the important features of a good system so that basic assessment of effectiveness and performance can be made.

'An Introduction to Local Exhaust Ventilation' — ISBN 0 11 883954 3 — is available from HMSO bookshops and accredited agents. Price: £4.50.

Water quality – monthly newsletter

A new newsletter, Focus on Water Quality, was launched in July. It aims to provide technical and commercial news for the water treatment sectors with emphasis on legislation and environmental issues.

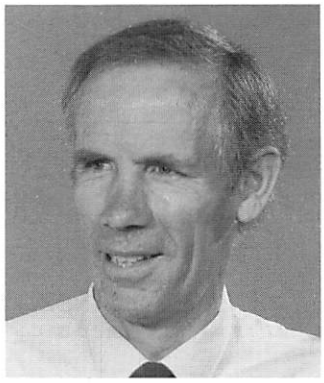
Orders to Alison Hey, Royal Society of Chemistry, Science Park, Milton Road, Cambridge, CB4 4WF — subscription July to December, 1993 : £75.

A survey of wheat straw swaths and the implications for in-field straw processing equipment

Mike Neale, Peter Williams

The variability of swath density is an important aspect when designing machines which require a regulated feed of straw from a swath. This survey measured swath densities at eight different sites in eastern England by weighing 20 one-metre lengths of swath from six sample swaths at each site. The change in linear density, metre to metre, was expressed as a percentage and the maximum measured change was 139 percent. However, 92% of all changes were less than a 40% variation.

Other parameters measured or assessed included straw length, leafiness and entanglement, but none of them had a significant effect on the variation of straw swath linear density.



Mike Neale

The Department of Trade and Industry (formerly the Department of Energy) through the Energy Technology Support Unit (ETSU) has put funds into the development programmes of two different straw wafering machines (ETSU Project profiles 025, 044 and Project summary 025), and laterally, to a project to further understand some of the problems of making wafers (ETSU Project profile 267).

One area investigated was the uniformity of straw density approaching the wafering machine and this survey formed part of that investigation.

Wafering machines will need consistent feed

The effective commercial production of wafers from straw (or other fibrous crop) in closed-end dies depends on a consistent density and rate of feed being passed to the compressing mechanisms of the machine.

It has been suggested that an optimised wafering die system is unlikely to be able to accommodate a feed that varies in density by more than ±15% around a mean. The pick-up, treatment and pre-compression mechanisms will have to condition the straw swath to meet this criterion.

Survey to determine swath parameters

Information describing the variation of straw within swaths is essential to establish design parameters for the feed and first stage compression systems. The work described here sets out to provide the necessary information and had the following objectives:

- to establish the variation on a metre by metre basis of the weight of straw in a range of wheat straw swaths;
- to examine a range of other factors and evaluate any correlation with weight per metre length ('straw linear density');
- to provide other information (eg straw length) which may affect wafering or any other relevant process.

– Site selection

Eight sample sites were chosen to represent a range of soil types, agronomic practices and combine harveter types in the arable area of eastern England ranging from Norfolk and Bedfordshire to Yorkshire. Site details are shown in Table 1.

– Measurements and assessments

For each of the eight sites, six swath samples each 20m long were chosen across the field. Swaths were selected which had no obvious visible density variations. On this basis, the operator of a straw processing machine could not easily identify parts of the swath where he may need to react.

At each sample point the following measurements and assessments were made:

- *Linear density:* straw from each of 20 x 1m lengths of swath was gathered and weighed;
- *Straw length:* 30 individual pieces of straw were chosen at random from each swath and measured to assess the real length of straw to take into account the degree of breakage during combining:
- *Leaf: Straw ratio:* a visual assessment of the leaf: straw ratio was made for each sample point and scored on a range of 1 to 3 (1 = leafy; 3 = stemmy);
- *Entanglement:* a subjective assessment was made to evaluate the linking of straws within the swath and this was scored on a range of 1 to 3 (1 = low entanglement; 3 = high entanglement);
- *Swath volume/density:* the overall swath width and profile were measured at three places for each sample swath. The profile was established by taking five height measurements equidistant across the swath width and measuring the stubble height on either side of the swath.

Table 1. Site details.

Site No.	*Variety*	*Soil type*	*Combine type*	*Header width m*	*Days from harvest to survey*
1	Avalon	sandy loam	axial rotary	4.96	2
2	Riband	sandy loam	straw walker	5.05	3
3	Mercia	clay loam	straw walker	4.40	5
4	Pastiche	clay loam	straw walker	4.40	6
5	Avalon	loam	straw walker	3.30	21
6	Mercia	chalky loam	axial rotary	6.00	1
7	Riband	heavy clay	straw walker	3.60	20
8	Mercia	heavy clay	straw walker	6.00	2

Variation in straw quantity

The variation in density along the swath is the most critical parameter in determining the design of any straw processing machine which requires a regulated feed rate.

The results of the survey have been evaluated with an emphasis on the change from one metre length of swath to the next, measured as a percentage of the density of

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P Williams is a member of SCG.

the first of each pair of metre lengths.

Results have also been assessed in both directions, ie assuming travel up from metre 1 to metre 20 and then down from metre 20 to metre 1. This completely describes the amount of change that the machine will have to cope with from metre to metre.

Table 2. Swath linear density – Site 4.

	UP		*DOWN*	
Sample point	*Biggest rise, %*	*Biggest fall, %*	*Biggest rise, %*	*Biggest fall, %*
1	31.91	–38.71	63.16	–24.19
2	56.67	–34.04	51.61	–36.17
3	13.64	–22.00	28.61	–12.00
4	43.75	–23.44	30.61	–30.43
5	29.27	–22.64	29.27	–22.64
6	50.00	–33.90	51.28	–33.33

Note: 1 Average linear density 2.40kg/m
Maximum linear density 3.50kg/m (+45.8%)
Minimum linear density 1.50kg/m (–37.5%)
2 Whole site – Biggest rise + 63.16%
Biggest fall – 38.71%
Average change 13.80%

In most situations, the rises in density are larger than the falls on a percentage basis (the reason for this is that as all changes have been expressed as a percentage of the first metre, a rise is expressed as a percentage of the smallest number and a fall is expressed as a percentage of the largest number.

Table 3. Swath linear density – Site 6.

	UP		*DOWN*	
Sample point	*Biggest rise, %*	*Biggest fall, %*	*Biggest rise, %*	*Biggest fall, %*
1	28.00	–18.31	22.41	–21.88
2	139.13	–43.90	78.26	–58.18
3	24.14	–22.67	29.31	–19.44
4	36.54	–23.75	31.15	–26.76
5	43.40	–26.39	35.85	–30.26
6	20.97	–24.10	31.75	–17.33

Note: 1 Average linear density 3.50kg/m
Maximum linear density 6.70kg/m (+91.4%)
Minimum linear density 2.30kg/m (–34.3%)
2 Whole site – Biggest rise +139.13%
Biggest fall – 58.18%
Average change 15.20%

Results for two of the eight sites are summarised in Tables 2 and 3.

By expressing swath variations as percentage changes, the effects of crop yield and the width of combine header are incorporated in the results.

Straw length

Straw length measurements have been averaged across each site (180 readings). The variation within any sample is that between short broken pieces to complete lengths (ie, from stubble height to head). The results are summarised in Table 4.

Particles of chaff or broken leaves will be included in the swath collected by a machine but were not included in the straws sampled in this survey.

Leaf : straw ratio and entanglement

The results of the subjective assessment of leaf : straw ratio and entanglement are summarised in Table 4.

There does not appear to be any correlation between leaf : straw ratio and either crop variety or the type of combine harvester used but an axial flow rotary combine produced a lower average straw length (Table 4, sites 1 and 6) and low swath entanglement.

Swath volume / density

Swath profile and width measurements and swath weight are combined to establish average swath volumes and densities for each site. The results are shown in Table 5.

As stated earlier, the change in straw linear density is the most important parameter affecting the input to a straw processing machine.These changes (Tables 2 and 3) are large. Variations that occur in crop yields and quality across fields are hidden in field averages.

The combine harvesting operation will exaggerate these variations when cond-itions prevent the straw from flowing smoothly through the machine or the operator has to lower the header to gather laid crop.

Changes in straw density

In Table 6, figures are given, for each site, of the maximum and minimum densities compared to the averages. Linear density changes within a range ± 55% would include over 99% of the changes measured above and below the field averages. Also, in Table 6, are given the average and the biggest changes in linear density from metre to metre. The averages are calculated from 228 changes at each site.

The results have also shown that, in considering the percentage variations from metre to metre for all sites, the number of large changes is relatively small – less than 14 percent are over 29% and less than 4% are over 50%. A ± 60% maximum change from metre to metre would capture 97.5% of all changes.

Implications for design of wafering machine

– high capacity needed

These results indicate that in order to accommodate these changes, a very high machine capacity is required. For example, a 99.9% ability to cope with metre to metre density changes implies a 0.5% overload rate (ie one occurence every 200 metres). At a typical forward speed of 4km/hr, an overload would, thus, be occuring every three minutes. This is unlikely to be commercially acceptable.

The frequency of acceptable overload depends on its nature. Today's commercial pressures imply that an overload failure requiring the operator to stop, dismount, and make an adjustment (eg to replace a shear bolt) is not acceptable more than twice a day. However, if the overload involves no more than a quick stop and the reversing of an hydraulic drive, then perhaps up to three per hour would be acceptable.

When operating at 4km/h in 2.5kg/m swaths (10t/h work rate), an over-load or under-load situation is estimated to occur every 1350m, unless the machine is designed to cope with the maximum level of variation indicated in this survey.

– straw length and entanglement – may be influenced by type of harvester

Entanglement, which may be significant in designing mehanisms to control straw feed, appears linked to harvester type (see Table 4). The entanglement was low for both fields where axial flow combines had been used, although the crop yield in both cases was low.

The axial flow combines also produced a noticeably shorter straw length and, consequently, a more dense swath. this change in straw length may have an effect on wafering or other subsequent processes.

High yielding crops appear to produce more entangled swaths, although this is affected to some extent by the type of combine harvester.

Conclusions

- A straw swath left by a combine,

Table 4. Straw measurements at each site – yield; length; leaf; straw ratio; entanglement.

Site No.	*Average yield t/ha*	*Straw length Average mm*	*Maximum mm*	*Minimum mm*	*Leaf: straw ratio**	*Entanglement**	*Swath*** density kg/m³*	*Combine type*
					Site averages			
1	4.2	158	600	25	1.8	1.0	14.1	Axial rotary
2	5.5	390	790	40	3.0	3.0	6.9	Straw walker
3	6.2	261	620	25	2.0	3.0	7.8	Straw walker
4	5.5	319	690	30	2.3	2.0	7.3	Straw walker
5	4.8	353	690	45	2.5	1.2	7.5	Straw walker
6	3.5	272	650	30	2.2	1.0	12.2	Axial rotary
7	7.0	590	945	60	2.0	3.0	9.0	Straw walker
8	7.1	381	790	35	1.0	2.0	10.5	Straw walker

* 1 – implies leafy; 3 – implies stemmy
** 1 – implies low entanglement; 3 – implies high entanglement
*** This measurement is made at 50% of stubble height to accommodate sinkage of the swath into the stubble

Table 5. Measurements of swath volume and density (average values per site).

Site No.	*swath width*	*swath height (inc stubble)*	*swath volume/m (inc stubble)*	*swath density (inc stubble)*	*stubble height*
	mm	*mm*	*m^3*	*kg/m^3*	*mm*
1	1123	221	0.25	8.4	177
2	1485	327	0.49	5.7	113
3	1591	308	0.49	5.5	171
4	1399	297	0.42	5.7	124
5	1461	218	0.32	5.0	145
6	1394	280	0.39	8.9	148
7	1266	287	0.36	7.0	130
8	1480	337	0.50	8.5	134

although visually even, was found to vary by as much as 140% in weight from metre to metre.

- The average linear swath density was 2.5kg/m and the average yield of straw was 5.48t/ha.
- Taken about the average site linear density, the most dense metre was + 55% and the least dense – 42%.
- Some 92% of all linear density changes are captured within a density variation range of ± 40%.

The prototype straw wafering machine developed at Silsoe Research Institute is illustrated in our front cover photograph.

Table 6. Changes in straw density and straw linear density.

Site No.	*Average site yield*	*Most dense metre*	*Lease dense metre*	*Average change (metre to metre)*	*Biggest change*
	t/ha	*%*	*%*	*%*	*%*
1	4.2	+48	–38	10.0	41.4
2	5.5	+50	–45	16.6	82.6
3	6.2	+50	–46	23.4	106.9
4	5.5	+46	–38	13.8	63.2
5	4.8	+47	–53	22.4	112.5
6	3.5	+91*	–34*	15.2	139.1
7	7.0	+82**	–44	16.4	78.6
8	7.1	+41	–41	13.8	100.0

* This result from site 6, sample point 2, implies a momentary slowing of the combine between metres 15 and 17. However, this was not obviously visible.

** This result was due to laid crop where the operator lowered the header for 3 to 4 metres so taking in more straw.

References

ETSU (1991). Development of a mobile straw wafering machine, *Project profile 025.* Renewable Energies Enquiries Bureau.

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ETSU (1991). The design and development of an in-field straw wafering machine, *Project summary 025.* Renewable Energies Enquiries Bureau.

ETSU (1992). Advances in straw wafering technology, *Project profile 267.* Renewable Energies Enquiries Bureau.

Japanese funding for research in grain processing

The Satake UK company, subsidiary of the Satake Corporation, Japan, has announced an agreement in principle with UMIST to establish the UK's first academic Centre for Grain Processing.

The Satake Centre, which will be funded initially by grants from Satake totalling nearly three quarters of a million pounds over five years, will establish postgraduate research programmes in the area of flour milling and grain processing leading to Modular MSc and Doctorate degrees when suitable, and an information, research and consultancy source for the world grain processing industry.

It is hoped that the first students will begin work in the Autumn of 1994.

Details: Tim Yates: Tel: 061 200 4000.

Tractor sales on the Up

Tractor registrations for the first six months of 1993 showed an increase of almost 17% over the same period of last year, according to the Agricultural Engineers Association (AEA).

The biggest increase was in the 121+ hp range (up 45%), with the 61 – 70hp group next at 35%. Down 31% and 20% respectively were the 41 – 60hp and 71 – 80hp ranges.

Forestry Association launched

A major new inititive to increase profitability, jobs and productivity in the £60m a year Scottish forest harvesting industry has been launched.

The Forestry Contracting Association, which has been set up with core funding from Scottish Enterprise National, Highlands and Islands Enterprise and the UK Wood Processors Association, aims to:

- Increase the profitability of forestry contracting
- Ensure continuity of work for contractors
- Provide training to raise skills
- Introduce a code of practice on quality standards, safety and environmental issues.

Further information:- Maureen McAlpine, Senior Press and PR Executive, Scottish Enterprise National;. Tel: 041 248 2700.

'War on wear' succeeds in changing working practices

Almost half of the companies advised in the first year of IMechE's Tribology Action 'War on Wear' Campaign have changed their working practices leading to improved reliability and lower maintenance costs. Major benefits experienced within one year were improved reliability (38%), lower maintenance costs (31%), improved product life (19%) and lower energy costs (6%).

For details of this year's programme, contact Maria Clarke on 071 973 1277.

Transmissions Products

– new catalogue from Cross and Morse

This new catalogue will give a lot of technical information to engineers responsible for the design, installation and maintenance of mechanical power transmissions. It covers roller chain, inverted tooth chain, timing belts and gears.

Copies of the catalogue obtainable from: Technical Sales, Cross and Morse, Shady Lane, Great Bar, Birmingham, B44 9EV (Tel: 021 360 0155).

BACK NUMBERS

We have a quantity of the following issues surplus to requirements:–

Vol 44 (1989) Issues 2 & 3

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Depreciation rates of farm machinery

Martin Turner

The changing resource structure of agriculture in the economically advanced countries has two major features – a marked decline in the farm labour force accompanied, if not caused, by a remarkable increase in the use of capital inputs and particularly of machinery and power.

Appropriate charges for depreciation are important for both the economist, with interests in resource use patterns at farm and sector level, and the accountant concerned with guiding farm-level decisions for effective business management.

This paper reviews first the concept of depreciation and discusses alternative approaches to its calculation. The estimates of actual depreciation obtained from the study are presented, and these are updated with a review of recent trends in machinery investment patterns on farms together with their implications for appropriate depreciation rates.

In England and Wales during the post-war period the change in input use and the availability of mechanical power has been dramatic and, although the number of tractors has changed little since the 1960's, average engine size has continued to increase. More recently, the integration of computer-controlled operations within complex machines has provided a new thrust to the process of mechanised farm operations.

Appropriate charges for depreciation are important but it has long been recognised that there is a significant difference between the accuracy with which current expenditures are recorded and the approximation involved in imputing an annual charge for machinery and equipment depreciation (Mathieson, 1963).

Although there is no dispute as to the significance of economic depreciation – the proration of the capital cost for an item over its useful life, preferably at a rate which reflects its total service flow – little empirical work has been undertaken except at case study level. A notable exception was the 1982/83 Machinery Study which formed part of the MAFF Commissioned Work Programme in Agricultural Economics. Data from this source was used to estimate the real depreciation rate for various categories of farm machinery in England and Wales (Cunningham and Turner, 1988).

Defining depreciation

In economics, 'capital' is used to denote an asset or durable good not entirely used up in the production process within the time period studied.

Paper presented at the Annual Conference of the Institution, Better by Design, Silsoe College, May 1993.

M M Turner is Senior Investigational Officer in the Agricultural Economics Unit, University of Exeter.

In agriculture, *physical capital* is the machinery, equipment and buildings directly used in the production of food and other commodities, and which can be used again in the following year. Such capital does not last for ever but the pattern of wearing out is different for various categories of machines and also for buildings (though this paper focusses only on machines).

How should the cost of such capital goods be treated in calculating either resource use or profits? Essentially, the true economic cost of a capital good in any period is the cost of using it rather than buying it. Hence depreciation can be considered as the loss in value resulting from the use of the machine.

Depreciation, or capital consumption, measures the rate at which the value of the existing capital stock declines per period as a result of wear and tear or obsolescence (Begg *et al,* 1987, pp 432–433).

Depreciation is a flow concept, indicating how much of the stock of fixed assets is being consumed in the process of production.

Calculating depreciation

It follows that the depreciation of a fixed asset could be determined by a series of annual valuations, but this would be unrealistically ponderous and difficult to apply for those items where no ready market exists. There are three common methods for calculating depreciation: the straight line method, the diminishing balance method and the sum-of-the-year's-digits method.

