The Agricultural Engineer

Incorporating **Soil** and water

Volume 47 Number 2 Summer 1992

Forestry and Tractors

The Agricultural Engineer

Incorporating Soil and water

Journal and Proceedings

Volume 47 No.2, Summer 1992

Front cover: Timber extraction in Knapdale Forest, Argyle. The forwarder is partially loaded in deference to the soft conditions.

Regular Features

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COMMENT

Barry Sheppard
Hon Editor

I mentioned in the last issue the effects of the recession in our industry on difficulty in obtaining copy for the Journal and my hopes that the new system of announcing two features per issue would help to stimulate authors. Although I have not been inundated, I am happy to say that in one day last week I received one paper through the post and promises of two more for the next issue by telephone. For those who may have missed the forthcoming features for the next three Journals they are:–

Autumn 1992:	Electronics Livestock Engineering
Winter 1992:	Alternative Energy Quality Control
Spring 1993:	Crop Storage Pollution

As I said last issue, can you afford not to be featured in an issue leading on your subject area?

Recruitment to the Institution is another area of pressing importance, and I put forward some ideas about this (page 53). Do not delay! Act now to get new members.

ISSN 0308-5732

High visibility tractor and higher performance engines for MF 3000 Series

Massey Ferguson's 'drop nose' tractor is being introduced in the UK as part of developments in the company's 3000 Series range.

The 85 DIN hp MF 3065 High Visibility tractor became available for delivery this spring, along with higher performance engines in the MF 3080 and MF 3095.

The steeply sloping bonnet of the High Visibility tractor dramatically improves the driver's view from the cab for operating front-mounted equipment. For the sleek new-look of the 85 DIN hp MF 3065, the company's engineers have been able to redesign the sheet metal without affecting the radiator cooling capacity. This enables the HV tractor to tackle all work as a conventional tractor, including the jobs that make the heaviest demands on engine power.

New SKF bearing heaters

The new generation of environmentally-friendly bearing heaters from SKF – pioneers in the use of magnetic induction heating for this application – sets the standards of safety, versatility and economy in the mounting not only of bearings but also of such components as bushings, gears, pulleys, couplings, pistons and sleeves.

Through the use of state-of-the-art electronics, the control of temperature, time and power offers precise regulation of the heating and ensures the safety of bearing shields, seals and cages. Any residual magnetism – a frequent source of contamination by metal particles – is eliminated through the use of an automatic demagnetising cycle. Thanks to the use of induction heating, only the bearing itself becomes hot.

The new extended product range comprises four models of heater – from the portable TIH025 for smaller bearings up to model TIH120 for bearings weighing up to 250kg.

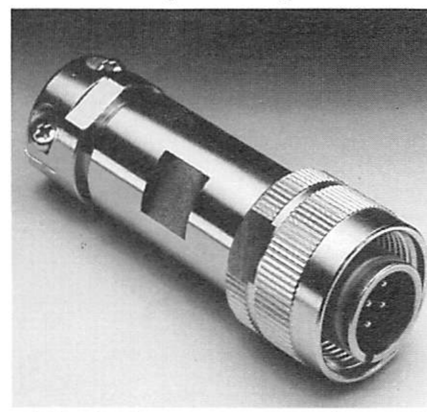
SKF (UK) Ltd, Sundon Park Road, Luton LU3 3BL. Tel: (0582) 490049.

Waterproof connectors for high humidity applications

Belling Lee announces the launch of its TC1108 Series of economical, high-reliability waterproof circular connectors designed specifically for high humidity applications. The new connectors incorporate hermetically sealed receptacles and are rated to IP68, making them waterproof to 3kg/cm^2 pressure and 30m in depth.

The TC1108 Series connectors feature between two and 37 contacts in a wide variety of insert arrangements. Current ratings are 3, 5 and 10A at various voltages from 300 to 600V AC.

Withstand voltages range from 900V AC for the eight-contact design to 1800V AC for the two-contact version. All conform to MIL-STD-202E for vibration, moisture and corrosion resistance and they operate over a –25 to 85°C temperature range.

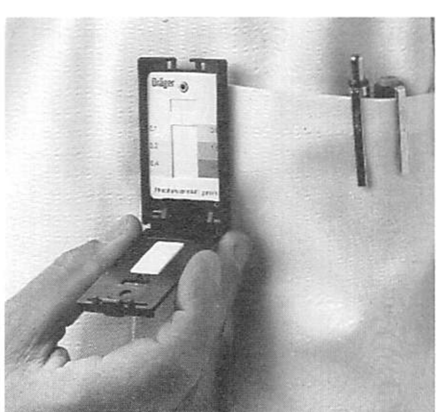


The circular connector range is ruggedly constructed using brass shells with nickel plating, gold-plated copper alloy contacts and synthetic resin insulation. The designs feature a minimum insulation resistance of 2G Ohm at 500V AC and a maximum contact resistance of 5m Ohm at 3V/1A DC. Resistance to shock is quoted as up to 50 g.

Belling Lee, Exning Road, Newmarket Suffolk CB8 0AX. Tel: (0638) 665161.

Simple-to-use badge monitors phosphine exposure

Workers involved with phosphine can now wear a new clip-on badge from Draeger to monitor accurately their exposure to the evil-smelling toxic gas – even at very low concentrations.



Commonly used for fumigating grain stores and bulk carriers, phosphine (PH_3: hydrogen phosphide) also occurs when machining ductile cast iron and during semiconductor manufacture.

Draeger states its badge is the first to indicate phosphine exposure levels directly. It has a measuring range of 0.1 to 2.4 parts-per-million x hours, and monitors for periods ranging from 30 minutes to eight hours.

Draeger specialises in breathing equipment and gas detection devices. It employs 7500 staff worldwide, operates in 100 countries and manufactures in six, including Britain.

Draeger Limited, Kitty Brewster Industrial Estate, Blyth NE24 4RG. Tel: (0670) 352891.

Automatic weedscreen cleaning system

The recently introduced Heron automatic weedscreen cleaning system from Fenland engineering company E J Lord of March, Cambridgeshire provides a reliable, automatic method for keeping weedscreens clear of blockages caused by floating and submerged debris.

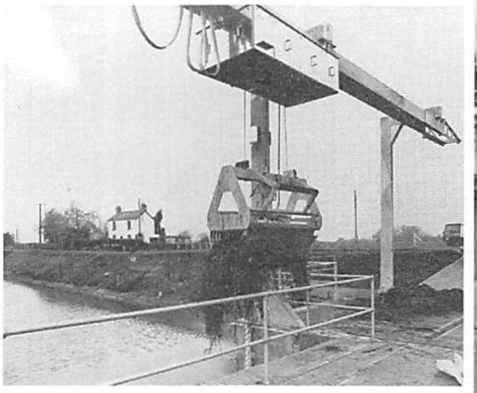
The system comprises a 1.6m wide hydraulically operated grab unit, featuring two sets of fully adjustable moving tines for total cleaning over the entire length of the weedscreen. The grab unit has a lifting capacity in excess of 500kg and is suspended from a trolley unit, running on an overhead gantry.