– First cost and likely life

Whichever method is used, in addition to the cost of the asset it is necessary to determine the length of time over which the asset should be depreciated.

The length of useful life should be based on deterioration (which will occur with use and with age) and obsolescence (which provides an upper limit on the length of life). However, if the annual use is great enough to wear out the asset before it is obsolete, then it is the wear out life which is important.

This concept of obsolescence is particularly relevant where machines are scrapped not because they have fully depreciated but because they are no longer profitable to operate, though still as productive as when new. Obsolescence may come from technical progress being incorporated in new machines of a similar type, from technical improvements in associated processes or from a decline in demand for the product with which the asset is associated (see, for example, Dunford and Rickard, 1961; Layard and Walters, 1987 pp 295–299).

– Inflation

The implications of inflation for the provision of an adequate depreciation charge have been considered from both economic and accounting perspectives (Davies and Dunford, 1977; Hill, 1978; Sandilands, 1975). Through a period of inflation the traditional form of historic cost accounting will provide inadequate estimates of depreciation and the Sandilands report recommends its replacement by a *current cost* method. Here, the basic choice is between the fairly straightforward current cost approach and the more complex *full replacement* cost method, which involves the calculation of backlog depreciation.

It has been demonstrated that the current cost method, which updates the book value of a capital asset at the beginning of an accounting period using an appropriate price index* (and on which revised value depreciation is then calculated), still fails to fully provide a fund large enough to replace the existing capital stock. There is a

**Ideally, a price index specific to the item of machinery though in practice the available indices are limited to tractors, major machines and all machine categories only.*

Table 1. Depreciation estimates for tractors and major agricultural machines in England and Wales, 1982/83.

Category	*(1–d)*[1]	*Deprec. rate %*	*MSE*	*Number of observations*
Tractors[2]	0.869	13.1	0.0313	676
Tractors[3]	0.870	13.0	0.0305	953
Combines	0.864	13.6	0.0285	134
Potato harvesters	0.842	15.8	0.0731	30
Sugarbeet harvesters	0.796	20.4	0.0226	27
Forage harvesters	0.819	18.1	0.0595	58
Balers	0.844	15.6	0.0452	60

Note: 1 (1–d) where 'd' is the depreciation rate
2 data for England and Wales
3 Data for England and Wales augmented by data for South West England (1980/81–1986/87).

deficiency which occurs because the inflationary element of the annual depreciation charge is related only to the change in replacement costs over the year rather than to that which occurs over the full period of ownership.

By introducing the calculation of backlog depreciation (the sum of the annual depreciation charges), the written down book value of the machine is equal to the estimated replacement cost in the year of disposal. For this method to achieve its potential, in terms of providing satisfactorily accurate results consistently, requires the use of an appropriate rate of depreciation and price index.

The price index should, of course, be quality-adjusted to allow for the technical improvements in machinery design and specification which almost certainly will have occurred over time, the theoretical benefits of which have been well documented (Fettig, 1963; Griliches and Adelman, 1961; Rayner, 1966). In the absence of such indices, estimated replacement costs will be exaggerated since they represent, in aggregate, the replacement cost of a more advanced machine.

However, as Cunningham (1988) has argued, although the 'loss in value' approach to depreciation implies replacement with an identical asset, technical innovation is such that this is rarely possible or desirable.

For functional purposes, replacement will take account of a steady 'quality' improvement in capital stock and thus a constant-quality price index, though theoretically desirable, is not a practical necessity. It becomes significant only where the pace of technical change has been dramatic or where machine replacement is contemplated after a long ownership period.

Empirical estimates of depreciation

The constant rate diminishing balance method (CDB)

In the 1982/83 Machinery Study, the parent sample of some 2000 farms in England and Wales included almost 9000 tractors. However, the estimates of actual depreciation were based of necessity on the 676 tractors sold during the 1982/83 accounting period.

In order, therefore, to provide an even more robust sample, additional observations on tractor disposals from farms in South West England were made available over the wider period between 1980/81 and 1986/87, bringing total sample size to 953 tractors. This augmentation can be considered acceptable providing the inter-regional and inter-temporal variation in depreciation rate is minimal. Examination of both of these aspects showed little variation in either the South West time series data or the regional results; and the evidence of regional consistency is given later in this paper.

Cunningham (1988) calculated a replacement cost diminishing balance rate of depreciation using the formula:

$$\frac{SV}{CV} = (1-d)^n \qquad (1)$$

where

d = depreciation rate

n = service life of the machine in years

SV = sales value

CV = current value as estimated by

$$CV = OC \times (P_n/P_o) \qquad (2)$$

where

OC = original price

(P_n/P_o) = price index

Equation (1) was estimated using a range of values for 'd' until the mean squared error (MSE) was minimised and, at this point, the results suggested a depreciation rate for tractors of about 13 percent (Table 1). This is lower than the rates commonly used in economic studies and for management purposes, and lower too than European Community guidelines for depreciation. Results obtained for other major items of machinery were similarly conservative by accepted standards although, clearly, sample sizes were much smaller and this should qualify the estimates somewhat.

The sample of tractors was large enough to permit an exploration of regional variations in depreciation and it is possible, *a priori*, to hypothesise several alternative situations which might influence the regional figures.

Little evidence of significant inter-regional variation in tractor depreciation was found (Table 2), with Askham Bryan College lowest at 11.5 percent and Aberystwyth highest at 14.2 percent, a national range of less than 3 percent.

Table 2. Depreciation estimates for tractors in England and Wales, 1982/83.

Category	*(1–d)*	*Deprec. rate %*	*MSE*	*Number of observations*
Newcastle	0.872	12.8	0.0218	52
Askham Bryan	0.885	11.5	0.0361	73
Manchester	0.874	12.6	0.0374	38
Nottingham	0.863	13.7	0.0229	87
Cambridge	0.862	13.8	0.0272	176
Wye	0.865	13.5	0.0310	57
Reading	0.875	12.5	0.0481	79
Exeter	0.868	13.2	0.0244	85
Aberystwyth	0.858	14.2	0.0453	29

Table 3. Depreciation estimates for tractors in England and Wales by tractor size, 1982/83.

Engine size	*(1–d)*	*Deprec. rate %*	*Number of observations*
Less than 25kW	0.842	15.8	9
25 – 40kW	0.861	13.9	147
40 – 60kW	0.876	12.4	371
60 – 80kW	0.855	14.5	111
80 – 100kW	0.874	12.6	28
100kW and over	0.873	12.7	10

Further investigation suggested that the type of farm did not appear to be a significant determinant of depreciation rate which, given other findings in the

Machinery Study relating to tractor power and annual usage, implied that these factors too are largely independent of estimated depreciation.

Table 4. Depreciation estimates for tractors in England and Wales by region, using the GADB method, 1982/83.

Province	*J*	*(1–d)*	*Deprec. rate % first year*	*Deprec. rate % subsequently*	*MSE*	*(MSE)*[1]
Newcastle	0.88	0.89	21.7	11.0	0.0216	(0.0218)
Askham Bryan	0.85	0.91	22.7	9.0	0.0350	(0.0361)
Manchester	0.80	0.91	27.2	9.0	0.0349	(0.0374)
Nottingham	0.81	0.90	27.1	10.0	0.0208	(0.0229)
Cambridge	0.84	0.89	25.2	11.0	0.0256	(0.0272)
Wye	0.83	0.89	26.1	11.0	0.0298	(0.0310)
Reading	0.80	0.91	27.2	9.0	0.0443	(0.0481)
Exeter	0.87	0.89	22.6	11.0	0.0236	(0.0244)
Aberystwyth	0.79	0.90	28.9	10.0	0.0429	(0.0453)
England and Wales	0.85	0.896	23.9	10.4	0.0297	(0.0313)

Note: 1. MSE's for constant rate diminishing balance method (see Table 2).

The results of estimating tractor depreciation in relation to engine size are given in Table 3. No clear pattern is evident, but there is no indication of higher depreciation rates with increasing engine size.

Leaving aside the unreliable results for tractors of less than 25kW which were based on only 9 observations, the range in the grouped averages is from 12.4 percent (40 – 60kW tractors) to 14.5 percent (60 – 80kW tractors), or little more than 2 percent. In the context of this study, these results were important because of the known bias towards larger farms and, hence, larger tractors.

Although only 1.3 percent of tractors in the sample were below 25kW, statistics showed that within the England and Wales population of tractors, 11.5 percent were below 25kW in 1982. Recalculating the depreciation estimates on a weighted average basis to correct for the identified inadequacies of the sample (in terms of engine size distribution) produced a small increase in the overall depreciation rate, from 13.1 percent to 13.6 percent. Since much of this was attributable to the influence of the unreliable estimate for tractors of less than 25kW, it was concluded that the unweighted depreciation estimates are not unduly biassed as a result of the engine size distribution.

The variable rate diminishing balance method (VDB)

The well established constant rate diminishing balance method used so far is flawed to the extent that it does not capture adequately the peculiarly high loss in value which may be incurred following purchase and initial use of a new machine.

Although the method does allow for a higher absolute loss in value during the early years of ownership (as a constant depreciation rate on much larger asset values) it cannot cope with disproportionately high depreciation where this occurs.

The possibility that the proportionate loss in value of farm machinery is noticeably greater in the first year or two than in subsequent years, associated, perhaps, with the perceived prestige value in owning the latest (or a new) machine, was explored in some detail by Cunningham (1988).

It was found by Cunningham that the variable rate model provided a better explanation of the data not only for tractors but also for the major categories of farm machinery studied. This is probably because of its flexibility as it imposes a higher rate of depreciation initially but then a much lower rate in later years.

The constant rate model, on the other hand, imposes a rate which is something of a compromise – in order to capture the high rates of depreciation in the early years it utilises a rate which is too high in later years.

The geometrically adjusted diminishing balance (GADB)

Several alternative methods of coping with a variable depreciation rate were explored using the 1982/83 data and, largely on the basis of convenience in use, it would seem that the geometrically adjusted diminishing balance (GADB) method has much to commend it.

This can be written as

$$\frac{SV}{CV} = J\,(1-d)^n \qquad (3)$$

where $0 < J < 1$ for all $n > 0$

The value of J represents an initial depreciation charge which is incurred as soon as the machine is purchased, after which depreciation is assumed to follow the normal diminishing balance pattern. In other words, the machine is subject to a high initial depreciation charge regardless of whether or not it is sold after the first year.

The GADB method has been used by the Agricultural Development and Advisory Service in farm management consultancy work, albeit with parameter values and coefficients derived from empirical work in the United States.

Evidence of the superiority of the variable rate model (with geometrical adjustment) over the constant rate model is given in Table 4.

In each case, the GADB method possesses a lower degree of error than the CDB. The estimated regional depreciation rates are fairly similar in the long run but there is some divergence in the estimates of first year rates.

Depreciation rates for agricultural machinery

Similarly, the GADB estimates for major agricultural machines are associated with much lower errors (Table 5).

The data in Table 5 has been included to illustrate the possible increases in accuracy which the more flexible GADB system appears to provide, rather than to give definitive rates of depreciation for universal application. It is considered that the sample sizes for individual categories of machine are not large enough to provide sufficiently reliable estimates and this therefore needs further empirical work to establish appropriate rates.

Table 5. Depreciation estimates for agricultural machines in England and Wales using the GADB method, 1982/83.

Province	*J*	*(1–d)*	*Deprec. rate % first year*	*Deprec. rate % subsequently*	*MSE*	*(MSE)*[1]
Combines	0.882	0.88	22.4	12.0	0.0268	(0.0283)
Potato harvesters	0.530	0.94	50.2	6.0	0.0499	(0.0731)
Sugarbeet harvesters	0.782	0.84	34.3	16.0	0.0206	(0.0226)
Balers	0.850	0.87	26.1	13.0	0.0437	(0.0452)

Note: 1. MSE's for constant rate diminishing balance method (see Table 1).

Influence of capital allowances

It is pertinent to point out at this stage the possible distorting effect on investment patterns, and on the second-hand values of machines, which the existence of 100 percent capital investment allowances for taxation purposes could have exerted.

It is feasible, at least, that the high initial rates of depreciation identified as a by-product of this study were related to the

100 percent first year capital allowances available in 1982/83. Further work is needed, therefore, to examine patterns of second-hand values following the reductions in first-year allowances.

Decline in farm income and investment

There is a further major influence on depreciation rates which has become apparent in recent years.

The long term decline in farm incomes as farm policy changes from near-universal price support towards a much more targetted approach does not need emphasis here. However, the consequences of the income and liquidity problems faced by many farmers, coupled with considerable uncertainty (until CAP reform was agreed, at least) over future policy directions, have changed machinery investment patterns considerably.

Table 6 gives details of gross capital formation for the industry since the 1980–82 period (in which the Machinery Study was undertaken), and highlights the rapid decline in investment that has taken place.

Table 6. Gross capital formation in plant and machinery in the United Kingdom.

	Average 1981–83	*1988*	*1989*	*1990*	*1991*
At current prices	481	538	489	431	394
At constant 1985 prices	541	474	395	337	289

Source: Agriculture in the United Kingdom 1992, Tables, 6, 7, HMSO, London.

This decline in investment has had widespread effects within the machinery supply sector, quite obviously, and has also changed the replacement pattern (for major machines as well as many smaller items) on many farms. The secondhand market functions quite differently now and, in the South West, at least, many machines are close to wear-out stage before being replaced.

Within the past year, the pattern may even have changed again, as the modest recovery in income has enabled rather more activity in the machinery sector.

Summary

This paper has applied a standard definition of depreciation to the problem of estimating the annual depreciation rates of farm machinery. The analysis of the 1982/83 Machinery Study provided an extensive dataset in which to explore alternative methods for the *ex-post* calculation of depreciation. The research undertaken identified appropriate depreciation rates for use in the constant rate diminishing balance method which were lower than those used hitherto. These, it was suggested, could provide an improved basis for *ex ante* depreciation rates applicable equally in economic studies and for farm business management work.

The applicability of a variable rate diminishing balance method was investigated using the 1982/83 data, and it was found that this model provided improved accuracy for depreciation estimates even at regional level, and for major machinery categories. In the longer term, however, the applicability of this model needs investigating because of the possibility that available 100 percent first year capital allowances for taxation purposes had influenced both investment patterns and secondhand values. The removal of this influence subsequently could reduce the validity of both the model and the results obtained in this study.

These comments are intended to qualify the results presented in this paper, though not to invalidate them, since they remain the best general indications of farm machinery depreciation in England and Wales.

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Obituary

Peter G Finn-Kelcey FIAgrE

Peter G Finn-Kelcey, a long standing Fellow of the Institution and former Vice-President, has died aged 79. He had been an independent agricultural engineering consultant for many years, playing a pioneering role over the period before the present range of specialist consultancies became available. He worked closely with the Government advisory services, particularly on cases involving legislation, and in more recent years was associated with the late Roger Arnold FIAgrE, when Roger became an independent consultant on retiring from the then NIAE.

'Finn', as he was known to friends and colleagues, made his first contribution to agricultural engineering when in charge of the Field Station of the Electrical Research Association at Shinfield, Reading, soon after the end of the Second War. His pre-war training had been as an electrical engineer, and his remit was to encourage, through research and development, the application of electricity to agriculture and horticulture. His special interest was in crop drying, both of grain and barn dried hay. Two stage drying, based on cold air at high volume followed by warm air at low volume was one of his successful developments. Other projects included tractor mounted generators for the control and operation of mounted equipment, the driverless tractor in conjunction with Reading University, milk cooling and heat recovery from milk, and lighting regimes for poultry, pigs and sheep.

Peter Finn-Kelcey was greatly liked and respected throughout the industry, and particularly by his staff who found him a benevolent and encouraging leader. He was a person of vision, whose ideas set off much later research work, and was as much accepted by practical farmers, where he had close contact with the foremost in the country, as with researchers. His contribution will be long remembered.

Brian Finney, 10 August 1993

Membership matters....

THE NEWSLETTER OF THE INSTITUTION OF AGRICULTURAL ENGINEERS

GRIM READING

Mr Frank Lindsay, Chief Agricultural Inspector with the Health and Safety Executive, announced recently the latest farm accident statistics. Therein is good news, bad news and downright shameful news.

- The good news is that fatal injuries fell in 1992/93 from 55 to 50.
- The bad news — that non-fatal injuries rose to a peak of over 2000 reported incidents for the accounting period of 1991/92.
- The shameful news is that the 50 fatalities include 9 children — up from two of last year and the highest for five years.

However welcome the reduction in fatalities is, the fact still remains that 50 families lost a loved one, creating hardship and grief on an enormous scale. four members of the public are included in the figures along with a further four killed by animals. Four more were killed as a result of falls and seven were killed by falling or flying objects. However, the products of our industry caused most deaths. Agricultural machinery accounted for 15 deaths, six from overturning tractors, two other tractor-related and seven involving field machines/mobile plants.

Hope amongst horror

Within the overall figures there was, however, a significant reduction in the number of self-employed persons who had been killed — down from 32 to 18. Mr Lindsay expressed hope that this was evidence of increased awareness amongst this category of the workforce. Hope, too, that there is a greater awareness of the effects of gravity – the number of deaths resulting from falls was down from eleven to four; but deaths from electrocution were up (five involved overhead power lines, a hazard that has recently been highlighted by the HSE through their latest film: 'Shock Horror'.

RIDDOR ignored

The non-fatal incidents reported, over 2000 in 1991/92 (the latest figures available), were up on previous years — this despite the continued trend of a reduced labour force in agriculture. Additionally, the proportion of self-employed has increased, a category which does not have to report injuries.

It is estimated that some 85 percent of the workforce engaged in agriculture ignore RIDDOR – the 'reporting of Injuries, Diseases and Dangerous Occurences Regulations 1985'. So the 2000+ cases could be, and probably are, the tip of the iceberg.

Innocents suffer

The number of children killed or injured on farms is something which must be stopped. How many factories and other work areas allow children to wander at will over the premises? Yet farms are often depicted as 'adventure playgrounds', attracting children and inviting them to move around unaccompanied. This has got to stop!

Selling safety

So what can our industry do to help reduce this carnage? Most of the accidents involved machinery or equipment which comes under the broad remit of agricultural engineering, so we have a responsibility and a very real part to play. Safety, though, is a very difficult feature to sell on a machine — the "it won't happen to me" syndrome takes over with many operators.

However, the car industry has recently proved that safety features can be a major selling point, most car manufacturers now stress the inherent safety of their products above the acceleration and the top speed and they wouldn't do that if the marketing department did not approve.

So, protecting idiots from their own actions on the road is proving profitable and, perhaps, now is the time to start a similar initiative in the farm machinery world?

Who will be first?

It will take a brave manufacturer to start this initiative but with careful marketing it should be worthwhile — the media attention would provide some valuable 'launch advertising' at least.

The technology required to provide the safety mechanisms is well proven in the main – it needn't be complicated — micro-switches or even the good old Bowden cable linked to guards and operating clutch mechanisms in the drive-line would overcome the problem of operators working on unguarded machinery. Such arrangements are 'de rigeur' on factory machines so why not also on farm machines, bearing in mind that operators of farm machines are often much less familiar with a machine than their factory peers.

Other features that spring to mind are simple clinometers for warning of impending overturn situation (this could even be marketed as a retro-fit kit for dash-top mounting); more resilient roofing panels; safety legs for ladders; safety nets to cover ground-level slurry pits along the lines of outdoor swimming-pool covers.

So who is going to be first to make the safest agricultural machine? Who is going to be first to go beyond the basic requirements of legislation and show the world they care about the people who have to operate their machines? And, by way of incentive, consider this – it can't be long before a bereaved asks: "Why didn't the manufacturer foresee this accident and do something to prevent it happening?", and we all know what the next stage is. No? Look across the Atlantic, the insurance premiums over there to protect against litigation make the most expensive safety features seem cheap!

MEMBERSHIP SURVEY

The President, Brian Finney, together with the President-Elect, Dick Godwin, are seeking your views. A questionnaire is enclosed with this issue of The Agricultural Engineer. Please do not 'put it by' to deal with it later – fill it in **today** and return it straight away in the reply paid envelope.

This is your opportunity to have your say and influence the future direction of your Institution. Please use it.

Admissions – A warm welcome to the following:

Member G C Soane (Scotland)

Associate Member J A Mawhinny (N Ireland); G R Osure (Kenya); G A Park (Northampton); N J Pigott (Irish Republic); M V Westwood (Surrey)

Student S G May (Shropshire); J Miller (Scotland); C D Nicklin (Derby); C Rukuni (Bedford); Y Wei (Bedford)

Re-instatements – welcome back!
U B Bindir (Papua New Guinea); J A G Constantinesco (Avon)

Transfers – congratulations on achieving the next step

... to **Companion** J J Evans (Glos)

... to **Fellow** A J Landers (Glos)

... to **Member** W S Cragg (Lincs); L L Kaluba (Bedford); P J Kettlewell (Bedford); C A Morse (Worcs); J M Sharp (S Humberside); F G Ward (Lincs)

... to **Associate Member** J A Cambridge-Clarke (Essex); A L Donald (Lincs)

... to **Associate** C A Stark (Northants)

... to **Student** A-T Menghistu (Essex); R M Nutt (Suffolk)

Resignations – thank you for your support, we wish you well.
J S Craven (Yorks); J H D Edmonestone (South Africa); P W Hewitt (Wales); D W Hill (Lancs); P Howell (Devon); L R Lee (Essex); J M Minting (Herts); J D Parker (Bedford); D W Reeves (Bucks); P H Woolfitt (Lincs)

Deaths – with sadness, and sympathy to those left behind
P G Armitage (E Sussex)

Engineering Council registrations – congratulations to the following on their election to the grade indicated

CEng N L Warner (Glos); D J Wilson (Cornwall)

IEng A M Hayton (Indonesia); D W Tilbury (Leics

IEng re-instatement J A G Constantinesco (Avon)

EngTech M C Thorne (Warwicks)

Movements – the following have moved:
S W Bedford (Netherlands to Cambs); C R Blessley (Philippines to London); M D Bush (Essex to Norfolk); W R Butterworth (Wilts to Wales); S J Farley (Wales to York); S J Gilbert (Glos to Somerset); B Green (Warwicks to Middx); A Mulder (Spain to Netherlands); R J Nicholson (Avon to Cambridge); M T Parish (Oxford to Suffolk); T Reeves (Staffs to Nigeria); J L Smith (Lincs to Leics); J Summerscales (Yorks to Devon); R R Taylor (Lincs to Shrops)

News of Members

Tony Chestney

Your letters arrive — keep them coming

I am grateful to have received letters from some members giving information on their work which they wish to share with fellow members and I shall be pleased to receive more in the future so as to make this page both interesting and informative.

Rural development in Africa

A G Chadborn is now part of a YWAM (Youth with a Mission) team working on various aspects of integrated rural development amongst the Teso people in Uganda who have been made destitute by five years of civil war. The work includes health care, education, income generating schemes and nutrition, as well as farming. Farming used to be ox-power until all of the cattle were stolen, so now he will be looking for suitable alternatives until oxen can be be bought again. It sounds as if he is doing a worthwhile job and I hope that he succeeds. I shall be interested to have information on progress so that I can keep members informed.

I have also had a very long and interesting letter from Graham Ovens who has recently moved from Zambia to Ghana. Thank you, Graham; we have been pleased to present your news as a separate report elsewhere in the journal.

Forest road management

From William J Elliot comes news that he is now employed by the USDA Forest Service Intermountain Research Station. He is a Project Leader of a group called Engineering Technology for Improved Forest Access. This is located at the Forest Sciences Laboratory, Moscow, Idaho, USA. The six scientists in the group are doing research in forest road management, development of soil erosion models for forest roads and harvest areas, and assessment and limitation of landslides.

Company news from Downunder

M S Holland tells us that for the last three years he has been the Sales and Marketing Manager for Fiatagri in Australia. This is soon to be re-named 'New Holland Fiatagri Division' and they are at present in the process of absorbing New Holland Ford. So far, they have incorporated the spare parts and administration into their premises on the outskirts of Sydney. New Holland Ford, he says, will continue a sales and marketing operation from the Fiat premises in Melbourne, close to the Iveco truck plant.

MSH makes the further point that Australian trade with the US and the EEC is suffering on account of subsidies.

I find it difficult to keep up with the changes in the agricultural engineering industry so many thanks to MSH for this information.

Now, how about some news from the UK?

Having had these very interesting letters from members working overseas it would be nice also to have something from some of you working in the UK. Surely, you must be doing something useful or interesting which is worth sharing with others?

Don't be shy — let Tony Know your news. It'll only take a few minutes and it is well worthwhile. his column is always avidly read by members. Tony's address is: 32 Beverley Crescent, Bedford, MK40 4BY

The Tractor ..... factor

Henry Gunston, the Hydrological Hero (self styled !) of the Revolution and ever attentive ear of the Institution, picked up an interesting comment on his crystal set emanating from that last bastion of capitalism — Auntie Beeb.

He writes:

Comrade Editor,

Here ..... is further evidence of the relentless attack on the Glorious Peoples Tractor Factories by the revisionist pseudo-cultured bourgeoisie:

NOT A HEROINE OF LABOUR AT THE SILSOGRAD TRACTOR FACTORY !

Agricultural Engineering seems to rate rather poorly with the 'artistic' community. Is this because they consider its most significant cultural image to be that of a Soviet Russian Tractor factory?

A reviewer of the Russian poet, Anna Akhmatova, in a recent Radio 4 'Kaleidoscope' arts programme, gave the following reasons why the poet experienced so much trouble with the Stalinist authorities:-

"She was in the wrong place at the wrong time, and didn't write poems about tractors".

Yours, in the spirit of Fergusonism-Culpinism

Henry Gunston

So the world is short on poems about tractors is it? I'm sure we can show the Russians, and Anna, a thing or two.

Come on you bards of our glorious profession, put quill to parchment and let's hear a few. The best will be immortalised in the pages of this publication.

Imports down/ exports up

Since the UK joined the EC, food imports have fallen by 10%; exports have doubled.

Farming Facts

O'er the sea to Silsoe

Northern Ireland Branch, (L.K.)

Early on Thursday, 1 April, a small group of members from the NI Branch assembled at Aldergrove Airport, destination Luton. Branch programme organisers, Dr Frost and Mr Hunter had laid the groundwork for this trip, an event which is now a firm favourite in our calendar.

From Luton onwards, everything had been carefully pre-arranged and was perfectly implemented by our hosts – Silsoe Research Institute. On our arrival at Wrest Park, we were warmly greeted by Laurie Osborne and Edwina Holden who plied us with coffee and explained the programme for the day.

Milking parlour automation

Introductions over, our first exposure to the sharp end of science and technology was the latest in milking parlour automation, via a video of robotic milking being carried out. This was viewed in armchair comfort because the development work is being done at Compton Research Institute in Berkshire.

Intense interest in milking machine developments sparked off debate on the possibilities of better mastitis control, more frequent milking, less cow waiting time, etc.

Because of the tightly packed programme, discussion on this and each of the other presentations given throughout the day had to be curtailed – some of it 'on the hoof' between the various venues visited on site.

Cereal harvesting and straw usage

The next series of presentations concentrated our minds on cereal harvesting and straw usage as we focussed on high density straw baling, straw slicing, wafering and cubing, the stripper/harvester, industrial uses for straw and straw incorporation.

Whilst the burden of straw disposal is not so great in Northern Ireland, the challenges posed and the engineering solutions arising in the UK mainland proved very interesting.

The Gantry system for arable growers was a thought-provoking concept and the self-propelled gantry in the development workshop certainly made a visual impact

Rubber tracks for improved traction

For those with a pre-occupation for modifying production tractors, the development work into rubber tracks by the Terramechanics group for improved tractive power provoked much speculation as to where there might be increased stresses; how it would affect overall gearing when fitted to other tractors; and so on.

From a 4WD Ford with only 2 wheels, the group went on to perhaps the most impressive in terms of sophistication and control instumentation — a 4WD Ford with no wheels. The tractor, fully suspended by its hubs on 4 direct external dynamometers can have each wheel loaded and monitored individually or as part of a combined programme to simulate field operations for engine and transmission performance evaluation.

The set up could also be used to obtain information previously collected by drawbar tests run on concete – (the power available in each gear) for the OECD tractor performance test. (The front axle dynamometers have a maximum power dissipation of 137kW and each rear one is of 182kW !).

Members of the NI Branch take a break from their discussions with their hosts at Silsoe Research Institute to pose for the camera. At the centre rear of the group are Mike Neal, Edwina Holden and Andy Knight, some of the party's hosts for the day.

Precision spraying

Our minds were then focussed on various aspects of spraying technology with the emphasis on minimising possible environmental pollution.

Whilst the research equipment for analysing the spectrum of droplet sizes from a particular spray nozzle and the equipment for estimating the amount of drift from a spray nozzle in the wind tunnel were interesting research tools, perhaps the most exciting area of work in this field was the development of a wide boom spraying system which could selectively treat areas of weeds automatically under the control of a satellite data information system.

This development literally is an example of applying space age technology to crop spraying.

Expert systems

The idea of Expert Systems was conveyed to us by our introduction to WEES (Waste Engineering Expert System).

WEES is essentially a computer programme, jointly developed with ADAS, which is intended to guide the user expertly through the steps necessary to arrive at the best solution to a particular waste problem.

The scope of this particular system is now being widened in conjunction with five other European countries so that it can be used European wide.

We were impressed with how the IT Systems group were pressing on with this development despite the inevitable problems associated with differing national outlooks and interpretations.

Finally, a new approach to low level, blockage-free slurry dispersal confounded the group with its simplicity and lack of moving parts. This device, the Fluid Diode, would seem to have a good future.

Greetings from the President

Overall, the visit highlighted some of the Institute's work areas to our Branch, and gave us a useful insight into ongoing work in areas of particular interest.

In addition to the intensive series of technical presentations, the group were well nourished throughout the day and enjoyed lunch with some of those members of this Research Institute who had spoken to us.

The President of the Institution, Mr Brian Finney, joined us also and, in a short address, greeted our branch. Old acquaintances were renewed and new friendships made.

Whilst we did not actually get mud on our boots (just rain), and that wouldn't have been appropriate when travelling home courtesy of Britannia Airways, the group thoroughly enjoyed the day. Thanks to all the staff of Silsoe who spoke to us and to Edwina Holden in particular for arranging it.

QUOTES/SHORTS

The amount of timber harvested in the Highlands and Islands over the next 40 years is likely to treble to around 3m tonnes a year and there are around 1200 people employed full and part time in the industry at present.

Bob Stubbs,
Head of Land Resources,
Highlands and Islands
Enterprise, 1993

Safety training for fabrication

The 1992 Management of Health & Safety at Work Regulations apply to all companies of five or more employees. The Regulations require that every employer nominates a safety assistant/advisor who is knowledgeable, experienced and trained in safety matters.

To help meet these requirements in the fabrication industry, the Welding Institute (TWI) has launched a series of one-day, modular training courses covering the five major aspects of the regulations.

The full course takes five days but attendance is flexible – trainees can attend when, and in what order, they wish according to what they need to know and when they are available.

The courses will start in October and run as required.

Full details from: TWI, Abington Hall, Abington, Cambridge CB1 6AL.

MF Award goes to a Soil Scientist

The coveted Massey Ferguson National Agricultural Award for 1993 goes to Dr David Jenkinson FRS for his work at Rothamsted Experimental Station.

The awards committee recognised Dr Jenkinson's distinguished research work, in particular his work on the behavior of soil micro-organisms and the action of chemical fertilisers (especially nitrogen) in the soil.

Designed to win?

The 1993 Design Awards are open for application. The rewards are substantial – £2000 for the winner, reducing by 50 percent for second and third respectively, plus national publicity for the entrant and his design.

Entrants are asked to produce an original design for use in mechanical or production engineering. Entries must be presented in the form of a business proposal which could be used to convince an executive management board to approve the development of the project.

The Award is made by The Worshipful Company of Turners in association with the IMechE, IChemE, and IEE.

Full details and an application form are obtainable from R G Woodwark, 33A Hill Avenue, Amersham,Bucks HP6 5BX. Tel: 0494 725903.

Closing date for entries: 31 October 1993.

Membership Survey

Have you returned the questionnaire?
Don't forget
This is your opportunity to influence the future direction of your Institution

The wise path to a career

The Engineering Council has published a booklet 'Awards, Courses, Visits' as a key part of the Women into Science and Engineering (WISE) campaign. This lists courses, visits, awards, career book schemes and other initiatives to attract women into engineering. It is divided into sections according to appropriate age groups from 13 years old upwards.

Copies are available free (send A5 sae) from: The Engineering Council, 10 Maltravers Street, London WC2R 3ER.

Scholarships cash

Applications are invited from post-graduate students for scholarships to study to Master's or Doctoral level at a Commonwealth university for one year.

The Commonwealth Scholarship Commission offer these annually and this year's applications, (which must be in by 29 October) are for the 1994/95 academic year. Candidates must be UK residents under 35 years of age.

Details obtainable from: The Joint Secretary, Commonwealth Scholarship Commission (Overseas Award) (PO), Association of Commonwealth Universities, 36 Gordon Square, London WC1H 0PF

Incentives for Engineering

From next year, students with very high 'A' Level grades will be eligable for a £500pa bursary if they opt to study an engineering degree at university.

The Department for Education (DFE) will be the awarding body. The purpose of the scheme is to encourage students to take up a career in engineering.

More details from the DFE, Tel: 071 925 5555, Fax: 071 925 6971.

Cover for catastrophe

Recognising that many registrants have had problems finding individual Professional Indemnity Insurance at a reasonable cost, the Engineering Council have recently launched their own scheme.

At present, cover under the scheme is limited to £250,000 but it is hoped to extend this for a small increase in premium.

EC registrants should have received the appropriate literature but more is held at the Secretariat if required, or details can be had direct from the Engineering Council at 10 Maltravers Street, London WC2R 3ER.

Royal Smithfield 1993

The Royal Smithfield Show will have several important improvements this year.

Of particular interest to exhibitors and visitors alike will be a fully computerised registration and badging system. This major development will allow all exhibitors to see who they are speaking to and also if they are Farmer, Dealer, International Visitor or Member of the Press. And, for the visitor, seeking follow-up information, it will save time and ensure accuracy in the noting of name and address details.

Tractor multinationals are now also giving further backing to the Royal Smithfield. Massey Ferguson have signed a two-year agreement to exhibit and there is a similar undertaking by the New Holland Group. Other big tractor names at the Show include Case IH and Deutz.

The Show organisers also announce that they will this year be developing the 'Farmers Weekly Farmer Forums'. This series of seminars ñ where visitors can hear about the latest issues and topical subjects from well known industry names ñ was very successful last year and attracted over 1200 visitors over the period of the Show.

As a further improvement – as a concentration of interest – the Show this year will be a four day event. The Royal Smithfield opens Sunday, 28 November and runs through Wednesday 1 December.

Obituary

Christopher John McLintic MSc IEng MIAgrE

I first met Chris when he was studying Agricultural Engineering at Rycotewood College. He is well remembered there by staff and students alike as a cheerful lad, very much committed to working overseas.

I came into contact with him again in 1989 at Silsoe College when he began studying for an MSc in Management for Rural Development. This he completed very successfully in 1991. Again, the staff and students have fond memories of Chris as an enthusiastic member of campus.He spent the years between these two periods of study as he had always wished – working abroad. He had spells in Belize, Sudan, Tanzania and Ethiopia. In all cases, there are glowing testimonials to his contributions.

I shall always remember him for his commitment to helping others, his enthusiasm for life and a gorgeous sense of humour.

Chris passed away in January aged 41. Our sincere condolences go to his wife and family. He will be greatly missed by his many friends in this Institution.