Control of the system is provided by a combination of PLCs, mechanical limit switches and hydraulic pressure switches.

The cleaning operation

When the system is running under automatic control two ultrasonic sensors monitor the water level on either side of the weedscreen. If the differential exceeds a pre-set level then the cleaning sequence is set in operation. In addition the unit may be programmed to operate in the manual mode.

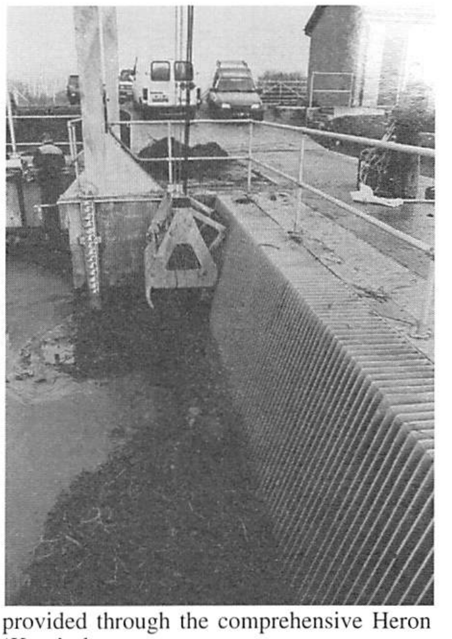
The Heron control system also enables the weedscreen cleaning operation to be automatically initiated at pre-set times, once a day, once every two hours and so on. In addition a manual control facility is provided for the removal of debris such as logs or oil drums, or for loading a skip or trailer with debris previously dumped.



Installation and servicing facilities

E J Lord provide a complete installation and commissioning service for the Heron system and can also carry out all ancillary work, including the installation of the weedscreen, fencing and general electrical work to provide a complete site service.

In addition, regular servicing as well as training in the use of the Heron system, including health and safety awareness, is provided through the comprehensive Heron 'Kare' plan.

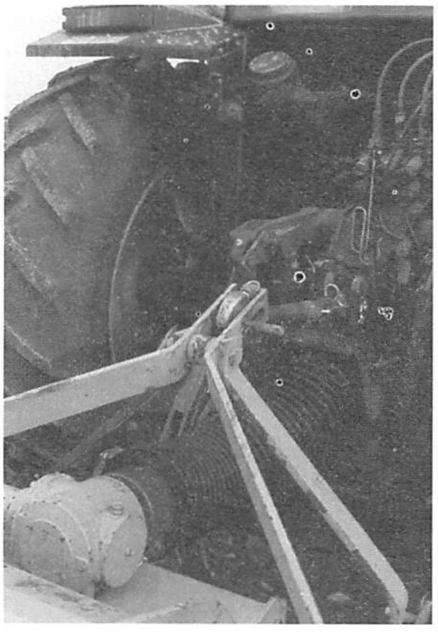


The Heron system is part of a range of weedscreen cleaning systems designed and manufactured by E J Lord.

Further information from the company's Engineering Representative, Sonic Connections Limited, Norton Hill Lodge, Snettisham, Kings Lynn, Norfolk PE31 7LZ. Tel/Fax: (0485) 542086.

A safety first

Now available from Spaldings Agricultural Ltd is their new PTO Total Guard. The guard, which won a Gold Medal at the 1991 Royal Show, has been extensively tested and is said to offer not only full safety but also easier fitting, versatility and longer life. Spaldings, Europe's largest distributor of alternative agricultural replacement parts (with operations covering the UK, Northern and Southern Ireland, Denmark and France) have recently purchased the production and marketing rights.

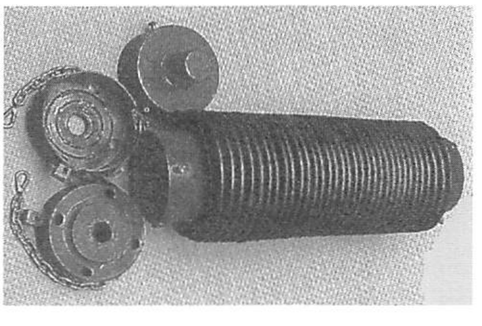


The 'Total Guard' system consists of a heavy duty Neoprene convoluted rubber cover with internal Polyacetal bearing support rings which resists the heaviest of impact. A metal bayonet fitting is attached to each end of the rubber cover. A patented universal quick release coupling is attached to the tractor and implement which accepts the cover bayonet fittings. The cover is supplied in two lengths (1500mm and 2100mm). These covers are for all intents and purposes universal, covering 99% of all known PTO shafts.

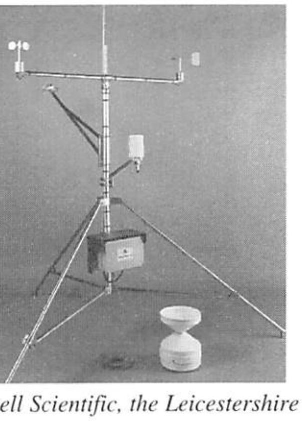
Where implements are fitted with a slip clutch (eg Power Harrows) an adaptor is supplied in order that the clutch as well as the PTO shaft will be guarded and enclosed.

'Total Guard' is supplied with two tractor/implement fittings and one convoluted rubber cover. Additional tractor and implement fittings are available.

Spaldings Agricultural Ltd, Sadler Road, Lincoln LN6 3XJ. Tel: (0522) 500600.



Environmental monitoring



Campbell Scientific, the Leicestershire based instrumentation and monitoring specialists, offer a range of environmental monitoring equipment including weather stations, snow-depth sensors and anemometers.

The automatic weather station is, says the company, a rugged system designed for precise recording of meteorological data. It provides unattended recording of wind speed and direction, air temperature, humidity, solar irradiance and rainfall. Additional sensors are also available, including barometric pressure and soil temperature.

A wide range of applications is envisaged including the assessment of spraying conditions in the agrochemical industry, studies of micrometeorology and effects on tree and grass growth in agroforestry research as well as within mainstream industry.

Campbell Scientific Ltd, 14/20 Field Street, Shepshed, Leics LE12 9AL. Tel: (0509) 601141.

Brian Finney CBE FIAgrE, President

Annual Convention 1992

President's Inaugural Address

A sense of direction

The success of the Institution of Agricultural Engineers depends on maintaining and expanding membership: this is only feasible if our major functions are planned with present and future members in mind.
We have a new 5 year plan which comprehensively covers that requirement.

The old adage about no business being able to stand still applies to the Institution of Agricultural Engineers as certainly as to any other organisation.

Our strengths . . .

We are on the edge of exciting developments as the Institution Secretariat takes over the administration of the European Society of Agricultural Engineers (EurAgEng). Within IAgrE the specialist groups continue to develop as a focus for the presentation and discussion of advanced technical information. The Institution branches, generally depending on a small core group, and not without their difficulties, continue to provide an Institution presence throughout the country.