M J Hann

Branch/Specialist group Meetings 1993/94

September		
13	**Tracklaying Vehicle Maintenance** Visit to N Stricklands Plc, Evesham Road, Cropthorne *West Midlands Branch*	M Sheldon 0926 651367
October		
5	**The Creation of a Formula One Car** – Mr M Macknight *S E Midlands Branch* – at Silsoe College, 8 pm – jointly with IMechE	A Howard 0525 860428
11	Development of John Deere 6/7000 series – Mr J Purvis *West Midlands Branch* – at Massey Ferguson, Stareton	M Sheldon 0926 651367
11	Powershift Transmissions – Mr M E Hall *Herts & Essex Branch* – at Writtle College	P A Hill
November		
2 & 4	**Visit to sugar beet factory** at Kidderminster *West Midlands Branch*	M Sheldon 0926 651367
8	**Agricultural crops for fuel** – speaker from E.T.S.U. *South East Midlands Branch* – at Silsoe College	A Howard 0525 860428
18	**Electronics in Agriculture** – Mr A Scarlett, S R I & ANO, Agri Tech *Herts & Essex Branch*, joint meeting with Herts Machinery Club	P A Hill
December		
1	**The Harry Ferguson Story** – Mr G Field *West Midlands Branch* – at Pershore College of Horticulture	M Sheldon 0926 651367
7	**The development of the speed hill-climb car** – Mr J Wood, MIRA *South East Midlands Branch* – at Silsoe College	A Howard 0525 860428
1994		
January		
10	**Grain storage in Syria** – Mr D Williams, Consultant *West Midlands Branch* – at Warwickshire College, Moreton Morrell	M Sheldon 0926 651367
10	**Research in agricultural engineering** – short PhD research presentations from Silsoe College and Silsoe Research Institute *South East Midlands Branch* – at Silsoe College	A Howard 0525 860428
10	**Niche Markets** – Mr E May *Herts & Essex Branch* – at Mr May's premises	P A Hill
February		
7	**Automobile sensors and control** – Lucas Applied Technology *South East Midlands Branch* – at Silsoe College	A Howard 0525 860428
14	**Yield mapping combinable crops** – Mr M Moore *West Midlands Branch* – at Massey Ferguson, Stareton	M Sheldon 0926 651367
23	**Protecting the Rural Environment** – Conference *Scottish Branch* – at Isle of Skye Hotel, Perth	D Welstead 031 336 5089
March		
tba	**Applications for plastics in engineering environment** – Mr A N Yates *Herts & Essex Branch*	P A Hill
7	**AGM**, followed by **Linseed and flax to fibre** – Mr H Gilbertson *South East Midlands Branch* – at Silsoe Research Institute	A Howard as above
14	**AGM**, followed by **Innovative Innovations** – Mr R Balls, ADAS *West Midlands Branch* – at Pershore College of Horticulture	M Sheldon as above

Panel member moves on

It is with no small degree of regret that I have to report that Ed Piepereit has stepped down from the Journal panel.

Ed has been involved with the 'What's On' section of the Newsletter for many years, reliably preparing the list of forthcoming events from the huge amount of material that comes over the doormat. That sounds easy until you have to do it! The time it takes must not be underestimated, – time when Ed should have been relaxing with his family. My thanks to him for devoting some of his spare time to this cause.

Ed will be embarassed by this note of appreciation, he's that sort of man – quiet, unassuming but thorough and efficient. I'm grateful for his help and advice.

Denis Cartmel

Lost Members

I give below a list of members and their last known addresses,with whom we seem to have lost contact. If any member knows their whereabouts would they please contact the Secretariat.

A K Jackson – W F Russell Farmrite Ltd., Great Edstone, Kirbymoorside, Yorks YO6 6NZ.

D Sims – Via dei Pescatori 153 A2, Castel Fusano, Ostia, Rome, Italy.

J G Martin – 39 Gardyne St., Friockheim, Angus, DD11 4SW.

A very worthwhile cause

Within our shores one member is accomplishing something which would petrify most of us.

Julius Reisner used to work in the Special Needs section of the Northumbria Social Services making the lives of handicapped people more meaningful and giving them a sense of purpose. Two years ago he was made redundant when the 'powers that be' deemed that this facility was not required.

Undaunted, Julian set about providing the care and rehabilitation skills that he knew were necessary, on a contractual basis. Unfortunately, Northumbria County Council did not come up with money to allow the initiative to continue, this despite several hollow promises.

Most would have given up at this stage, not so Julian. He had already secured the use of some ground as an allotment before the rebuff. Recently, he had the good news that British Rail were prepared not only to help financially but also they have given permission for him to sell produce at Stocksfield station and use some derelict land nearby as an 'adventure playground' for children.

Gateshead, obviously a more enlightened Local Authority, are interested in Julian's project and could be sending six handicapped people to participate. The idea is that the 'students' will learn how to grow crops, how to sell them and how to supervise a childrren's play area. All-in-all, a commendable project that deserves the full support of the able-bodied.

Companies or individuals who feel they can help Julian either with donations or with equipment should 'phone him on 0661 843136, or write to: 32 Meadowfield Rd, Stocksfield, Northumbria, NE43 7PY.

QUOTES/SHORTS

Farming accounts for 1.75% of Gross Domestic Production and employs 2.2% of the UK workforce – a figure only bettered by large scale construction and mechanical and electrical engineering.

Public support for agriculture is far less than for many other industries. Per person employed, agriculture receives only 50% of the amount paid to British Coal and only 60% of that paid to British Rail.

In 1962, food accounted for an average of 30% of family income in this country. By 1989 that figure was down to 12% – despite the wider range of food on offer. Food prices in UK have consistently risen by less than inflation – 30% less since 1980.

Farming Facts

Don't forget the questionnaire!
Fill it in and post it off today

Quality certified

Herts and Essex Branch

BS 5750 is on the lips of most managers at the moment and was, therefore, an appropriate topic for a meeting of the Herts and Essex Branch. Neil Fearn, the speaker, is a consultant with Portman Hart and specialises in advising on quality systems and management.

Neil explained that there has been a steady uptake of the principles of this management tool since its publication in 1979. Initial problems have been overcome with revisions and BS 5750 has been brought into line with the international standard ISO 9000, known as EN 29000 in the EEC. The number of companies certified to this standard and registered with the DTI in the UK is approaching 17000.

Market driven

Most of these companies have been encouraged to adopt this standard by their customers since BS 5750 is 'customer lead'. Indeed, a broad definition of quality was suggested at the meeting as: 'satisfying the requirements of the customer'.

The three parts of the standard were outlined, each dealing with a different part of the infrastructure of a company. It was stressed that the standards within these parts were not technical specifications and do not define absolute quality, they are the 'bottom line' of company procedures and organisation. Companies can work towards any or all of the parts at will, there is no statutory requirement but the DTI does offer significant financial help with accreditation costs. Furthermore, not all of a company's activities need be certified – the process can be tackled one section at a time.

So what is a **quality system**? Neil explained the basics:

- it must have POLICIES and these must be clearly understood, implemented and maintained (the accrediting body check on this every six months);
- the PROCEDURES and METHODS must be defined and documented;
- WORKMANSHIP STANDARDS must also be clearly identified.

The right people . . .

Staff training to meet the standards put forward is an essential part of the accreditation procedures and a training record is necessary for every job which clearly shows the minimum qualifications and experience required to do that job. As procedures change so this training record will need updating.

The best practice

So what is required of a quality manager? Neil suggested:

- provide what the customer wants;
- get it right first time;
- use your best practices;
- learn by your mistakes;
- but above all COMMUNICATE EFFECTIVELY.

Canute in concrete and steel

The Thames Barrier has, quite rightly, received much publicity as a major feat of civil engineering. But the problem of North Sea surge is not confined to the Thames, the south-east seaboard of our country features many instances where tidal surges could threaten the welfare of the population. Along this stretch of our coast several tidal barriers are being built or are envisaged.

One such example was the subject of a recent visit by the Herts and Essex Branch and our roving reporter, Richard Langley was there to relay the occasion. The Colne Barrier spans the mouth of that river at Wivenhoe, near Colchester. At 130m long and containing 63,000m³ of material it is a 'tiddler' compared with its Thames counterpart, but still no mean feat of engineering. The navigable channel is provided by two 15m mitre gates each weighing 130 tonne. The two gate piers are linked by a concrete sill on the river-bed through which passes a series of pre-stressing tendons and service ducts. The cost of the venture – £12.5m. It has taken two years to build and is due for commissioning this autumn.

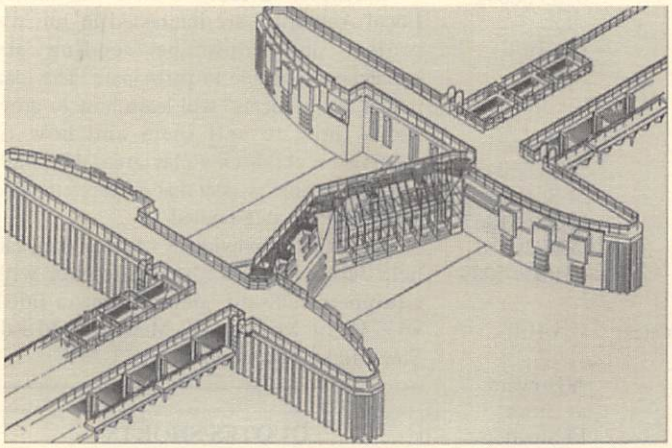
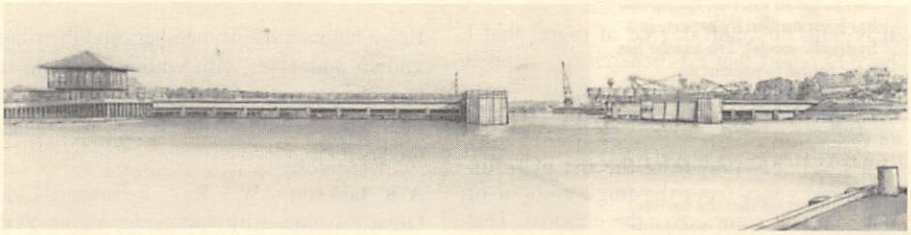


Fig 1. Colne Barrier, the Herts and Essex visit venue.

The guides for this visit were two men who had been closely involved with the project from its inception – David Johnson (Principal Engineer, NRA) and Derek Chilver (of Posford Duvivier).

Both men stressed the lengths to which their organisations had gone to minimise the environmental impact of this structure both this structure both during and beyond its construction. With a design life of 50 years, Mr Johnson assured the party that the barrier could cope with all estimations of rising sea-levels envisaged in that period.

A guided tour of the structure lead the assembled to ponder the logistics of co-ordinating the individual bits of work – a critical path analysis exercise beyond anything experienced by those present. To 'top-off' a fascinating visit, and as if by design, a grain ship duly obliged with a photo opportunity by negotiating the half-finished gate opening. But you can't keep agriculture away from even this project and the assembled party, after proffering sincere thanks to their hosts, were seen to 'disappear into the sunset' arguing the merits and demerits of different grass species for their suitability to grace the banks that line the approaches.



The Colne Barrier – view from upstream – (above): at high tide; (below): at low tide.

Clever 'box

Herts and Essex Branch

Standing in for a speaker from Case-IH, who was unable to attend at the last minute, was Adrian Pipe of the New Holland Ford Service Training Centre, Boreham House, a move which further substantiated the Herts and Essex Branch' belief that 'every cloud has a silver lining'.

Our 'man on the spot' was Paul Hill in this instance (Richard Langley usually sends meeting reports for this Branch but, this time, was unable to attend – and regretted it!). Below is a summary of his report:

The subject of the meeting was Powershift Transmissions and attention was focussed, understandably, on the unit fitted to the 6-cylinder Ford tractors. Inside the 750kg gearbox are 18 forward and 9 reverse gears (with the option to 'double up'), courtesy of the Funch Corporation of America.

Adrian explained the main characteristics and how to operate the system, ably supported by an excellent slide presentation. Then it was over to the workshop to see a partially stripped example with additional major components fully stripped for inspection. Details of the torque limit clutch and the ëlimp homeí facility became clear at this stage.

The clever bit

Back to the lecture room now for an expose of the electronic control system, in particular how the diagnostic and calibration procedures are accomplished.

It was evident that, to get the best from this 'box, practice at gear-changing and the use of the inching pedal would be essential. Once mastered, the benefits would be very apparent.

Food packaging developments

Northern Branch **(J.F.)**

The Northern Branch recently hosted a seminar at Newcastle Univesity on developments in packaging technology to help maintain the quality of fresh and prepared produce from the time it leaves the farm gate until it is purchased from supermarket shelves. Three speakers contributed to the seminar:-

Brian Day of the Camden Food and Drink Research Association, who discussed the principles and areas of application of Modified Atmosphere Packaging (MAP) technology.

Nigel Down, of CVP Systems (UK), who looked at gas and machinery options for MAP, and

Ian Husband, of Cavanagh and Gray Ltd., who described the packaging of cook-chill meals and the development of long-life ambient storage temperature meals.

Modified Atmosphere Packaging

The use of MAP as a technique to improve product image, reduce wastage and extend the quality shelf-life of a wide range of chilled foods is becoming widespread in Europe with the UK leading in the range of products and number of units packed. Mr Day quoted an estimated figure of 2000 million MA packages produced in 1990.

MAP involves flushing the pack containing a food product with gas of a composition determined by the desired physical effect. For nearly all food applications the gas mixture will be some combination of CO_2, O_2 and N_2.

The effects of the gases

Mr Day explained the purpose of these gases within the package and described how they achieve the desired effects. The CO_2, at enhanced levels (30 – 100%), dissolves in the tissue moisture to form carbonic acid and this acts as a bactericide on aerobic spoilage bacteria.

Although O_2 enhances aerobic spoilage, thereby reducing shelf life, it is used in some retail packs in order to enhance the colour and flavour of fresh meat and cheese; to inhibit growth of anaerobic bacteria and to reduce aerobic respiration of salads and vegetables.

N_2 is an inert gas which is used to help equalise pressure and reduce the effect of pack collapse in semi-rigid packs.

Container materials

Fresh and prepared produce sold by the large retailers is now often packed in containers made up of a combination of support and gas/vapour barrier plasics such as polyester/EVOH/polyethylene rather than PVC or polystyrene.

Recently, microperforated barrier plastics have been developed which will maintain a desired equilibrium of O_2, CO_2 and moisture in fresh and prepared vegetable and fruit packs thereby increasing their quality shelf-life up to ten days.

Mr Down described the use of bulk MA during distribution of meat, bakery and salad products. This is a cost efficient method of bulk packaging where multi-packs or pallets of traditionally packed produce are enclosed by a barrier film inside which is a MA.

Long-life ready meals

Mr Husband gave a fascinating account of the development of long-life ready meals. He emphasised that this product, although pasteurised, is different from other pasteurised foods developed by the canning industry, in that the production processes similar to that used for cook-chill meals.

With long-life ready meals, the product container materials and the sealing mechanism allow high temperature sterilising and later reheating by microwave.

Haute-cuisine lovers will not be rushing to buy this product just yet – the first available meal is shepherd's pie – but potential users include the military, travellers and hunger-relief organisations.

Brian Bell MBE

Just days after Brian Bell MIAgrE, Vice Principal of Otley College in Suffolk, decided to take early retirement at the end of the summer term he was included in the Queen's Birthday Honours List with the award of an MBE for services to agriculture.

Following an apprenticeship with W R Ford & Son at Salhouse in Norfolk, a year at Writtle College where he gained an NDAgrE, and two years National Service, Brian joined the East Suffolk Education Department as their first lecturer in farm machinery in 1958. A few years later, with increased staff numbers at the Witnesham Agricultural Education Centre he was appointed Head of Farm Machinery and then became Vice Principal in 1969.

In addition to his work at Otley College, Brian has been an active member of the East Anglian Branch of the Institution since 1960. This period has included three spells as Branch Chairman and he is currently Branch Secretary. He was presented with a Meritorious Service Certificate in 1990. Other farming organisations which have called on his time over the years include the Suffolk County Proficiency Test Committee, the Suffolk Farm Safety Committee and the Otley and Orwell Training group. He was also chief examiner for City & Guilds Farm Workshop subjects for a number of years.

After 35 years in agricultural education, Brian Bell will have plenty to do. He is Secretary of Suffolk Farm Machinery Club, a task he started in 1960 and he will probably be writing more books to add to the present list of: 'Farm Machinery', 'Farm Workshop' and 'Machinery for Horticulture' co-written with his colleague, Stewart Cousins. Indeed, a new volume – 'Fifty Years of Farm Machinery' – will be published in September.

Well done, Brian. Best wishes from the Institution for a long, happy and well-earned retirement.

G. O'C.

Pits, piles and saddle sores!

Wrekin Branch

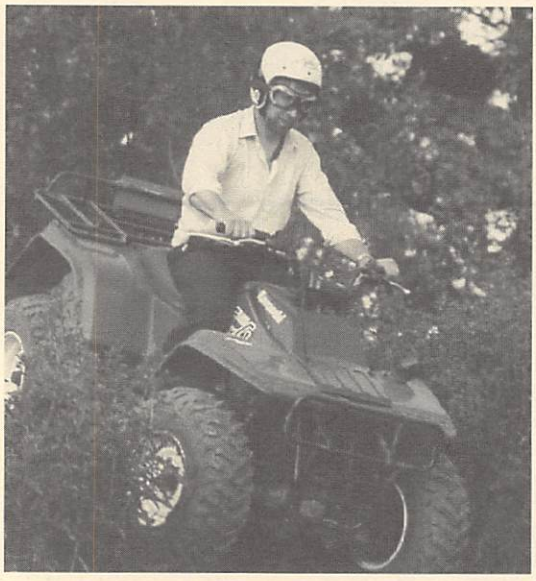
A balmy June evening was the perfect weather for the Wrekin Branch' summer visit. The setting was the Reaseheath College' rough terrain driver training ground in deepest Cheshire, an area of rough ground and woodland close to the college over/through which trainees are given instruction on how to make the seemingly impossible passable.

Branch members were given the opportunity to test their skills and nerve, ably overseen by one of Reaseheath's instructors who just happens to be our Branch Hon. Sec., Alistair Taylor! Thank you Alistair for a fun evening albeit with serious overtones, and thanks to Reaseheath College for the loan of equipment and venue.

Left: Jim Smith tests the axle articulation of the Land-Rover.

Below: "Where's the road gone?" David Cashmore goes over the top on one of the ATV's.

Left: Alistair Taylor and Roy Williams pick their way through the undergrowth.



"Snoopy prepares to dive into the set-aside (née weeds)". Dave Russell looks a little apprehensive about the impending descent.

Roy, in command this time, and Nick Houseman in the 'hot seat'. The smiles never wavered all evening — great fun!

Breakdowns in agricultural tractors

In 1989, payments by LFAB (Provincial Insurance Company, Sweden) in respect of damage to tractors amounted to more than 17m SwK; a further 9m SwK repair costs was paid by the policy-holders themselves. Mats Bohm reports on a survey undertaken by the Swedish Institute of Agricultural Engineering on behalf of LFAB to examine the nature and frequency of the breakdowns involved.

Machinery costs represent 30% of the total costs of agriculture. The cost of repairs and maintenance of agricultural machinery represents, in turn, almost 30% of the machinery costs. That amounts to some 8–9% of the total costs in agriculture.