The Engineering Council is investigating how best to unify the engineering profession. An influential steering group has been set up to report to the Council of Presidents of the Institutions this year. IAgrE will contribute to those deliberations, and in that way make a contribution to the status and influence of professional engineers and engineering in the United Kingdom.

. . . in a changing world

On the other side we see an agricultural and horticultural industry facing economic hardship, the supply industries, and particularly engineering, suffering severe problems, and this is reflected in falling membership and the contributions that members are able to make to our activities.

The Institution, given the continuing support and enthusiasm of members, has the means to survive, prosper and expand, but it will not be easy.

The greatest strength of this Institution is the variety and breadth of experience of its members. We have among our members people highly qualified in most sectors of the engineering profession. We represent many skills and interests outside but related to engineering within the land based industries; we represent many levels of interest, from the wholly practical to the esoteric, we are concerned with primary production, manufacturing, retailing, teaching, research, and consultancy.

All of this gives us exceptional opportunities for exchange of information and professional support between members. It also gives us a splendid technical base from which to develop in many areas of opportunity for agricultural engineers. Among these are the care of the environment, food technology and food quality, and containing the cost of agricultural production. But it also means that the Institution has to be many things to many people, with all the vulnerability that entails.

The part we must play

One might ask why an Institution with more than 50 successful years behind it should have anything to fear from its own particular character and constitution. The fact is that we and the world have moved on.

During the lifetime of the Institution training in agricultural engineering in Britain has developed from virtually nothing to the wide-ranging and internationally renowned facilities that we have available today. The Institution and individual Institution members have played a leading role in these developments.

The continuing part that Institution members can and must play arises from the fact that young people graduating from the various Universities and Colleges need guidance, work opportunities, and further training to progress to full professional status.

This is a vital role of comparatively recent origin, and we need to guard it carefully, because, if we fail the very people who will in the future represent the technical and professional excellence in agricultural engineering, they will focus their attention elsewhere.

continued opposite

What we must do – and are doing

The Institution has to provide for 3 main functions:

The Professional Status function:
We must attract and retain the people who lead the profession, and registration at all levels, chartered engineer, incorporated engineer, and engineering technician is vitally important.

Our approach to members' registration, continuing professional development and work experience must be whole hearted. Our contribution to the discussions in Engineering Council on raising the status of professional engineers must continue.

A major reason for joining the Institution has always been the opportunity for professional recognition and professional qualification. This will certainly assume greater importance as the single European market evolves.

The Learned Society function:
Our Journal carries papers of high calibre covering a wide range of topics which reflect the diversity of interests among members. In fact papers have been contributed by all the outstanding figures in agricultural engineering in our time. I have used some of these papers as standard reference material throughout my working life. The papers I have picked out for personal use are those applying to my particular interest, which brings us to the fact that the success of the Learned Society function depends strongly on small groups pursuing special interests. This is where our Special Interest organisation plays a vital role, and where its success is seen in good attendance at meetings and outstanding papers which attract Institution prizes.

The Discussion Society function:
Many of our members value meetings and excursions of a more general engineering or mechanisation nature. The attraction is very largely that it provides an overview of the industry and what is happening in the field and factory. This is often, but not essentially, the function of the branch meetings.

The difficulty that arises is that the subjects of the meetings may be less important to daily work, may be more of a social nature, and therefore may be given lower priority against other demands on members' time. This is to the detriment of the Institution, because the coming together of members who enjoy a common culture, often with their families for social as well as technical gatherings, adds real strength to our purpose.

A prospect of continuing strength and influence

Our major functions are being planned and pursued with present and future members in mind.

We have a new five year plan which comprehensively covers that requirement.

The Engineering Council are intent on a restructuring of the engineering profession, and in this IAgrE will play a part; but there will be no enforced amalgamations or takeovers.

EurAgEng should develop rapidly and strengthen the learned society activity.

Our own branches and specialist groups will continue with their excellent work.

The Institution can and will prosper.

The Forestry Engineering Specialist Group

Civil and Mechanical Engineers working in forestry are joining the Institution of Agricultural Engineers' Forestry Engineering Group in the sure knowledge that it is their true professional home.

Other major production forestry countries have Forest Engineers in senior management which accords with general business practice where the major budget holders have the greatest executive power. A Forest Engineer should be one-third Engineer, one-third Forester and one-third Manager; a mixture very hard to find. However, with the Specialist Group now in existence and having a distinguished membership of well over 100 already, the necessary steps will be taken to ensure a training system to produce this required mix.

The Group was inaugurated on 15 March 1989 and a Committee was formed to represent every aspect of the industry. Our aims are summarised:–

"To represent the interests of, and form liaisons with, all individual professionals in forestry."

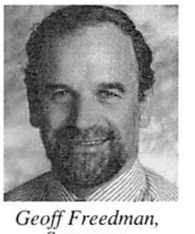
To achieve this we have created a forum for forest engineers to meet and encourage them to download their knowledge. This forum has become the standard professional one of evening meetings, day outings and publishing papers. To add to this we have held annual Symposia on special subjects and these paying events have helped finance the Group's activities*.

Forthcoming Symposia

Our extensive programme for 1992 has been well advertised but I make special mention of the two paying Symposia planned for the next 12 months.

In September 1992 "Harvesting Machinery Equipment – Can It Work, Can It Pay?" is designed to encourage the attendance of forestry harvesting contractors.

In the future, most harvesting will be carried out by small contractors so the professionals managing forestry need to understand how they operate and in that way tailor contracts and work methods to produce an efficient industry.



Geoff Freedman, Secretary, Forestry Engineering Specialist Group

In 1993 – 22 March – we are planning a Symposium on "Low cost roads in Britain" at Heriot Watt University. This will be more of a course than a conference, covering the full range of topics on the subject from planning and design to construction and will include bridges. Participants will be issued with a set of papers which should collectively become a code on low cost roads. Speakers confirmed to date are mainly in the forestry industry. We shall be pleased to consider relevant papers from other fields.

Further members welcome

It is our hope that these activities will swell our ranks and encourage Members to take a share of the Committee work. This is something which we need at the moment so please contact me if you can help.

*In fact this year some funds deriving from earlier successful conferences are being donated to a forestry student to finance his research into a mechanised tree planting machine for lowland forestry. It is hoped this 'research grant' can be sustained in the future as an aid to the profession and as a recruitment device at student level.

Agricultural challenges – the alternatives

Colin Spedding

Keynote address to the Annual Convention of the Institution, May 1992.

The Agricultural Industry cannot easily be defined or described any longer, because it is highly integrated with other industries and other parts of society.

At the very least, we must mean the agricultural and food industry, since such a high proportion of the products of farming are now processed (Table 1) but, just as the input and service industries to farming have long been seen as integral to the agricultural industry, so it is now necessary to take account of the input and service components of the food industry. The added complexity is immediately apparent, in terms of machinery, packaging, distribution and a host of other sectors, many with no connection with agriculture at all. Furthermore, the food industry does not necessarily depend upon UK farming for its sources, any more than the consumer necessarily has to consume products of the UK food industry. Indeed, we are being constantly reminded that the biggest contributor (40%) to the current trade deficit is represented by the £6 bn attributable to food and drink. The size of the industry is correspondingly large, in both absolute and relative terms (Tables 2 and 3).

Table 1. Proportions of UK agricultural products that are processed.

Farm gate product	*Percent processed*[1]	*Examples of processed product*
Raw cows' milk	97[2]	Pasteurised or sterilised liquid milk, yoghurt, cheese, butter
Sugar beet roots	100	Sugar, molasses and pulp
Cereals	100	Flour, breakfast food and malt
Live animals for slaughter	100	Carcase meat, cooked, cured and smoked meats, pies
Raw potatoes	51[2,3]	Canned, crisped, dehydrated and frozen

Notes: 1. In addition to transporting and marketing.
2. 1979/80.
3. The remaining 49% will be cooked before consumption.

Source: Spedding (1989)

Impact on the environment

A comprehensive and detailed account of the state of this industry would clearly require more space than is available to me: I therefore aim only to illustrate the key features.

The contributions of the main sectors to output in monetary terms (Table 2) is one way of judging their importance.

Table 2. The value of UK agricultural products (1986).

	£m
Total farm crops	3,312
Total horticulture	1,309
Total livestock	4,224
Total livestock products	3,056
Own account capital formation	108
Total output	12,009

Table 3. Agriculture's turnover compared to that of other industries (1984/85).

	£ billion
National Coal Board	4.8
British Steel	3.7
British Rail	2.8
British Shipbuilding	0.9
National Bus Company	0.4
Total above	12.6
Agriculture	12.0

However, in terms of impact on the environment, such a simple comparison will not serve. Farming occupies some 80% of the UK land surface and thus dominates the landscape and a large part of the natural environment, its flora and its fauna. Its activities are therefore widespread and the agro-chemicals it uses may affect other parts of the environment, such as rivers and aquifers.

The impact of the food industry on the environment is quite different, accounting for a much larger proportion of the UK fossil fuel consumption, for example (Table 4). Food is both a major export and a major import, sometimes of the same product (eg rabbit meat). Total exports of food and drink from the UK in 1990 were £6,334m; but imports amounted to £12,299m in the same period.

Table 4. An example of support energy use (MJ) in the UK agricultural and food industry.

Process	*Support energy, MJ for a 1 kg loaf*
Production on farm	4.02
Processing	15.99
Packaging, etc.	0.71
Total	20.72

Source: Spedding (1989)

Animal production is a dominant part of the industry, occupying at least the two thirds of the UK that is in grassland and consuming about one third of UK cereal production.

Professor C R W Spedding, CBE, DSc, retired from Reading University in September 1990, having been Professor of Agricultural Systems for 15 years. During this period he also served as Director of the Centre for Agricultural Strategy, Dean of the Faculty of Agriculture and Food, and Pro-Vice Chancellor at different times. Professor Spedding maintains an active interest in a large number of committees and enterprises in agriculture.

Economic pressures and public concern

Public concern about animal welfare illustrates (a) another way in which agriculture now affects society and (b) why agriculture cannot be satisfactorily viewed in isolation. Because of the importance of the animal production sector, the impact of any marked change in consumption patterns (for example, towards vegetarianism) would be considerable (Spedding, 1990).

Public concerns of this kind are likely to have a dominant effect on the future shape of Agriculture.

Since the 1940-45 war, however, its shape and structure have been determined by the economic pressures of the Common Agricultural Policy (CAP), largely in terms of stable prices and guaranteed markets. These provided the incentives for the post-war increases in food production which have run into the surpluses bought into intervention, incurring additional costs of storage and disposal.

In the UK, the CAP support has resulted in increases in average farm and herd size, decreases in the numbers of farms, farmers and farm workers, rapid uptake of production technology, and increases in the value of land and of input costs. All this has resulted in a high cost structure and much land bought at high prices on borrowed money.

In the last decade, producer prices have declined by around 25% (when account is taken of inflation) and borrowed money has incurred high interest charges, whilst the value of the land has fallen substantially (see Fig 1).

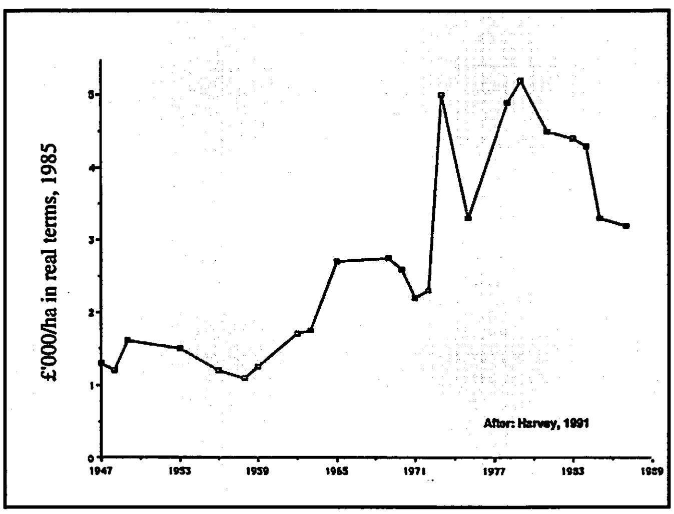


Fig. 1 Changes in the value of land.

Farmers' incomes have fallen greatly in real terms and the impact has been, and is, very much more severe on those who are heavily indebted (see Fig 2).

Power of the multiple retailers

The food industry has also embraced new technology and has become dominated by quite a small number of very large companies. Multiple retailers are now extremely powerful, relative to producers, but are exposed to fierce competition amongst themselves.

Farms have tended to be much larger in the UK than in other EC countries and the development of co-operatives has been poor. The power of the retailers to set and demand production and quality standards could be a force for good. However, competition between retailers can cause these standards to change in a rather volatile manner, to suit purchasers' preferences and fashionable trends, that can severely disadvantage producers, who cannot change their products or methods overnight.

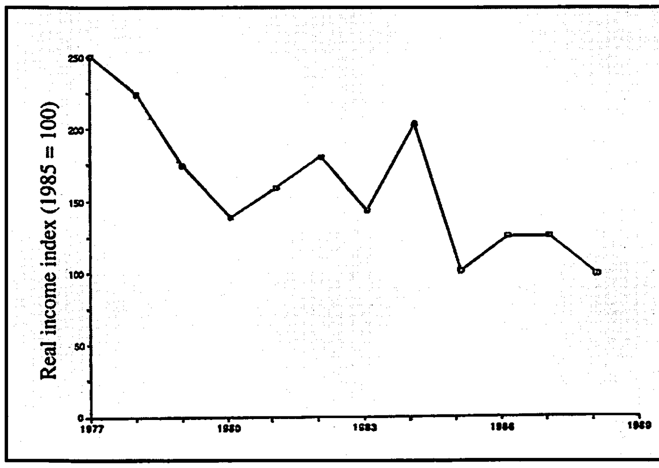


Fig 2. Change in real farm income, 1977-1986.
(based on Byrne and Ravenscroft, 1990)

This is particularly so for most forms of animal production but also applies, for example, to top fruit growers. This vulnerability to demand is now a major feature of farming and comes as something of a shock compared with the post-war years when virtually everything that was produced could be sold at a reasonable price.