In 1989, the cost of repairs and maintenance amounted to 2158m SwK for Swedish agriculture. This figure can be compared with cost of fuel and lubricants — 0.9m SwK, or about 12% of the machinery costs, in 1989 (Swedish Board of Agriculture, 1991).

Seek to reduce repair costs ...

Large savings can, however, be made in relation to repair costs — for example, by discovering and repairing primary damage at an early stage and so avoiding unnecessary breakdowns or, at least, reducing the extent of any eventual breakdown.

Larger savings can probably be made in repair costs than in the costs for fuel and lubricants but it must be noted that, in these sectors, the savings will sometimes compete with each other. For example, large implements, high gear and low driving speed all imply that fuel will be saved but, on the other hand, the life of the tractor will decrease and the risk of breakdowns will increase.

...but also insure against damage

Damage to the technically advanced agricultural machinery of today is often comprehensive and expensive to repair. Consequently, many farmers choose to insure their machines, mainly tractors, against machinery damage.

The payments by insurance companies for damage covered by this insurance amount to tens of millions of SwK annually. According to figures collected by the Provincial Insurance Company's Research Fund Committee, payments in 1989 by LFAB (Lansforsäkringsbolagen AB) for machinery damage amounted to more than 17m SwK for the 18 makes of tractors included in the study. In these payments, not only repair costs after depreciation and excess are included but also compensation for loss of productive time, journeys, tranportation and recovery.

Despite these tractors being insured, the farmers, the policy-holders, have also had major expenses in connection with breakdowns. During 1989, the policy-holders paid more than 9m SwK for accidents covered by the machinery insurance policy, i.e., more than one-third of the total costs for repairing the damage.

The share paid by the policy-holders consists of excess, depreciation from material cost owing to age, and reductions on account of the policy-holder not having complied with insurance conditions, e.g., with regard to preventative maintenance.

The LFAB survey

In order to get a clearer picture of the nature and frequency of tractor breakdowns, the LFAB commissioned the Swedish Institute of Agricultural Engineering to make an analysis of a 12 month's series of damage claims. This report gives an account of the overall picture and presents mean values of all the 18 makes of tractors included in the study.

The results reported are the number of breakdowns per tractor per year, as well as per 1000 operating hours and also the repair costs per tractor, per year and per 1000 operating hours. An account is also given of the breakdown frequency for components in the tractors and a summary of the breakdown frequency for groups of components such as the transmission and engine. The results reported have been calculated from all machinery breakdowns on tractors that were settled by the LFAB machinery insurance policy and also those that occurred during 1989. The costs given are in Swedish crowns and are based on 1989 prices.

Mention should also be made of the limitations of the material. All the limitations arise from the fact that the breakdowns discussed are only those that have been settled in accordance with the LFAB machinery insurance policy. This has the following results:

- Only reported breakdowns are included. Breakdowns with low repair costs are frequently not reported. The share of reported breakdowns with repair costs less than 5000 SwK for a certain make of tractor is also influenced by the mean value of the excess.
- Only those cases that have concerned 'sudden and unforeseen breakdowns' are included. Damage resulting from normal wear-and-tear is not included in the material.
- There is an uncertainty relating to whether insured tractors are handled and operated in the same way as uninsured tractors.
- Breakdowns covered by other comp -anies than LFAB are not included. Thus, certain makes of tractors may be either over- or under-represented, which may affect the result.
- Only damage to tractors that are insured for machinery breakdowns are included. Since relatively new tractors are those that have machinery breakdown insurance, the insured population does not have the same age distribution as the actual or registered population. This may imply that breakdowns associated with age, e.g., certain types of axle and gear fractures are not included.
- Repairs that the manufacturer has paid for as 'good will' without contacting the insurance company are not included. This may occur when a certain tractor

Table 1. Summary of data — all types of breakdown; all makes of tractor

Feature	*Mean*	*Low*	*High*
Age — years	6.3	2.7	8.0
Operating time per year —hours	391	203	661
Breakdowns per 100 tractor per year	15.3	8.5	34.8
Breakdowns per 1000 hours	0.39	0.16	1.71
Repair cost per breakdown —SwK	16362	8076	20136
Repair cost per tractor per year — SwK	2497	1140	4004
Repair cost per 1000 hours — SwK	6388	2096	13839
Repair time — days	5.40	3.46	6.69

Notes: 1. The mean values are for all types of breakdown and for all makes of tractor
2. The high and low values are for different makes of tractor
3. The costs in SwK are at 1989 prices

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model suffers from design or manufacturing deficiencies. Since this frequently concerns a special type of breakdown, it will naturally affect the result.

However, it must still be emphasised that the material here presented is extremely comprehensive for this type of study. Probably it is very difficult to obtain material that is as objective and has such good cover, not only of make, model, year-model and user, but also of geographic district, as that used in the present study.

Table 2. Breakdowns in front axle and suspension

Feature	*Mean*	*Low*	*High*
Breakdowns per 100 tractors per year	2.3	2.7	8.0
Breakdowns per 1000 hours	0.059	0.027	0.117
Broken component per 100 tractors per year	4.2	2.3	10.1
Broken component per 1000 hours	0.108	0.054	0.231
Repair cost per breakdown — SwK	12283	8998	13386
Repair cost per tractor per year — SwK	282	147	525
Repair cost per 1000 hours — SwK	722	345	1342

Notes: 1. The mean values are for all makes of tractor for breakdowns in the front axle and suspension
2. The high and low values are for different makes of tractor
3. The costs in SwK are at 1989 prices

Breakdown frequency and total cost of repairs

Of the total of 1462 reported breakdowns in the study, 1286 occurred during 1989. At 31.12.1989, LFAB had an insured population of 8418 tractors with machinery damage policies for the 18 makes included in this material. The total repair cost for the breakdowns was just under 23.8m SwK.

The number of cases of machinery breakdown per 100 tractors per year was thus 15.3 on average. Note that each machinery breakdown may have several damaged components and thus the sum of the number of components in the list of parts given in Tables 2 to 5 will be larger than the number of breakdowns (Table 1).

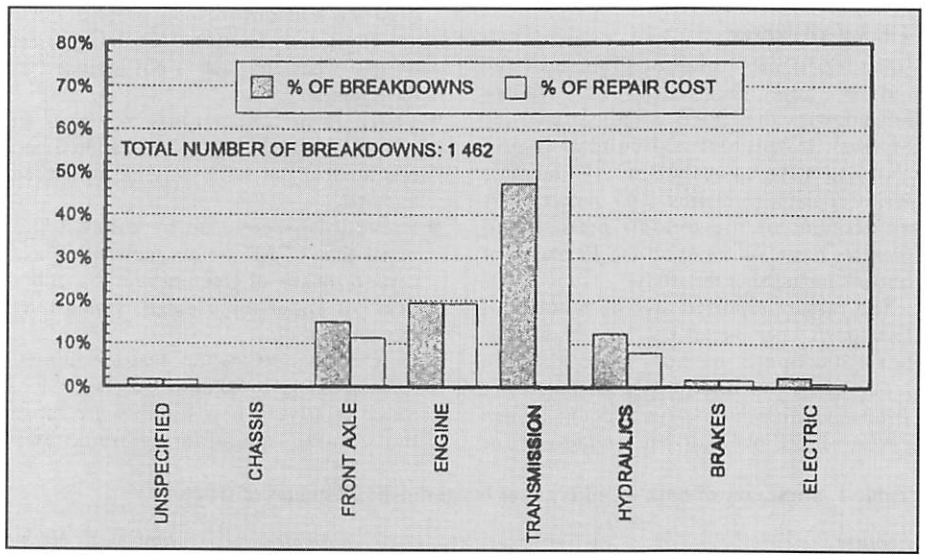

Fig 1. Distribution of breakdowns among the different machine parts

The average age of the tractors when accident occurred is 6.3 years and the operating hours was, on average, 2476 hours. This results in an annual operating period of 391 hours, on average. Using these data, we can calculate that the mean value for the number of breakdowns per 1000 operating hours was 0.39.

There was a large difference between makes both with regard to the number of breakdowns per year and the average annual operating period and, thereby also, with regard to the number of breakdowns per 1000 operating hours.

The mean value of the repair cost was 16,362 SwK per breakdown. This gives a mean repair cost of 2497 SwK per tractor per year, or 6388 SwK per 1000 operating hours. The average repair cost per breakdown also showed a larger difference between different makes and thus this also affects the repair cost per year and per 1000 operating hours.

Table 1 shows the mean value for all makes as well as the lowest and highest mean values for different makes. Note that it is not the same make that throughout has the highest or lowest values.

– compensation for loss of production

Machinery breakdowns frequently lead to the tractor being at a standstill. A standstill implies costs both to the farmer and to the insurance company. Altogether, compensation for lack of production was paid for 7839 days, relating to 1462 breakdowns, which gives a mean value of 5.36 days per breakdown.

Compensation for loss of production time requires an initial two qualifying days, so the mean value for standstills per breakdown should be two days greater (and not counting the day when the breakdown occurred). This figure may still be too low since the number of days receiving compensation for standstills is limited to a maximum of 15 days and thus longer standstills do not show in the data.

For these 1462 breakdowns, a total of over 1.9m SwK was paid out in compensation, with the mean value pre breakdown at 1336 SwK.

– costs of transport and recovery

There is, of course, a further cost in machinery breakdowns relating to travelling, transportation and recovery services. For breakdowns included in this investigation, the LFAB paid a total of 532k SwK for such services, implying 364 SwK, on average, per breakdown.

Where do the breakdowns occur on the tractor?

Fig 1 shows how breakdowns, on average, are distributed between different parts of the machinery or groups of components in the tractors. For most makes of tractor, the distribution does not differ much from the pattern shown in Fig 1. However, there are some makes that diverge strongly from the mean value – for example, there are some makes that have extremely many engine failures and some that have almost only transmission failures.

The expense of repair work also varies according to the different parts of the machine. A transmission failure often leads to comprehensive secondary damage, and, by the same token, frequently implies considerable work to expose the damaged part, whereas a breakdown relating to the front axle and suspension of the tractor is easier to correct. Consequently, transmission breakdowns are, on average, more expensive to repair than other breakdowns.

From Fig 1 it can be seen that the transmission system is the most severely affected, with almost 50% of the number of breakdowns and almost 60% of the total repair costs.

The machinery components with most breakdowns are listed below in order of magnitude:

feature	*percent of breakdowns*	*percent of repair cost*
transmission	47.3	57.3
engine	19.4	19.3
front axle	15.0	11.3
hydraulics	12.4	7.8

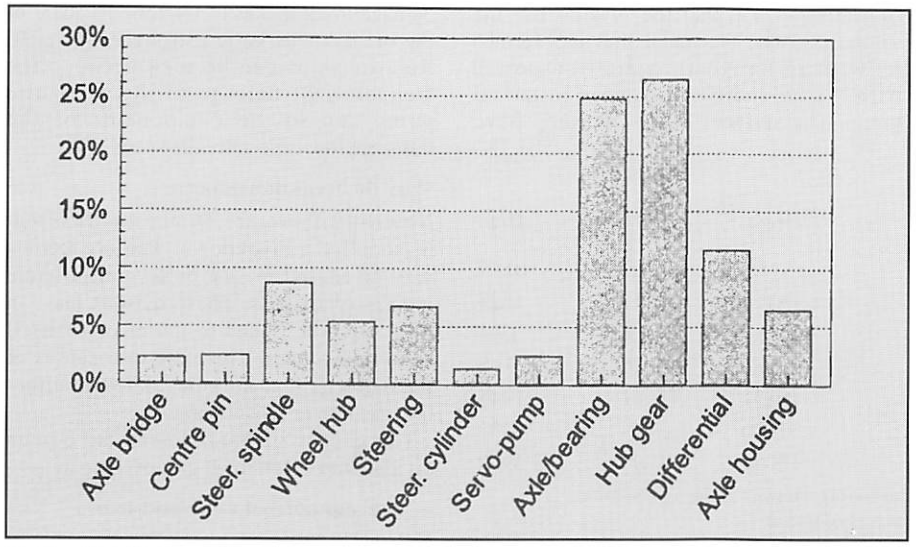

Fig 2. Distribution of breakdowns among components of the front axle and suspension

These four machinery components together made up 94.1% of the breakdowns and 95.7% of the repair costs. Other breakdowns occurred in the chassis, brakes, electricity system, or were unspecified.

A more detailed analysis of how the number of damaged components was distributed among the most important machinery parts or groups of components is presented in Figs 2 to 5. Since the data illustrated in the Figs apply to the number of damaged components, the sum is greater than the number of breakdowns (cases reported).

Tables 2 to 5 summarise the data on breakdowns in these four major areas. Again, as in Table 1, The mean figures are for all makes of tractors, whilst the low and the high figures are for particular makes and then only where more than 100 breakdowns were recorded for the make. For makes that had fewer breakdowns, it was recognised that one single breakdown may have a major effect on the overall picture and, consequently, such makes of tractors have not been included in this more penetrating analysis of components.

— Front axle and suspension

Table 2 shows results as regards breakdowns in the front axle and suspension. Of the total number of repairs, 15% concerned the front axle and suspension, but this represented only 11.3% of the total repair costs. Breakdowns in the front axle and suspension are thus seen to be less expensive than for the average breakdown.

Fig 2. shows how the breakdowns relating to the front axle and suspension are distributed among the relative components. Driving axles and hub gears were the foremost sources of breakdowns in the front axle, together making up more than half of the total. Thus, in the front axle and suspension, it was again the transmission that suffered most as regards mechanical failure.

The distribution among components was relatively similar regardless of make of tractor. Naturally, makes with a larger proportion of 4-WD tractors had a larger proportion of breakdowns in the transmission and in the front axle and suspension than for the other makes.

—Engine

Table 3 shows the results relating to breakdowns in the engine. Of the total number of repairs, 19.4% concern the engine and represent 19.3% of the total repair cost.

Fig 3 shows the distribution of engine breakdowns in individual components. Three components made almost half the engine breakdowns; linings/pistons, cylinder head and bearings. Among the other components, the breakdowns were fairly uniformly distributed.

Table 3. Breakdowns in engine components

Feature	*Mean*	*Low*	*High*
Breakdowns per 100 tractors per year	3.0	1.4	6.0
Breakdowns per 1000 hours	0.08	0.03	0.13
Broken component per 100 tractors per year	6.4	2.9	14.2
Broken component per 1000 hours	0.16	0.07	0.31
Repair cost per breakdown — SwK	16348	11612	21177
Repair cost per tractor per year — SwK	487	155	1268
Repair cost per 1000 hours — SwK	1246	379	2744

Notes: 1. The mean values are for all makes of tractor for breakdowns in engine components
2. The high and low values are for different makes of tractor
3. The costs in SwK are at 1989 prices

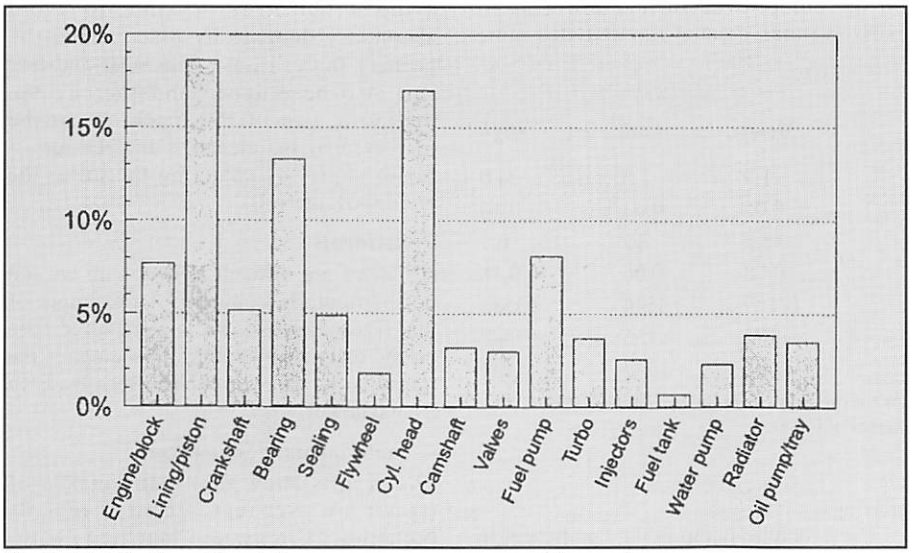

Fig 3. Distribution of breakdowns among components of the engine

—Transmission

Table 4 shows the results relating to breakdowns in the transmission. Of the total number of repairs, 47.3% concern the transmission and represent 57.3% of the total repair costs.

Fig 4 shows how the breakdowns in the transmission were distributed among different components. The components suffering most were the main gearbox, clutch and the speed shift — together making up 56% of the breakdowns. However, the rear axle components are also severely affected, with 27% of the breakdowns. The components suffering the most are the same for almost all makes of tractors even if their proportion of breakdowns and the order between them vary.

The transmission has the largest share both of the total number of breakdowns (47.3%) and the total repair cost

(53.7%). The transmission is a complicated part of the tractor, containing several gearboxes, speed shifts, hub gears and differentials, etc. During heavy work it is also extremely heavily loaded.

Table 4. Breakdowns in the transmission

Feature	*Mean*	*Low*	*High*
Breakdowns per 100 tractors per year	7.2	4.7	10.44
Breakdowns per 1000 hours	0.18	0.10	0.28
Broken component per 100 tractors per year	12.1	7.6	17.4
Broken component per 1000 hours	0.31	0.16	0.45
Repair cost per breakdown — SwK	19851	17581	21443
Repair cost per tractor per year — SwK	1426	844	2233
Repair cost per 1000 hours — SwK	3654	1794	5949

Notes: 1. The mean values are for all makes of tractor for breakdowns in the transmission
2. The high and low values are for different makes of tractor
3. The costs in SwK are at 1989 prices

The entire transmission and the hydraulic system use the same oil. This implies that damage and wear may affect the entire transmission and also the hydraulic system since metal shavings and other polluting substances can be transported throughout the system and cause damage to several places. Pollution may also enter through the hitch-points for external hydraulics. It is, therefore, extremely important to check oil levels and to replace oil at least according to the prescribed intervals. It is also important when receiving an indication that something is wrong in the transmission, e.g., that gears jump out, or unaccustomed noises are heard, to stop the machine immediately and call a mechanic.

—Hydraulic system

Table 5 shows results relating to breakdowns in the hydraulic system. Of the total number of repairs, 12.4% are in the hydraulics, representing 7.8% of the total repair cost. Breakdowns in the hydraulics are, thus, much less expensive to repair than the average breakdown.

Fig 5 shows the distribution of the breakdowns in the hydraulic system according to its components. The hydraulic pump is the most damaged component. This partly is explained by what was mentioned earlier in the section on transmission, i.e. that the systems use the same oil. Thus, the metal shavings formed by wear in the gearbox are transported with the oil and cause damage to the oil pump. The surfaces of the oil pump have high demands on measuring accuracy and surface smoothness in order to create the pressures and flows required. If the working pressure decreases, a speed shift, for example, may start slipping which will create more metal shavings, greater wear on the pump, even further lowering of pressure, thus greater slip and still more shavings.

The hydraulic pump is the component in the hydraulic system that suffers most damage in all makes of tractors; its share of the breakdowns varied strongly, however. Relationships can be seen between the frequency of damage to the hydraulic pump and to the components of the transmission, especially the speed shift.

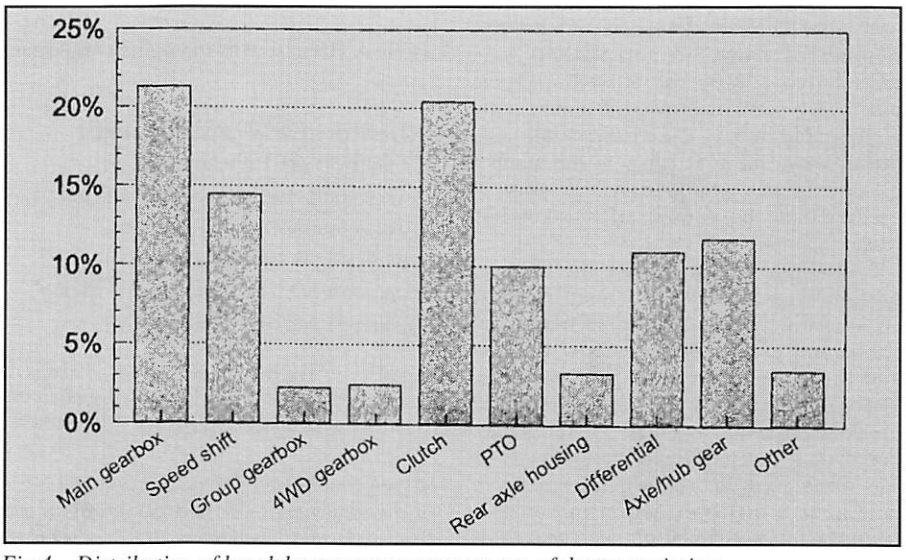

Fig 4. Distribution of breakdowns among components of the transmission.

Table 5. Breakdowns in the hydraulic system.

Feature	*Mean*	*Low*	*High*
Breakdowns per 100 tractors per year	1.9	1.3	4.0
Breakdowns per 1000 hours	0.05	0.03	0.10
Broken component per 100 tractors per year	3.3	2.5	6.9
Broken component per 1000 hours	0.08	0.06	0.18
Repair cost per breakdown – SwK	10139	8644	13588
Repair cost per tractor per year – SwK	192	155	447
Repair cost per 1000 hours – SwK	492	347	1141

Notes: 1. The mean values are for all makes of tractor for breakdowns in the hydraulic system
2. The high and low values are for different makes of tractor
3. The costs in SwK are at 1989 prices

Why do breakdowns occur?

Naturally there are numerous different reasons for a breakdown. The breakdown may be caused by one or several different individual reasons. These reasons may, in turn, often be linked to the machine itself or to its operator. There are also causes of breakdowns that are not related to either the machine or to its operator.

The causes of breakdowns have been divided into seven main groups, namely:-

— age and normal wear-and-tear

Naturally, this is a common cause of breakdowns. However, it is not visible in the results in this report since the machinery damage insurance policy does not normally cover wear-and-tear and deductions for age are made on the cost of material.

This type of breakdown cannot be avoided but it is possible to avoid secondary damage by discovering the primary fault in time. The wear-and-tear can also be reduced and thereby the operating life of the machine can be increased by maintenance and service — for example, by changing the oil at the prescribed intervals.

— accidents

Accidents are difficult to deal with but are not particularly common. An example of this type of breakdown is a fractured tube on the external hydraulics that empties the transmission of oil, which in turn leads to a breakdown.

— material and design errors

The results show that many makes of tractor are over-represented as regards breakdowns in certain machine components. If, for example, engine break-

downs are strongly over-represented for a certain make of tractor, then the reason can hardly be found among the operators but more probably in the design itself.

The frequency of this type of breakdown can only be influenced by contacts with manufacturers or importers. However, secondary damage can be avoided by being observant in relation to the weaknesses of the machine.

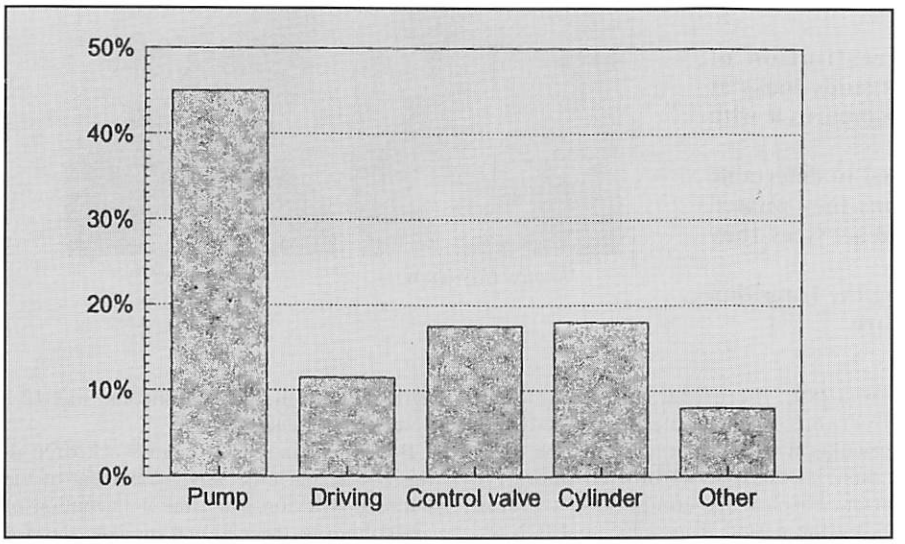

Fig 5. Distribution of breakdowns among components of the hydraulic system.

— deficient maintenance

Many breakdowns depend on maintenance not being done to a sufficient extent or being done incorrectly. Deficiencies on tractors could be:- low oil levels, incorrect oil, old oil or clogged filters. In order to reduce the frequency of breakdowns on account of such problems, the attitude to machinery care among operators must be changed.

The operators must know why service and maintenance must be done and understand that it is profitable. Some of the operators of the machines must perhaps also be encouraged to participate in better machine care by schemes such as as discounts on service tests or lower insurance premium.

— incorrect use

Many of the breakdowns are simply the result of the machine being overloaded or being used in a manner for which it was not designed. This often leads to difficult and comprehensive breakdowns.

Examples of incorrect use are: high power demands for long periods in combination with low speeds and high gear, together with failure to use the differential lock when the wheels are slipping.

In order to decrease the frequency of breakdowns as a result of incorrect use, the operators must be properly informed about how the machine should, or can, be used. Such information is largely found in the tractor instruction manual but in some case s needs to be supplemented.

Technical solutions can also be used, such as a driving computer limiting the period for continued use at high power inputs.

— incorrect repair or service

An earlier study at JTI showed that incorrectly-done repairs or service are commonly found. This particularly applies when the work is done by the farmer on the farm.

Common faults are incorrect assembly, incorrect adjustments and poor cleaning. Breakdowns resulting from such causes will lead, in the best case, only to the repair having to be done again, but they may also lead to extremely comprehensive secondary damage that will be expensive to repair.

Attempts to save money by doing one's own repairs may thus give the opposite result if one is not thorough or if one lacks sufficient knowledge.

— secondary damage

Secondary damage is very common and represents a large part of the total costs.

If a primary fault is not discovered in time, or the symptoms are ignored, a fault that initially may be relatively inexpensive to repair may lead to large, expensive and unnecessary breakdowns.

Particularly the transmission and the hydraulic system on agricultural tractors are very sensitive to this since they use the same oil. This results in the faults spreading as a result of metal shavings from the primary fault being transported to other parts of the machine with the oil.

Hitched machinery using the external hydraulic system of the tractor may also be affected.

In order to avoid or, at least, restrict the extent of secondary damage, it is extremely important that the primary fault is discovered at an early stage through maintenance and inspection, and work is immediately stopped when indications of faults are observed.

References

Swedish Board of Agriculture 1991. Calculations relating to the agricultural operating surplus.

Northern Branch

Symposium

Wednesday 10 November 1993 (1.30 – 5.00 pm)
Agriculture Building, University of Newcastle upon Tyne

Developing Lowland Forestry for Energy and Amenity

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Information will be sent direct to members in Scotland in January

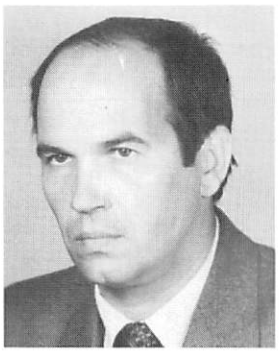
Agricultural Engineering in Bulgaria – the way forward

Nikolay Naydenov and Ian Gedye

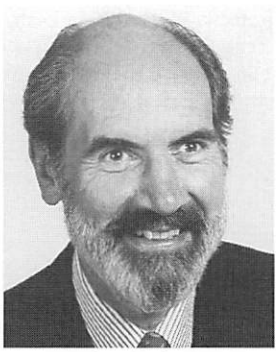
The year 1992 saw the process of restitution of agricultural land begin in Bulgaria. This study looks at the state of agriculture in Bulgaria and compares it with the developed countries in Europe.

A questionnaire among farmers was used to determine the method of ownership and size of farms they wanted and the associated farm machinery and services they required.

Some ideas are presented for facilitating the transition to private and small co-operative agriculture.



Nikolay Naydenov



Ian Gedye

Agricultural land in Bulgaria covers about 6.2 million hectares, or 55.6 percent, of the total area. Within this, the arable (cultivated) land accounts for about 4.6m ha, the remainder being meadows, pasture and other land (Eurostat 1991).

At the end of the 1940's (when the collectivisation of Bulgarian agriculture had begun) about 2.5 million landowners owned approximately 2 to 3 plots of land each, which were not necessarily adjacent. Each farmer owned about 2.5ha of land on average.

The maximum area of land allowed for one holding had been according to the 'Land Law' of that period. This was 30ha for the Dobrudza, the mountains and foothill areas, and 20ha for all other areas in Bulgaria. The Dobrudza area is in the north-east of the country and is known as the corn belt of Bulgaria.

The formation of co-operatives

The process of formation of industrial-scale holdings by incorporating the farms into co-operative ('colhoz') was essentially completed by 1958. Concentration and centralisation of 'colhoz' farms originally consisting of of 500–700ha land continued to the early 1970's when 170 territorial agro-industrial complexes with areas of 30,000 – 40,000ha each were formed.

The main disadvantages of this policy were the removal of links between producers and their original holdings and the use of forms of payment and remuneration which were not directly linked to output results. Thus, by the mid 1980's there were already problems with agricultural production.

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In 1989, therefore, the communist government attempted to redefine agricultural policy by redividing the agro-industrial complexes into co-operative farms which were comparable to those during the period from 1965 to 1968. So, by 1989, co-operative farms were 1750ha of arable land on average with one or two villages associated with each. At that time the deterioration of the agricultural industry was already becoming apparent.

Fig 1A. The changing requirement: This Bulgarian-made maize forage harvester is typical of the large scale machines needed for State farms and large co-operatives. (Contrast this with the small tractor shown opposite).

Importance of agriculture

As in all Eastern Bloc countries the contribution of Bulgarian agriculture to the national income was relatively high. People engaged in agriculture in 1988 were a little over 19 percent of the national workforce and the contribution of agriculture to the national income was 12.1 percent (Eurostat, 1991).

By comparison, the farm workforce in the UK at that time was 2.2 percent of the national workforce and the contribution of agriculture to the national income was 1.4 percent (Fiegal and Rampton, 1991).

The importance of agriculture to the Bulgarian economy is further strengthened by the fact that it accounts for a relatively large part of the export trade (about 13 percent in 1988). A feature of the export policy has been the concentration in three or four product groups namely:

- tobacco and cigarettes (about 46 percent of the whole agricultural export),
- fresh and caned fruit (20 percent) and
- wines and spirits (12 percent).

The remaining 22 percent were sunflower, wheat and some other cereals. It was significant that about 80 percent of the whole Bulgarian agricultural export went to the USSR (Crippa, 1992).

Intensive production; lack of capital

The technology in crop and animal production systems and technical equipment is similar to other European countries. The problem was that the predominant large co-operative farming system was built on intensive production technology and a lack of capital investment.

During the period of state control, agriculture declined and the level of production efficiency was very low. For example, in 1990 the gross product per worker in Bulgarian agriculture was $4500 which was one third lower than in Greece, four times lower than in the UK and France and seven times lower than in the Netherlands (Crippa, 1992).

– machinery old and in poor condition

Agricultural machinery (see Table 1) was generally old and in poor condition.

About 80 percent of the tractors were over seven years old and there was a great variety of types and makes (trade marks) from the ex-USSR, Germany, Czechoslovakia and Bulgaria.

A relatively large number of tractors (about 15 percent) were high-powered tractors such as 'Zetor Krystal' and 'ZT—300/303' (100–120hp), 'T-150K' (130hp) and 'K–700/701' (200–250hp) ideally suited to the large co-operatives.

The 'second hand' agricultural machinery market, so necessary to farming in West European countries and in America was lacking in Bulgaria.

– working capital controlled and limited

The amount of working capital of 'colhoz' farms has been controlled and limited by the government. Any surplus working capital was cut by the government and could only be used by 'colhoz' farms after asking permission from the state. It was typical on big co-operatives to maintain few capital reserves.

After 1990 the prices of machinery, fertilisers and agro-chemicals were dictated by the open market but prices of produce sold by the farms was still controlled at a low level. This resulted in farms incurring high levels of debt.

– problem areas

The main problem areas were in animal production and in the growing of forage and hay and also of sugar beet.

Because of the inefficient utilisation of the 500,000ha of natural grassland and the use of of imported concentrates, the costs of animal production were high. This resulted in a reduction of the herdstock of dairy cows, calves, sheep and pigs. This was accelerated after 1991 when the large co-operative herdstocks were disbanded by the liquidation boards and the livestock given back as membership-property were also slaughtered.

Cow and calf numbers in 1989–1990 had decreased by 12 percent compared with 1980. Over the same period sheep had decreased by 23 percent and pigs by 13 percent (Crippa, 1992). Between 1991 and 1992 a further 20 percent reduction in livestock numbers has taken place.

– machinery, buildings, stock

Liquidation boards in ex-colhoz farms have been established to carry out the transfer of ownership of agricultural machinery, farm buildings and livestock and, in the meantime, they have also been given the responsibility to carry out all the husbandry work on these farms as well.

It was planned that the liquidation boards should finish their work by the end of February, 1993 but this is now clearly impossible.

Fig 1B. The changing requirement: The small agricultural tractor popular with the emerging small farmers sector. The tractors are manufactured by private enterprise.

There were big problems in grape and sugar beet production, too. The area of vineyards had decreased by 30 percent for the period 1962—1992 and annual sugar beet production halved since 1980 because of the import of raw cane sugar from Cuba (Crippa, 1992).

The main agricultural imports have been maize for stockfeed (45% in the last two to three years), agricultural machinery and equipment, fertilisers, and agro-chemicals.

Restitution to private owners

– land

A process of deep change in Bulgarian agriculture began with the 'Land possession and utilisation law' in 1991. This applied the same maximum size of property as in the Land Law of 1946. The changes were, however, expected to be slow because of the centralised character of agriculture and the resistance of those who managed the 'colhoz' system.

The process of land restitution is carried out by the village land commissions and it was planned by the current government that about 70 percent of the agricultural land would be restored to the original owners by the end of 1993.

Unfortunately, only 15% of the total land has been restored by the end of February, 1993. The land so far restored has predominantly been made up of plots with easily defined borders or those which could be estimated easily in mountain and foot-hill areas.

There are, as yet, no instances of private farming practices in Bulgaria. The transition to forms of farming based on private ownership will be a long and difficult process.

Currently it is assessed that agriculture and also tourism and light industry will be of major significance to the economy in the next few years. So, there will be great damage done to the Bulgarian economy if any mistakes are made in agricultural policy.

Survey of farmers' attitudes and requirements

At the beginning of 1990, when it became apparent that some radical changes were going to take place in farm ownership and management, a team from the Faculty of Mechanisation of Agriculture at the Technical University Rousse developed a comprehensive questionnaire to obtain information about the attitude of the farming community (Naydenov, 1992).

The questionnaire consisted of 20 questions which invited many alternative answers and was designed in two parts to find out:-

1. What was considered to be the ideal holding size and organisation and what was the preferred agricultural machinery by type and size.

2. What kinds of services would be required from contractors, service companies and advisory organisations.

The questionnaire was carried out from 1990 to 1992. A total of 252 farmers from over 40 villages of 9 districts were surveyed. The group in 1990 included 157 farmers; in 1991 – 27 farmers and in 1992 – 68 farmers. Twenty farmers of the 1992 group had several months experience as private farmers or as leaders of small groups of 3 or 4 private farmers who had used machinery and buildings in co-operation. Predominantly the farmers of the 1992 group were from north-east Bulgaria.

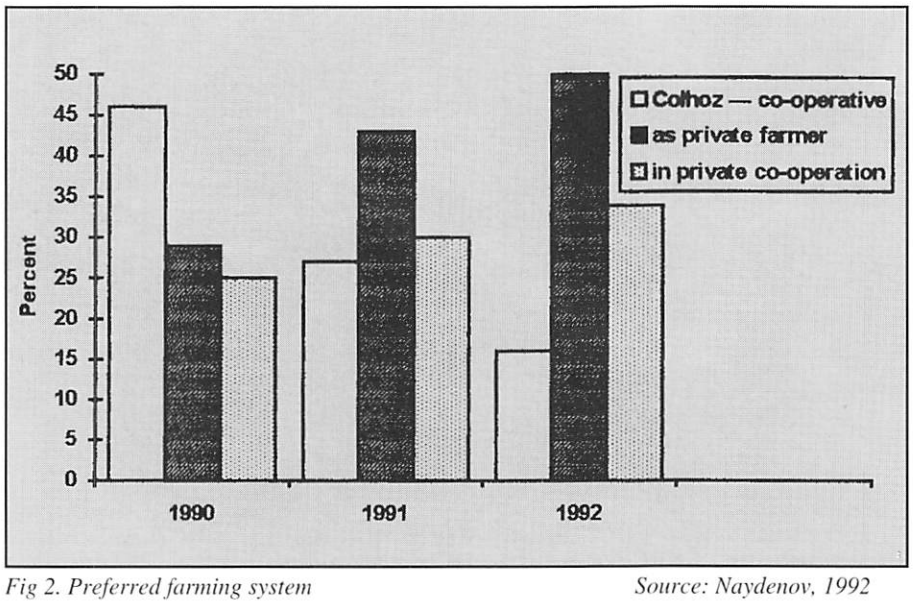

Fig 2. Preferred farming system *Source: Naydenov, 1992*

— what form of farming?