Alarm at prospect of changes to CAP

Not that **all** commodities have been supported and it is important to remember that some sectors have received virtually no subsidies (Fig 3).

For those sectors that have been supported, the prospect of changes to the CAP are alarming. It is widely assumed that prices will have to be reduced and there are sound arguments that agriculture would be a healthier industry if it was obliged to respond to market forces. Eventually, it is argued, a lower cost structure would prevail and prices might then be adequate to sustain farmers' incomes, provided that all countries behaved in a similar manner.

This is small comfort to farmers, particularly those that are heavily indebted, who may not survive the transition period.

Although it is recognised that farmers and farming contribute to the management of the countryside – indeed there is no other means of doing so on the necessary scale – it is generally felt that positive payments for environmental benefits should be kept separate and not allowed to distort agricultural production.

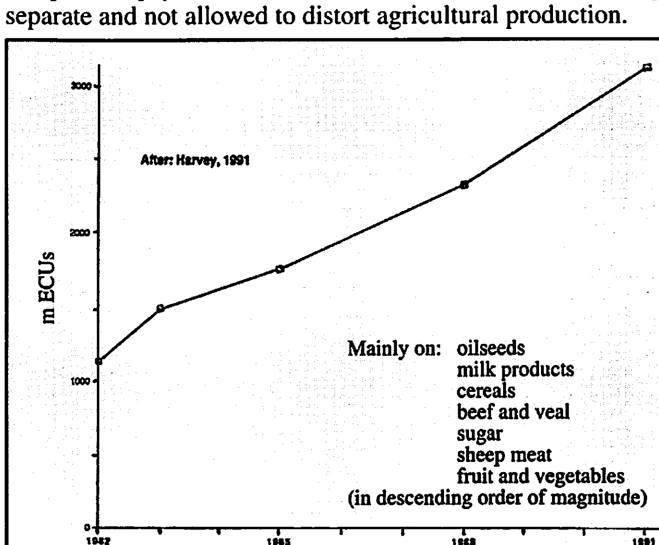


Fig 3. CAP support from EC budget.

However, this is not a simple matter and it is important that rural, environmental and agricultural policies are not working against each other.

It might be thought to be a little odd that the agricultural industry should see itself as almost inevitably set to decline, in size, value and importance, against a background of considerable existing and future potential (Table 5).

Table 5. Existing and future potential for the UK food and agriculture industry.

Existing:	Net balance of imports over exports	£6 bn
	Potential for import substitution	£3.5-4 bn
	Management of at least 70% of the land area	
Future:	Potential for non-food production	
	(a) animal fibre	
	(b) energy fuel crops	
	(c) trees	
	(d) raw materials for industry	

The problem, of course, is that such new developments require fresh investment and this requires both financial resources and confidence, both currently in short supply.

It is therefore necessary to distinguish between future prospects for existing farmers and the prospects for Agriculture.

Future prospects

If the price of land continues to decline – which seems likely for land other than that of top quality or with some development potential – it will be possible for 'new' farmers (without debts) to enter the industry.

New, lower-cost, enterprises may then be possible but also the production of raw materials for industry (including cereals) and fuel crops could become economic.

However, the over-riding constraints on future developments are likely to be major public concerns about:–

- Food safety and quality;
- Environmental impact;
- Animal welfare;
- Sustainable land use.

Food safety and quality

Unfortunately, food safety can be jeopardised at any point in the food chain, including the kitchen and up to the point of consumption. Concerns about food safety will affect the food industry in all its procedures, of processing, preserving, handling, packaging, storage, distribution and retailing. The conditions under which food is kept, the additives introduced, the packaging employed and the ways in which it is displayed, will all be increasingly controlled by legislation.

On the farm, concerns are likely to focus on the use of agrochemicals, both in production and storage, largely in terms of the possibility that dangerous residues could remain in the product.

There may be some conflict here with the pressure to maintain appearance and improve quality, although quality is tending to be defined increasingly in terms of production method.

Environmental impact

Concerns here largely relate to agricultural practices, including the use of agrochemicals (because of their effects on wild flora and fauna), but include physical alterations to trees, hedges, field size and cropping patterns.

There are worries about conservation (of species, landscape, habitats) and the possible effects of pollution on water-courses (for river life) and water sources (for human consumption). Specifically, concern centres on nitrate pollution and the more persistent pesticides and herbicides.

Environmental impact of the food industry may be local (especially pollution) or global (see later section on sustainable land use).

Animal welfare

Concerns about animal welfare (see panel) grow stronger all the time and can lead to changes in demand and/or changes in legislation.

Both raise worries about damage to the competitiveness of UK livestock farmers relative to imports from other countries with lower standards, less pressure and less policing of whatever standards obtain.

Most of the concerned public tend to associate animal welfare problems with intensive methods of production, especially battery cages for hens and close confinement of sows.

The main concerns about animal welfare

1. Close confinement	7. Very early weaning
2. Overcrowding	8. Bullying
3. Intensive feeding	9. Lack of shelter
4. Lack of food or water	10. Bleak environment
5. Lack of attention to health	11. Mutilations
6. Physical ill-treatment	12. 'Unnatural' processes

Extensive methods can, however, also give rise to problems, especially of poor nutrition and disease, sometimes of lack of shelter.

Table 6. Number of animals forecast to be slaughtered in the UK (1991-92)

Stock	*'000 head*
Cattle	3,042
Calves	60
Sheep	19,417
Pigs	13,737

Source: MLC (1991)

There is also great concern about the handling of livestock, in transport and at markets, and about methods of slaughter. The sheer scale of animal slaughtering for food (Table 6) illustrates the difficulty of devising satisfactory methods.

Sustainable land use

It is not always clear what is meant by 'sustainable' but it generally implies that an activity can be maintained in the long term, without intolerable damage to the environment, the people involved, the capacity of the soil, the resources available and the prospects of future generations.

In the food industry, the main problem is probably seen as excessive dependence on 'support' energy, that derived from previous solar radiation in the form of fossil fuels, such as coal, oil and gas. The burning of such fuels releases large quantities of additional CO_2, a 'greenhouse' gas thought to contribute to global warming. Dependence on 'support' energy is not sustainable, therefore, since fossil fuels are not a 'renewable' resource (on any relevant time-scale), but may also not be sustainable due to consequent changes to the global climate.

(concluded at foot of next page)

The role of the conventional tractor

Acknowledging that the world is currently in a severe recession, Alec McKee looks at history and points out how past recessions have been followed by periods of expansion and development. He identifies key steps in tractor development and although recognising there will be some 'niche' markets he suggests the bulk of demand will continue to be for a 'conventional' tractor, incorporating new technology but still capable of general purpose work on a long-life basis world wide.

Before setting out on any journey, either real or a gaze into the future, it is as well to know from where you are starting and in some instances how you got here in the first place.

I think it is fair to say that today we are in as severe an economic recession as many of us can remember.