Fig 1. presents the results of the main question about the future form of farming. The alternatives offered were:-

- colhoz co-operative;
- as a private farmer and
- in co-operation with other farmers.

The number of farmers who preferred 'colhoz' co-operatives decreased about three times between 1990 and 1992.

The percentage of farmers in 1992 who wanted farming on the basis of private landownership is very high (84 percent) but many of them (45 percent) would prefer to work in some form of co-operation with other private farmers.

According to the experience of developed European countries the possible forms of co-operation might include:

- the formation of machinery and building syndicates and/or machinery rings;
- co-operation in buying machinery, chemicals, fertilisers, seeds and in selling of output products.

The average size of a family holding in accordance with land possession law is expected to be about 6ha for the whole group questioned in 1992. However, the average size for the group of people with some experience as private farmers or as members of a small co-operative is 7.1ha. The maximum expected holding size for this group is 30ha.

— what size of farm?

The distribution of the farming land which the farmers of the 1992 group wanted to have in order to realise a profitable business is shown in Fig 2. Most of the farmers (67.6 percent) would like to hold between 0.5 and 30ha. About 37% of the farmers surveyed wanted a farm size of between 0.5 and 10ha. The average preferred size for the whole group in 1992 is 38.3ha. For the group of farmers with some experience this rose to 48.8ha.

It is noticeable that the average preferred size of farm for the people who want to be private farmers is 31.5ha. The average preferred size of a small co-operative is 60,5 ha for the whole group and about 83ha for the sub-group of experienced farmers.

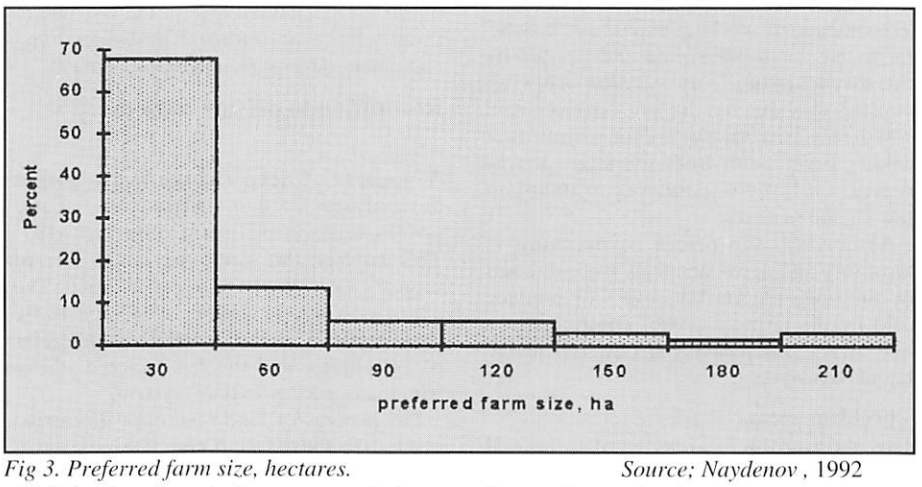

Fig 3. Preferred farm size, hectares. *Source; Naydenov*, 1992

Comparing these results to farm sizes in other countries it can be concluded that most of the private (family) farms in Bulgaria are expected to be small, similar in size to farms in Greece, Portugal and Italy and partly to those in the Netherlands, Belgium and Spain. Co-operative farms would be comparable in size to the farms in the UK.

It would appear that the choice of a small size farm in Bulgaria is because of the preference of mixed farms (arable and livestock). Only 10 percent favoured arable farming and 12 percent livestock farming. The remaining 78 percent preferred mixed farming systems based on their own grassland and on their grain forage production. This system would provide higher levels of employment on the family farms and also diversification by production and selling of meat, milk and eggs. However, a larger farm size will be necessary to provide sufficient income and profit margin.

By comparison, it is recommended in EC countries that the minimum farm size should be 200ha. This would provide a 35 percent reduction in cereal production costs and therefore could ensure a good standard of living for the farmer. These figures are based not only on investigations, but also on the experience of smaller farms in Europe.

Clearly, it would be difficult to operate a profitable business on small farms up to 10ha as one third of surveyed farms wanted.

— machinery requirements

The questionnaire showed that the most preferred alternative would be for farmers to buy only the most necessary machinery and to rent the rest (on average, 54% of the people asked in 1990–1992 agreed). However, the percentage of the farmers who wanted to buy the machinery they needed increased about four times from 1990 to 1992.

The questionnaire results also showed that the JuMZ–6 (65hp), TK–80 (80hp) and Zetor Krystal wheeled tractors were assessed by the farmers as most suitable for their farming. Lowest-powered 25hp wheeled tractors, T–25 caterpillar tractors and combine harvesters wre rarely met in the answers.

The results from this part of the questionnaire showed also that the expected arable land per one tractor would be between 24 and 33ha. Firstly, referring

to Table 1, and the tractor distribution in other countries, we might suggest there would not be enough tractors in Bulgaria to cover the needs of each small-size farm.

For example, small co-operative farms with average size 60ha would need two or three tractors. One private (family) farm with the average size as mentioned above of 31.5ha would use one tractor. Two or three private farms with size up to 10ha (which are expected to be one third of all private farms) would be forced to use one tractor in machinery syndicate.

Secondly, but of great importance for the mechanisation of agriculture in Bulgaria, it would be too expensive to maintain in good condition one or two tractors on a small farm because of high fixed costs for a shelter with workshop.

Role of machinery co-operatives and contractors

The analysis of the results of the second part of the questionnaire showed that most future farmers would use services from machinery co-operatives and private businesses (see Table 2).

About 84 percent of the farmers suggested that service workshops based on new management will have to be established to provide spare parts and various repair and maintenance services but they would not use services from the 'colhoz' workshops because of their poor reputation. The same negative attitude was noticeable towards the work of state repair plants which are responsible for major overhaul.

The results of this part of the questionnaire also showed that between 55 and 72 percent of the farmers preferred to do their own preventative maintenance and some easy repair works without help by service workshops. However, they preferred to buy services which required complicated equipment — as, for example, repair of worn-out units and technical diagnosis.

The authors suggest that these attitudes correspond to the conclusions of similar surveys in EC and Scandinavian countries which show that the farmers who operate smaller farms usually prefer to do their own relatively easy maintenance and repair works.

The future pattern

The results of the survey would indicate that both private (family) and small co-operative farms will probably be established in Bulgaria. Because of the expected relatively small size of farms and the lack of money for investment it is anticipated also that machinery co-operatives and/or contractor firms will probably have to be established. These firms may be organised by privatisation of current state machine-tractor stations. They can provide mechanisation services and also offer several repair and delivery services for private farmers and small co-operatives.

Challenge for agricultural engineering education

Changes in farm size and in the management of the whole land-based industry will undoubtedly lead to changes in agricultural engineering education. Currently, engineering specialists for Bulgarian agriculture are trained only at the Faculty of Mechanisation of Agriculture at the Technical University Rousse. Up to 1992, two courses have been offered:

1. Agricultural Machinery Design: On average 25 students per year, for manufacturing enterprises, research and development units for agricultural machinery.
2. Mechanisation of Agriculture: 100–125 students per year to meet the needs of 'colhoz' farms, machine-tractor stations, repair and servicing firms and delivery organisations.

—Agricultural Machinery Design

The problems in training of students in 'Agricultural Machinery Design' are not so much in curriculum contents as in the need to improve the training programme and especially to extend the training into the use of CAD systems.

In the last two decades under state pressure many enterprises for manufacturing of simple agricultural machines, irrigation and drying systems were appendages to other branches of the machinery industry. The manufacture of such machinery was consequently somewhat disordered and this resulted in a need to import agricultural machinery. Nowadays, however, imports are limited by financial difficulties and prohibitively high prices.

However, as private farms and small co-operatives will be established, a need for lower-powered tractors (30–60hp) and a demand for a wide range of implements such as ploughs, cultivators, seed machines and trailers is expected. A regeneration of the Bulgarian agricultural machinery industry could, therefore, take place and this industry could be competitive in prices both in Bulgaria and in some markets of the developing countries, too.

This process of revival will need engineers who are skillful in modern methods of design, manufacture and

Table 1. Use of tractors and cereal combines in Bulgaria and some other European countries; 1989.

Country	*Arable land per tractor (has)*	*Annual usage of tractors (hrs)*	*Harvested area per combine (has)*
Bulgaria	75	580 – 825* 1130**	250 – 300
United Kingdom	34	600 – 800	70
Germany:			
— west districts	11	100 – 600	30
— east districts	33 – 50	1000 – 1500	150
France; Denmark; Netherlands; Austria; Belgium	16 – 22	400 – 500	52 (France)
Czechoslovakia	33	–	130
Portugal; Greece	36	—	130 –200

* the average use of TK–80 (MTZ–80) and JuMZ–6

** the average use of high-powered tractors T–150K and K–700/701

Sources: Crippa (1992); Fiegel and Rampton (1991); Naydenov N (1992)

Table 2. Attitudes of the future farmers to agriculture services

Kinds of service	*Percent of farmers who would use it*
Delivery of spare parts and technical materials	85.5
Mechanisation services (to use contractor) or leasing of machinery	68.8
Veterinary surgeon services	66.3
Delivery of fertilisers and agro-chemicals	65.8
Repair and maintenance of agricultural machinery	59.1
Agronomy advisory service	54.0
Marketing services	47.6
Services for selling of farm produce	45.2
Agro-technical forecast service	35.7

Source: Naydenov N (1992)

testing of agricultural machinery. These methods are widespread in west-European countries.

— Mechanisation of Agriculture

The basic disadvantage of the course on 'Mechanisation of Agriculture' is the aim to give knowledge to work for large co-operative farms. A strategy for three narrow specialisations is adopted in the last study year —

- Machinery use in arable farming,
- Stockbreeding farms and complexes and
- Machinery service.

This specialisation is pointless with the collapse of the 'colhoz' farms. Engineering subjects form a particularly large part of the curriculum and there is insufficient material about the basis of agriculture for crop and animal production.

Considering the trend of transition to private and small co-operative agriculture in a market economy, it can be expected that Bulgarian agricultural engineers will need greater knowledge of machinery management and farm business management.

The authors feel that the future training of engineers in mechanisation of agriculture must be on a more relevant platform, based on the three areas of agriculture:-

- crop and animal production;
- mechanisation and management;
- farm management.

The TEMPUS project

In order to effect the necessary changes in agricultural engineering education, the EC TEMPUS Office in Brussels has supported a TEMPUS Joint European Project (JEP No.3329-92).

Contractor of the JEP is Harper Adams Agricultural College in Newport, Shropshire. Co-ordinator is the Faculty of Mechanisation of Agriculture at the Technical University Rousse, Bulgaria. Also involved in the JEP are the faculties of mechanisation of agriculture from University Hohenheim in Stuttgart, Germany; University College Dublin in Ireland and the University of Lisboa, Portugal.

Fig 3. Students and lecturers from the Technical University Rouse, Bulgaria have spent three months this year at Harper Adams Agricultural College on a course of study and updating of technical skills. Seated here at the monitors (left to right) are students Julian Trayanov and Anton Nedyalkov and lecturer, Kamen Uzarov. Standing are Dr Wynne Jones, Vice Principal, HAAC; Ian Gedye; Nikolay Naydenov; Richard Bruce, Head of the Enterprise Unit, HAAC.

The principal objective of the JEP in Bulgaria is to develop and update new curricula and establish a centre of excellence for higher education in Agricultural Engineering and Management. Resources will be devoted to solving particular problems of Bulgarian agriculture to facilitate the transition from 'colhoz' to privately owned and small co-operative enterprises.

The project will also provide opportunities for Bulgarian students and higher education teaching staff to undertake training in well-known universities in EC countries, to exchange experiences and to establish strong professional and personal contacts with colleagues abroad.

The main aims of the JEP initiative are:

- development of modern materials (curricula, textbooks, course books), initially intended for Bulgarian students. The project will also benefit EC universities since the developed teaching materials and experience will be shared amongst them.
- producing up-to-date highly qualified Bulgarian teaching staff in the field of agricultural engineering and management.
- development of a training centre in Agricultural Engineering and Management with an appropriate infra-structure.
- establishing long term co-operation and joint activities in education for collaborative projects with EC universities, forging relations with Bulgarian agricultural engineering industry and with industry partners from EC countries.

The JEP started in September, 1992. The team hopes that as a result of the main activities foreseen for the period till 1995 the agricultural engineers in Bulgaria will be better prepared to work in the conditions of a market economy.

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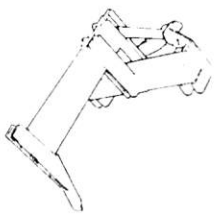
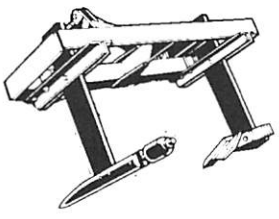
'NAYLER' SINGLE SUBSOILER



LARGE STOCK IRRIGATION HOSE AND EQUIPMENT

'NAYLER' TWIN SUBSOILER CHISEL OR MOLE



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Project cost estimating

John Hives & David Chilton

For major building projects cost estimating is provided by a specialist cost consultant – the Quantity Surveyor. For smaller projects as encountered in agricultural construction it will be necessary for the design consultant (Architect, Surveyor or Engineer) to prepare his own project cost estimates.

This article seeks to highlight a number of factors to consider in the preparation of the Rural Project Cost Estimate.

One certainty in a building design project is that your client will want to know, in advance, the likely total cost of his project. Part of the design consultant's job will be to provide an initial cost estimate for a project. This estimate will be a guess, as every estimate is a guess – an intelligent one, we hope, but nevertheless still a guess. It will be based on many assumptions made by the estimator.

What should we aim for?

You have probably encountered tenders which appear to be costing another project altogether – so where did you go wrong? In order to answer this you must firstly consider what you should be aiming for when preparing the project cost estimate.

Your estimated construction costs should emulate the tendering process of the contractor who will be tendering. You may not wish always to get down to the lowest tenderer's figure as this is often full of errors – you should be aiming for the second lowest.

Now let us think about this in more detail.

Clearly it will involve much more than just a compilation of rates gleaned from a collection of off-the-shelf price books, rounded of by addition of some percentage figures – often the approach of many!

A contractor's estimator has to consider many steps after accepting an invitation to tender:

Estimate construction costs for:
- Labour
- Plant
- Materials

Plan project progress
- Schedules
- Resources
- Site visits

Sub-contractors/Suppliers
- Selection for quotes
- Obtain quotations

Consider additional factors
- Review project risk areas
- Level of overhead inclusion
- Level of profit
- Projected cash flow for project
- Local market conditions
- Company position, etc.

There is much in this process that you can, at this stage, only guess at. All stages have a cost implication, some of which will be passed on to the client via the final tender price. For instance there will be head office to run with its overheads. Maybe an overdraft at the bank to be paid for, payments on the JCB, its service costs and many other considerations. None of these may have a direct effect on your project but a portion of these costs may need to be included in the tender.

Trainee Estimator: ". . . it will cost about £54,243.73"

Estimator: ". . . it will cost about between £50,000 and £60,000"

Senior Estimator: ". . . it will cost about £55,000 and this includes for . . ."

Very Senior Estimator: ". . . how much did you have in mind?"

Thus is the confidence of inexperience replaced by the caution of experience!

Economic and general market factors will affect the actions and attitude of the tendering contractor. He will react to these forces accordingly.

In a recession, as at present, the market demand for contracting is low and thus the competition for any work will be high. Contractors may be forced, by such competition, to reduce margins to get work. The contractor may even buy in work to keep the yard going.

Alternatively there may be a large employer of contracting skills in the locality so urgency to get jobs may be low. Large scale projects in the locality, such as a new power station will affect the supply and demand of labour, plant and material prices – usually upwards!

In general terms, the costs of the construction resources; labour, plant and materials, tend to shadow the Retail Price Index. However Tender prices are more affected by market and economic forces.

Construction cost or tender price?

There is a clear difference between construction costs and tender prices.

The construction cost is the cost of providing the labour, plant and materials together with other resources necessary to complete the project. The tender price is the sum that the contractor wants to carry out the project and will include other factors such as profit, overheads, market conditions etc.

The difference between the construction cost and tender price can be 30 – 40 % dependent upon these market and economic conditions.

Our interests lie in the tender price, but to achieve this aim you also need to know the likely construction costs. The main considerations that go to make up the tender costs are:

Estimating stage		
Direct costs	)	
Site overheads	)	=Nett
Construction costs	)	costs
Site preliminaries	)	
Tendering stage		
Nett costs	)	
Overheads	)	=Tender
Profit	)	offer
Risk factors	)	

You must be aware and consider all of these factors when compiling your estimated tender price. Unless you do you will never get a realistic estimate.

Presentation of the estimate – – the first figure remembered

An unfortunate trait we all suffer from is that of an anchoring bias. We will always tend to remember the first figure given. It is important that your first estimate is realistic enough not to cause embarrassment later.

– The Design Contingency

Unfortunately, experience tends to show that the tender figure seems to bear little relationship to the first estimate. This is usually due to project changes during the design cycle. This difference should have been covered by a Design Contingency inclusion.

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D Chilton is a Design consultant with the ADAS Building Design Group at its Leeds Consultancy Centre (0532 611222).

The size of the design contingency will depend on how much you know about the project. Thus, in the earlier stages when little or no design work has been done, the contingency is normally fairly high. As the project develops and more detail is available the contingency can be reduced but never excluded.

– Range costs – further scope for bias

In your earlier presentation of costs (Feasibility and/or Outline stages) you might decide to give range costs. These tend to give the client further opportunity for anchoring bias as he remembers the lower range figure and judges results on it.

Tenders received at within 10% of your higher range estimate figure, may make you happy: but the client is likely to see and judge on the lower range figure as illustrated below (Fig 1).

	Range cost figures		*Tender*
	£50000	*£60000*	*£59000*
your view			within range
client view	remembered	forgotten	estimate seen as 18% out!

Fig 1. The conflicting views of the tender.

There is nothing wrong with providing a range estimate providing that you discuss and record with the client the reasoning behind the range.

The golden rule in all estimating is ALWAYS QUALIFY your estimate to state what it does or does not include.

Estimating data used during the design process

As the project goes through its various stages of the design cycle you will also need to appraise the developing design in cost terms and advise the client of the cost implications of any changes. There will be at least two and preferably 4 stages at which the client should receive an estimate of project cost:

- Stages 1 & 2: Feasibility and/or outline design;
- Stages 3 & 4 : Scheme and detail design.

The methods adopted in estimating for these stages will vary dependent upon available information.

Stages 1 & 2 Feasibility and/or outline design

The traditional choice for both stages is utilising Basic Unit Cost methods.

Unit, or superficial costs, are obtained from widely available sources such as cost books or verbal quotations from contractors etc. They are very useful for the "can I really afford it?" stage of the project. However they are basic and cannot properly reflect size and changes in design. They have the paramount failing that they are only accurate for the one instance of model form from which the costs were taken.

Adjusted unit costs, derived from looking at various model options, can be utilised with a little more confidence as they are likely to reflect design size and change.

A simple example

Fig 2 provides unit costs in £ per m^3 for a simple reinforced waste structure. The cost data include preliminaries, overheads, profit and VAT. The model is square on plan with 3.00m walls and assumes 2mm/m^2/day for 120 days rainfall.

The Basic Unit Costs line uses a cost derived from a 750m^3 volume model. Notice that the unit cost line is straight and rises inexorably. Remember that a graph line derived from single unit costs is merely a series of models, all with the same elemental assumptions. Obviously, as the size changes so will the elemental make-up of the model. So, as the line moves away from the original 750m^3 model size, the more inaccurate the prediction line becomes.

Basic Unit Costs tend to under-estimate at the volumes below the deriving model and over-estimate at volumes above it. It must be stressed that Basic Unit Costs are only accurate for estimating within their original model parameters. Unless you know the deriving model sizes you cannot be sure of the accuracy of your estimate.

With the *Adjusted Unit Cost line*, each data point on the line is based on a changing, reasoned model which reflects the correct elemental make-up of that particular model. The result of this adjusted unit costs line is that it is curved.

The adjusted unit costs line reflects the changes in costs at the larger volumes by tending to flatten out as economies of scale occur. Notice how it meets and pivots about the 750m^3 mark on the other line.

Let us now look at a simplified version of the store and explore these differences further.

For this exercise, ignore freeboard and rainfall. Assume a square plan structure and a required storage volume of 1020m^3. The actual values of the unit costs are irrelevant here as we are considering relative fixed and variable values only.

– basic unit cost estimating (derived from a single model)

Assume unit costs for the model as follows:

Per m^2: £64.50 Per m^3: £30.80

i). Using the model wall height of 2.10m:

For plan size 22.04 x 22.04m

cost based on area = £31419

cost based on volume = £31419

ii). By increasing the wall height to 3.00 m same volume stored then:

For plan size 18.44 x 18.44m

cost based on area = £21932

cost based on volume = £31419

For the adjusted second store, the cost based on the volume unit cost has not changed. Clearly this would be wrong even at a basic level. The cost based on area unit cost has dropped by 43% even though the volume stored remains the same. Some drop will be expected, but by this much?

– adjusted unit cost estimating (for staged model changes)

iii). Assume initial unit costs and overall costs for the 22.04 x 22.04m x 2.1m high store remain the same as (i). above:

For plan size 22.04 x 22.04m

cost based on area = £31419

cost based on volume = £31419

iv). Now by increasing wall height and using a revised model that reflects change:

New unit costs are: per m^2 = £87.40 per m^3 = £29.10.

For plan size 18.44 x 18.44m

cost based on area = £29718

cost based on volume = £29684

The cost based on volume unit cost has now changed to reflect model change.

The cost based on area unit cost has dropped to reflect the change in area but only by 5.7%.

The reasons for the reduced % drop reflects the needed change in relative proportions of the flooring. For this structure, the reinforced walls have a thick, reinforced heel which doubles as part of the floor. The length of the heel varies with the height of the wall thus the proportion of floor accounted for by this expensive floor item varies. In the above, the heel dimensions are:

1.65m long for a 2.10m high wall

2.45m long for a 3.00m high wall

From this we can derive the relative areas as follows:

plan area	*2.10m wall*		*3.00m wall*	
	m^2	%	m^2	%
total floor	485	100	340	100
central floor	351	72	183	54
heel floor	134	28	157	46

There is a play-off between the saving on the central floor against the extra heel floor and the cost of the extra wall height.

The basic unit method is therefore wrong on both counts:

- no adjustments in volume costs and
- incorrect adjustments in the area costs.

The curved adjusted unit costs that provide costs based on significant model changes reflects these changes and so produces a better, reasoned estimate.

Stages 3 & 4: Scheme or Detail Design stage estimates

Having now completed the Feasibility and/or Outline Design stage estimates let us now look at the later stage estimating techniques.

By this stage in the design process you should be much clearer of just what will be involved in the project. You should be able to estimate more accurately and gradually reduce your design risk contingency element.

A more accurate way of estimating for these stages would be by measuring approximate quantities to which measured rates, obtained from price books, can be applied. (This assumes no Bill of Quantities is being prepared).

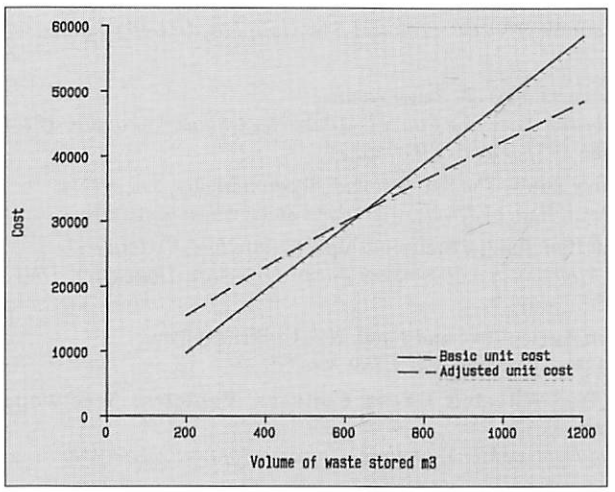

Fig 2. Cost comparisons for waste store example.

However most of today's building price books do not have that much in common with agricultural structures and, although there is a number of agricultural price books, these primarily deal with basic unit cost data or strict model based data which, as we have seen, do not readily give a very comprehensive, flexible or accurate way of costing agricultural structures.

A further snag with the approximate quantities approach is that not everyone has either time, skill or inclination to take off quantities once, let alone repeat the exercise as the design cycle proceeds. So, taking off quantities is probably not a realistic option for most of us.

One alternative approach that could be considered would be to aggregate the quantities into 'composite' or 'significant' items of cost to which suitably calculated rates could be applied. Taking off would then be reduced to a minimum number of items and adjustments during the design cycle could be more readily accommodated.

Unfortunately there is not, at present, a widely available costing system which presents cost data in this format. We are currently developing such a system within our consultancy with a view to it being made more widely available.

The adjustments

So far, your estimating will have only provided for the likely construction costs for the project. A number of adjustments will be required to achieve tender stage.

– Design Risk Contingency:

This has been mentioned earlier. The design risk contingency covers those areas that are considered unforeseen risks. Lack of information will mean a higher risk figure must be included. The simpler the structure the smaller the inclusion and vice versa.

An element for risk is inherent in tendering a figure before work starts on site. For example, weather, undisclosed site conditions, unknown timescales will add to the risk element inclusion. This means there will always be a risk contingency in the estimate.

– Preliminaries:

Preliminaries are project related items which cannot be allocated to specific areas of measured work. These could be: site set up, storage areas, small plant, shared plant (eg scaffold), site related contract management overheads such as insurances, travel, welfare etc.

These items normally would fall within a band of 6 – 15% of the construction cost. As they fall under the contractor's control they can be affected by market conditions.

In present conditions these items tend to be low as the competition for work remains at a very high level.

– Overheads & Profit:

Overheads relate to non site-specific aspects of the contractor's business – the company's fixed costs that are considered to be included in the tender.

The Profit element is market related and will be the contractor's considered assessment of what the market will stand. In recessional periods, as are presently being experienced, this figure is very low and may be nil.

– Value Added Tax (VAT):

VAT, a very important item, must be included unless instructed by the client otherwise. Recovery of VAT is not your concern, it is part of the building cost. It may not form part of the tender, but it will be part of the project total or OUTTURN cost. The client will normally have to pay VAT and service it until he can reclaim.

You must be aware of these factors when compiling your estimate of the tender price. Unless you consider and quantify these factors you will never get a realistic estimate (See Fig 3).

Other adjusting factors

There are many other factors and indices which can be applied to obtain your final estimate. Beware, these must be used with caution, as it is all too easy to imply spurious accuracy.

The BCIS Tender Indices location map index is often used as it appears to give an indication of the differences in TENDER levels across the country. Remember that you cannot apply these to individual measured rates, only to the final figure. But what kind of tender, and on what kind of project is the data derived from? Is it applicable to your project?

Generally, there seems to be little difference in the cost of materials across the country. So variations will be in the cost of labour, non specific items, local factors and the market. You can also find data to adjust your estimate because of the size of the project, ie larger projects = more materials = better discounts and hence lower costs and vice versa. You could combine size with location but where do you stop?

The final figure: Does it or doesn't it include . . . ?

At the beginning of this article we stated that we were trying to emulate the contractor's estimator to arrive at a figure. But is that what the client wanted to know!

Often the client is interested in the OUTTURN cost for his project – the cost to him to complete and finish the project. To arrive at this he will need to consider ALL the costs involved.

It is therefore of paramount importance to advise him of what and, more importantly, what has not been included in your estimate. To arrive at this OUTTURN cost, the following need to be considered and costed as appropriate:

- Project tender cost estimate
- Fixtures and Fittings (not in cost estimate)
- Time related costs other than those in cost estimate
- Consultant's fees (own and others)
- Land purchase costs
- Statutory fees (Planning, Building regs etc)
- Finance charges.

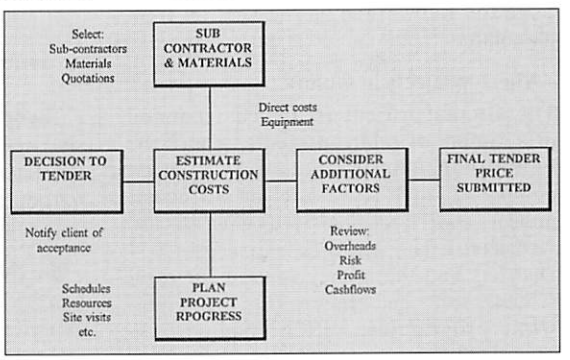

Fig 3. The steps to tender.

Finally the golden rule for estimating bears repeating:

ALWAYS QUALIFY YOUR ESTIMATE AS TO WHAT IT INCLUDES AND WHAT IT DOES NOT INCLUDE.

Development programmes in Africa

Graham Ovens reports on projects in Zambia and Ghana

Rural development in Zambia

In February, this year, I completed six years on an ODA-financed programme supporting the six District Councils of Central Province, Zambia. The programme, labelled CPDDP (Central Province District Development Programme), was based at the Provincial capital of Kabwe, an old-established lead and zinc mining town. The principle was to encourage the Districts to build up their own capabilities to manage District affairs, and to undertake small-scale rural development projects – these were often repairs or rehabilitation of the existing, run-down infrastructure.

Having had responsibility for the CPDDP fleet of 15 Land Rover 110's, I must record the frustration experienced on account of the down-time required for their maintenance.

Kabwe, generally, offers a varied scene. A remarkable HEP dam – a very modest wall across a deep, narrow gorge – creates major storage with an 18km throwback. This hydro station was built in 1926 with the power house at the foot of the Muchinga escarpment. The installation remains almost unmodernised, providing a working museum piece still generating continuously. The capital costs must have been written off decades ago.

There is also a variety of rusting steam locomotives, lying forlorn in Zambia Railway's workshop sidings in Kabwe. Amongst them are some of the amazing Garrett locos which were built especially to serve the Kabwe line on the haul up from the south.

– Micro-projects in Ghana

The Ghana project is an EC-financed programme of micro-projects, where the EDF finance is directed into a large number of small-scale rural infrastructure projects concentrated in 15 of Ghana's 110 Districts. It is soon to be expanded to 34 Districts and the money is used for rural schools, wells and clinics. This is a worthwhile programme, with a good success record, but the large number of projects makes a heavy admin. and management workload which at times can be overwhelming.

Ghana suffered some very hard times economically about 10 years ago but took the bitter IMF recipe for 'structural adjustment' and is now the IMF's only real success story in sub-Saharan Africa. The economy is much improved, though income differentials have widened and life for most Ghanaians is still very tough.

Ghana has a friendly, cheerful, well-educated population with a surprisingly low crime rate and a good work ethic. The capital, Accra, right on the Atlantic shore, is a bustling, lively settlement of round 1.4 million people. The climate is a bit warm for comfort (and for sport)!

–The charms of Africa

Living and working in Africa is an experience not to be missed. The scenery and the game animals are a component, but the main plus is the people themselves – work colleagues, friends and the kaleidoscope of daily life with its vitality and optimism.

Zambia and Ghana are good countries to work in, as are many others in black Africa which do not hit the media headlines. Each country has its own characteristics and its own problems. Some of these problems need to be adjusted to by expatriates with commonsense and caution.

A lasting impression of the African experience is that it retains the daily ability to surprise, to stimulate, to encourage and to depress!

September

11–12 Dem'stration — **West of England 4x4 Festival,** Shepton Mallet
Mandy Adler, Royal Bath and West of England Society, Shepton Mallet, Somerset BA4 6QN (Tel: 0749 823211, Fax: 0749 8231690)

23 Symposium — **Environmental Law and Liability in Pollution Control,** Westminster Conference Centre, London.
Conference Manager, Institution of Water and Environment Management, 15 John St, London WC1N 2EB. (Tel: 071 831 3110, Fax: 071 405 4967)

October

3–7 Exhibition — **Saudi Agriculture 93,** Riyadh, Saudi Arabia
Overseas Exhibition Services Ltd, 11 Manchester Square, London W1M 5AB, (Tel 071 486 1951, Fax 071 935 8625)

6 Exhibition — **South West Dairy Show,** The Showground, Shepton Mallet,
Mandy Adler, Royal Bath and West of England Society, Details as above

9–10 Dem'stration — **British National Ploughing Championships,** Shillingford, Oxford
The Society of Ploughmen Ltd, Quarry Farm, Loversall, Doncaster, DN11 9DH, (Tel: 0302 852469)

12 Conference — **Developments in Agriculture and Food,** N A C, Birmingham,
Dr Ian Givens ADAS, Drayton. (Tel: 0789 266704)

25 Conference — **Suspensions for Wheeled Cross Country Vehicles,** Weetwood Conference Centre, Leeds
Mrs C Goulborn, Dept. of Mech. Engin'g, University of Leeds, LS2 9JT

November

6-10 Exhibition — **Esposizione Internationale della Industrie di Macchine per l'Agricoltura,** Bologna, Italy

16 Symposium — **Sensing and control aspects of spatially variable field operations** Silsoe Research Institute, Silsoe, Bedford – organised jointly by SCI Process Sensing and Control and SCI Agriculture and Environment
Dr J V Stafford, Silsoe Research Institute, Silsoe, Bedford MK45 4HS, (Tel: 0525 860000; or SCI (Tel: 071 235 3681, Fax: 071 823 1698))

22–24 Symposium — **European Symposium on Industrial Crops and Products,** Tuscany, Italy
Gerda A Wolzak, Elsevier Science Publishers BV, PO Box 521, 1000 AM, Amsterdam, The Netherlands. (Tel: 020 580 3240 Fax: 020 580 3270)

28–2 Dec Exhibition — **Royal Smithfield Show,** Earls Court, London
Philbeach Events Ltd, Earls Court Exhibition Centre, Warwick Road, London SW5 9TA. (Tel: 071 370 8224)

December

14–17 Symposium — **ASAE International Winter Meeting,**

January	**25–29**	**Agromek 94 Danish Agricultural Machinery Show**
	26–27	**Lincs Agric Manufacturers Assoc Exhibition**
February	**13–17**	**SIMA 94 Agricultural Show, Paris**

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APPOINTMENTS

The Douglas Bomford Trust
and
The Agricultural and Food Research Council
are Pleased to Announce

The Douglas Bomford Centenary Fellowship

A Prestigious Award for Research to be Carried Out at
Silsoe Research Institute
On an Autonomous Vehicle for Plant-scale Weed and Pest Control

Environmental pressures and the need to remain competitive under reduced support are forcing farmers to consider reducing chemical inputs. One important route is through precision techniques such as applying small amounts of chemical exactly where needed, or removing weeds mechanically. This could only be done efficiently by automatic methods and the potential for an autonomous vehicle is being investigated. Work on weed identification by optical image analysis is already in progress, and this Fellowship will cover the vehicle navigation down crop rows and at headlands, safety issues, vehicle dynamics and control, and operational systems. A small existing vehicle will form the basis but it may be necessary to investigate energy efficiency. The concepts will be incorporated into a demonstrator using an existing actuator.

Silsoe Research Institute is the AFRC Institute concerned with engineering and the physical sciences, located in a historic mansion and park at Wrest Park in Bedfordshire.

The Fellowship is funded for 3 years with provision for equipment, travel and engineering service support. Applicants should have a degree in an appropriate scientific or engineering discipline and a doctorate or equivalent qualification in a relevant topic. This is an opportunity to apply state-of-the-art techniques to an important environmental and agricultural problem. The Fellowship celebrates the Centenary of the birth of the noted agricultural machinery innovator, Douglas Bomford and is thus a unique award.

Further details and application forms can be obtained from the Personnel Office, Silsoe Research Institute, Wrest Park, Bedford MK45 4HS (Tel: 0525 860000, Ext 2204). Completed applications should include a CV and names of two academic referees, and should be returned by 24 September 1993.

AFRC

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