In the last 150 years there have been four recessions which have affected agriculture but in the periods between the recessions there has been growth and development. Firstly, we saw the introduction of tractors, then their more widespread manufacture. A further spur to development brought us the hydraulic lift and the rubber tyre; whilst the umbrella of guaranteed prices for agreed farming outputs provided machinery suppliers with an unprecedented market to supplement export sales and product development.

More recently, the 1976 legislation on the safety cab has been the greatest transformation of all. The strong, rugged frames of early cabs have given way to the operator's station of today. With noise levels down below the 80's, the comfort is there to enable a man to work a full day without being fatigued.

These factors, coupled with tax incentives in the form of capital allowances which ended in 1985, fuelled the desire for better technology and advancement in tractors. At \this point, however, it is interesting to note that to transmit maximum power, the configuration of the operator at the rear and big wheels at the back is still the same as in the original tractors such as the Froelich, the 1897 Harnsley-Akroyd and the Hart Parr of 1903.

Paper presented at the Institution's Scottish Branch Conference, 'Tractors for tomorrow', Edinburgh, February 1992.

A McKee is General Sales Manager, John Deere (UK) Ltd.

Delegates at the Scottish Branch Conference 'Tractors for tomorrow'

Design for life

Turning to the role of the tractor, I believe

continued from previous page

Farming also uses 'support' energy, though not as much and at least employs it in order to use a higher proportion of **current** solar radiation. If some of this were used as fuel (in the form of straw, digestion of wet foliage, vegetable oils or tree products), it could substitute for fossil fuels and thus confer a nett benefit.

In all of this, it has to be remembered that unimagined new sources of energy may yet be discovered, just as oil replaced wood (in developed countries) and nuclear power began to replace oil. This is, in fact, no more far-fetched a scenario than the use of solar radiation, which is not strictly renewable but is nonetheless, for practical purposes, inexhaustible.

Possible scenarios

Since all future possibilities could occur in countless combinations, the value of postulating specific scenarios is very limited.

However, there are clear indications that the whole industry should use more solar radiation and less support energy: certainly energy should not be wasted.

Recycling of resources using solar radiation would be of benefit.

Recognising that only technology which is economic will be applied, it is still wise to ensure that new technology is not dismissed because of **premature** economic assessment.

A change in the balance of production from food to non-food products could have beneficial effects by:–

(a) preserving agricultural production capacity that may be needed for food production at some time in the future;
(b) reducing overproduction of food by diverting resources to non-food production;
(c) contributing directly to energy supplies from renewable resources;
(d) increasing the total market for agricultural products by diversification;
(e) offering less intensive animal production by combination in agroforestry systems.

Whatever systems are devised, they will have to be economically and energetically efficient, probably within a lower-cost framework, and they will have to satisfy the public concerns referred to earlier.

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one cannot consider the tractor in just a UK scenario. Any company or engineer who fails to understand the complete life cycle of its product could end up meeting a sticky end.

A tractor, on average, can easily have a useful working life of 20 years – many longer – though some, through benign neglect, shorter. Very few buyers of new tractors will keep the machine until it is eventually scrapped. Large farmers will often trade out after 2-3 years, some will keep machines longer, say 5-8 years, but today these latter users may find the cost difference between their trade-in and a new machine too great. Hence, there is a demand created for recent vintage used machines.

Table 1. Western European tractor market.

1980	*1985*	*1990*	*1991*	*1995*	*2000*
297,269	241,374	200,087	180,000	175,000	150,000

What is often neglected is the enormous demand in less developed countries – such as Turkey, Mexico and Korea – for used tractors (often units where the cab can be removed without impairing the use of the tractor). In such environments air conditioning can also be a liability as the expertise to maintain it is lacking.

Beware the limited-life 'niche' market

One is often encouraged to develop a niche market opportunity from an identified need for the most progressive innovations but if the product cannot be traded out after 2-3 years at an economic value, then that need is soon filled with a product that does maintain a higher market value.

The articulated tractor is a good example of this. In the early 80's we sold up to 20 units a year but as farmers had to gear up their whole operation, very few could make economic use of these units. After 4-5 years they had very little value as no one else in the UK wanted them – the French market was soon saturated and many were re-exported to the United States at great cost. Most of the farmers are now using conventional 180-200 HP machines which do have a ready second-hand market.

However, in marketing there is only one constant – change. So, while that experience held true 10 years ago, it may be different in the next 10 years – who knows what possibilities Eastern Europe will hold.

How many tractors will be needed?

We also need to consider how many tractors are sold and to try and predict what the market is.

Sales of farm wheeled tractors in the Western World in 1951 were 805,000. This dropped dramatically in 1956 to 588,000. It bumped along but began to rise in 1972 with the introduction of quality cabs. The market peaked in 1979 and has since dropped and is now, once again, down at 650,000 levels.

These 650,000 annual sales cover everything from 16 HP right up to 400 HP and obviously the application of these units is as wide and variable as the HP differences.

In 1987, the top 13 free world countries accounted for 81% of all tractors – which gives an indication as to where manufacturers should be aiming their development of potential new machines. This also reinforces the potential market for used tractors throughout the remaining world once they are traded.

Since 1979 the market for tractors in the US has dropped from 223,000 to a fairly static 120,000 units per annum. However, this market is now considered to have bottomed out and may rise slightly by the year 2000.

In Western Europe, while the market has, like the rest of the world, declined since 1979 it has not done so as quickly and stands at around 180,000 for 1991. The CAP reforms are not yet implemented and so one can argue that the market will continue to decline. I believe the ultimate drop will be similar to the United States but over a longer period. Hence, by the year 2000, the European market as we know it today, is likely to be in the region of 150,000 (Table 1). However, don't forget the 350,000 in today's Eastern Europe.

It is felt that in the old Western World the number will continue to decline and I would predict less than 600,000 in the next 5 years. This prediction is influenced also by certain important suppositions:–

- no major restructuring of agricultural trade through the present GATT negotiations will occur for at least 5 years;
- in the second half of the decade income and population increases and resolution of third world debt problems will allow domestic and world demand to rise sufficiently enough to draw down carryover stocks;
- at best through 1995 farm income will be protected through deficiency payments.

The UK picture

Having reviewed the world and European scenario, one now needs to review how the UK fits into this picture.

– the total market

According to the latest MAFF figures we have 512,540 tractors in the UK (Table 2). However, many of these, if they are all there, are unregistered. The number of tractors actually registered is 253,000. We would argue that the real figure may be somewhere in between, at around 300,000. Furthermore, as can be deduced from the published figures of tractor registrations, Table 3, sales of new tractors over the last few years in the UK have reduced dramatically. It would also be wrong to assume that all tractors registered actually end up in agriculture.

Table 2. Tractors in the UK

England	352,530
Wales	52,810
N.Ireland	47,450
Scotland	59,750
Total	512,540

When one compares the 15,230 machines 'sold' in the UK versus the 650,000 in the Western World (the UK a mere 2.4% of the total) you can perhaps understand the differing strategies of the various companies – as a niche market player or attempting to address the broader general market. Deere, as you will appreciate, is in the latter category.

– breakdown by HP sizes

Registrations are the key indicator used for the general state of the agricultural machinery sector. They give a fairly accurate position of retail sales for, barring the <50 HP sector, just about all new tractors will go on the road and thus be registered. You will note, Table 4, that only some 9% are <50 HP. We believe that the 0-50 HP sector is understated by approximately 50% as many units sold to golf courses, local authorities and horticulture are not registered. In comparison to 1984, this sector, contrary to a lot of belief, has also declined in units although it has increased in % of the total market.

Table 3. Tractor registrations, UK.

1982	25,078
1983	28,079
1984	25,892
1985	25,595
1986	19,453
1987	18,818
1988	22,866
1989	20,251
1990	18,573
1991	15,230

It is also likely that very few of the <50 HP tractors are used in agriculture in its true sense, albeit they may have substituted not only lawn mowers but older 30-40 HP machines used in ground maintenance applications. Four wheel drive and, for mowing applications, hydrostatic drive, have proved highly efficient in negotiating obstacles. Their high degree of versatility has meant they can be used year round in avariety of jobs and applications. Conversions to liquid gas enable them to also be used in environmentally sensitive areas and they have replaced trucks in many applications.

The 51-70 HP sector shows the biggest drop in numbers. Again, many of the smaller tractors are being used in golf/local authority applications. Together with the smaller mixed farm, one often hears the desire for a cheaper stockman's tractor in the 60-70 HP sector and whether it is the lack of such a model which accounts for the dramatic fall in that sector or the availability of second-hand 70-90 HP units which meet that need more economically, obviously requires investigation.

The 71-80 HP sector remains strong as does the 81-90 HP sector, although there has been a drift upwards to the 91-100 HP sector. Sometimes one has to be a little careful in reading too much into these figures as a replacement tractor with a slight increase in HP can mean a higher recording in the next sector. What has been noticeable is the change from 4 cylinder units to 6 cylinder units in the 95-100 HP sector, although one does hear the demand for a good turbocharged 4 cylinder 100 HP unit.

It is interesting to note that for Europe the 41-70 HP category is more popular than in the UK and relates, we believe, to the average size of farms being so much smaller. Europe has a lesser demand for the 91-100 HP models but in the over 100 HP sector, the requirements seem similar, again reflecting a shift to larger farms at the top end of the scale.

Table 4. Tractor sales by HP category, Europe and UK.

Territory	*HP range*									
	0-40	*41-50*	*51-60*	*61-70*	*71-80*	*81-90*	*91-100*	*101-120*	*121-140*	*141+*
Europe	7.3	5.9	8.2	15.2	15.9	18.1	9.1	13.5	3.0	3.8
UK	6.2	2.7	3.8	6.1	20.6	17.2	24.5	11.0	3.2	4.8

Tractor usage

It is very difficult to generalise about the ultimate use but the level of loaders sold for the 50-80 HP segment is quite high, indicating that these tractors are used in a variety of applications.

We have found that approximately 66% of 70-90 HP tractors are used for light draft and PTO applications, ie secondary tillage, planting, spraying and harvesting forage crops. Average usage varies from around 500 hours in mainland Europe to 750 hours in the UK.

There is a transition of usage pattern at around 90 HP. These units are purchased basically for heavy tillage and heavy PTO work with average usage of 500-600 hours in Europe and 1000 hours in the UK.

Substantial export of used tractors

A startling statistic is the number of second-hand tractors which are exported from the UK. For many years it has been 50% of the number of new machines sold but more recently this has risen to as high as 70%. The statistics for these exports are provided by Customs & Excise so they should not be considered as totally accurate as the tariff codes can be reported incorrectly but at least they give a very good indication.

Farmland in the UK

In assessing the role of the tractor one must obviously also take account of the area of farmland, the crops being grown, the number of holdings of different sizes and any trends indicating long term changes in the situation.

According to MAFF we farm 18,553,000 hectares which is 76% of the total land and this is diminishing. Of this 18 million hectares, 12 million are crops and grass and 6.5 million are arable. There are 256,651 holdings, giving an average of 76.92 hectares per holding – the highest in Europe.

Fuller details are presented in Table 5 and you will note that in the category >300 ha there are 7673 holdings – 3% of the total – holding 32.6% of the total farmland. If you take away the large hill men the remainder are those who are capable of buying a large combine today.

Will the conventional tractor be substituted?

Such a distribution of farm sizes and sales by HP sectors shown previously, indicate the wide variety of needs for the various farm sectors and the problem for a manufacturer to develop a homogenous product to meet all requirements.

What is certain is that the bigger farmers will continue to request greater HP and flexibility to meet specific requirements, while the small-medium type farmer will want a tractor to meet a wider range of needs.

Table 5. Farm holdings in the UK.

	Size of holding, ha				
	50-99.9	100-199	200-299	>300	Total
No. of holdings	41,607	24,949	7,141	7,673	256,651
% of total	16.2	9.7	2.8	3.0	100
Area of holdings, '000 ha	2,945	3,444	1,717	6,055	18,553
% of total	15.9	18.6	9.3	32.6	100

The question behind the title of this paper is really, therefore, 'To what extent will the conventional tractor be substituted?'.

One could argue the conventional tractor has been substituting for other products and now these niche market machines are finding their own level again but they cannot be high volume as only the larger farmers can identify the economical need.

Let me illustrate that point with the telescopic four wheel drive loader. This machine, in agriculture, replaces the tractor and conventional loader or it is purchased as well as the tractor. It is fairly flexible in its material handling capabilities and for larger holdings can be justified.

The largest market for these products has been the UK followed by France. Other countries have not accepted them as readily for a variety of reasons, including safety.

It is estimated that there are 17,000 units in operation in the UK of whch 7,000 are in agriculture. At their peak 4,000 units were sold per annum but this has now dropped to just over 1,000 and is not predicted to increase.

One of the major reasons, I believe, for this is that under a certain size farmers cannot justify the economics of such a machine, hence, the second-hand value is reduced – original purchasers keep them longer – companies involved exit the market or have to be capable of running production lines down to 100 units per annum. So, while there will always be a demand for niche market products, the economic need for the conventional tractor will remain.

Predictions

Therefore, my predictions for the role of the tractor are as follows:–

- Economic aspects will have more and more influence on the purchasing decision due to reduced income;
- Power to weight ratio of tractors will continue to increase. If additional weight is required, then this will be added later;
- Methods of crop production and multi train implements will determine the change in the basic tractor layout;
- Engines will continue to be improved – diesel engine smoke emission regulations will result in virtually all engines being fitted with turbochargers; torque rises of 20% within the working range, together with good fuel consumption will be the norm;
- The ability to select a transmission speed exactly as required is still a major requirement. While the hydrostatic drive is acceptable in smaller units it is still not proven in the larger ones. Infinitely variable transmissions are a distinct possibility;
- There will be improved serviceability and the ability to limp home or continue operating if some of the electronic functions cease functioning;
- There will be improved reparability. The cost of a repair is often today the signal to replace a tractor. That will have to be improved so that a failure does not entail a week in the workshop.

Finally, I believe that both ecological and economic influences will play major roles in the development of tractors through the 90s and beyond. The successful manufacturer will identify the farmers' needs and be able to interpret and meet them at a price the farmer believes is economical.

In other words, engineers' ideas, marketing needs and economic reality will have to work together in harmony as they never have before.

Tractor developments

It is hoped to feature a paper by Dr Andy Scarlett in the next issue.

'The suspended rubber track tractor'

Developments in tractor transmissions

Karl Th. Renius

The transmission of a conventional tractor with rear axle and PTO drive covers about 25 to 30% of total tractor costs thus being the most important component. Costs are influenced more by the shift elements than by the number of speeds. The paper deals with a survey on practical needs for tractor transmissions and typical development trends from a Mid-European view. After decades of stagnation, the power shift principle is now gaining importance. Also upcoming are forward-reverse shuttles. Four recently introduced tractor transmissions are evaluated on this basis, advantages of a computer aided mapping system are demonstrated. Regarding the future, it is shown, that two specific concepts of infinitely variable transmissions could gain importance for the drive of agricultural standard tractors.

For conventional standard tractors with block concept, the component 'transmission' is usually defined as shown in Fig 1:– master clutch, basic speeds and ranges, differential, park brake, front wheel drive control and (output) shaft, service brakes, final drive and PTO gearbox. If the PTO clutch is positioned in the rear transmission housing, the engine power is independently available for hydraulic pumps. The brakes are positioned between differential and final drive, where the torque level is lower than near the rear wheels.

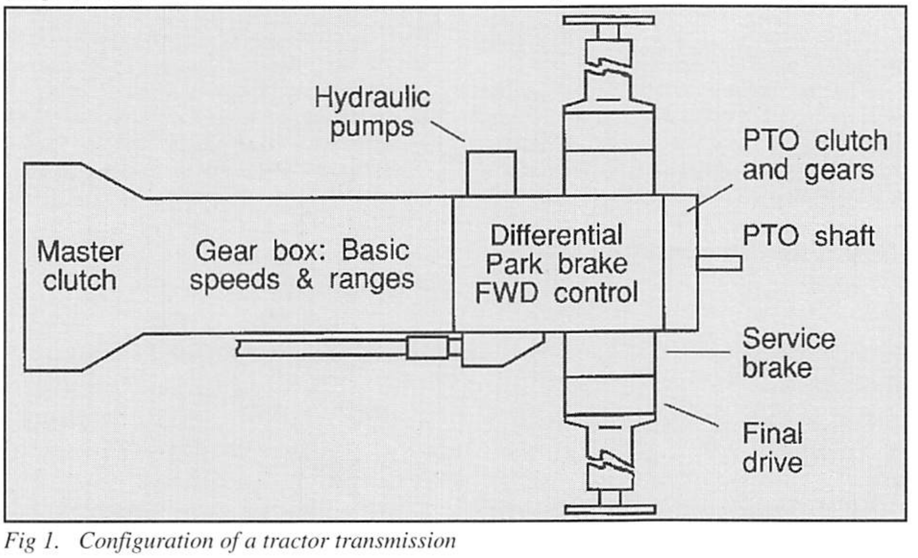

Fig 1. Configuration of a tractor transmission

A high proportion of total tractor cost

The so defined tractor transmission represents about 25 to 30% of the total tractor value, ie nearly twice the engine value. Investment for development and tooling of an entire new transmission is about £20m to £50m (depending on production volume and design complexity). The desired return on investment requires product life cycles of about 15 years and the freedom for design experiments is therefore strongly limited by economics.

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Paper presented at the Institution's Scottish Branch Conference 'Tractors for tomorrow', Edinburgh, 12 February 1992.

Basic requirements and trends

Typical practical tractor operations for West Germany are summarised in Fig 2 by time portions versus rated engine power. While the shares for transport and harvesting are widely independent from tractor size, the rest of about 60% is divided nearly diagonally into a 'utility' and a 'tillage' section with more than 50% time spent for tillage above 110 kW.

Regarding harvesting, West German farmers like to chop silage maize in backward operation – mainly three rows with at least 110 kW tractor power, demanding adequate reverse speeds. As 'reverser' concepts can also improve front end loading, headland manoeuvring and other operations, they are in increasing demand for all tractor sizes. Also big tractors are used for on-the-road transport – trucks are not popular because of tax paying and more stringent road traffic regulations.

Some practical transmission specifications are summarised in Table 1 by tractor size groups I, II and III. The highest function level can be seen for group II, which is also the most important one in the market. The comfort level is, however, steadily increasing with the tractor size.

Desirable speed ratios

Including the options, nominal tractor speeds are today covering a very wide span of about 0.5 to 40 km/h, representing a ratio of 1 to 80. Creeper speeds from about 0.5 to 1.5 km/h are for instance used for planting or

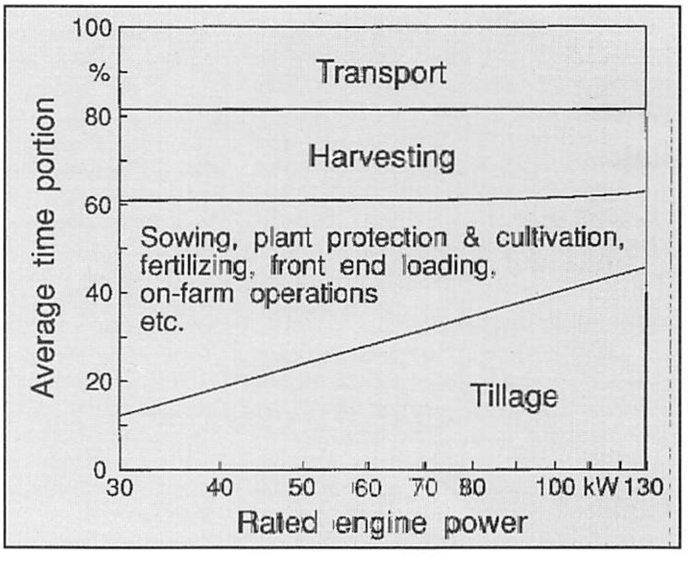

Fig 2. Tractor use in West Germany. (Estimation, excluding dairy farms, Renius 1987)

Table 1. Tractor transmission speeds (some examples).

Feature	*Tractor size group, kW*		
	I	*II*	*III*
	3 cyl, <50	*4/6 cyl, 45-85*	*6 cyl, >85*
Forward speeds[1], km/h	(0.5) 2.0–30 (40)	(0.5) 2.4-30 (40)	2.8–(30) 40
Reverse speeds, km/h	at least 3.5–12 (increasing demand for reversers)		
Comfort level	moderate	high	very high
Shift concept	——— from simple synchromesh to complex power shifts ——▶		
Number of speeds forward/reverse (standard versions)	21/6 Fendt 16/6 Deutz 12/4 MF, Fiat 8/8 Ford	21/21 Fendt 18/6 Deutz 16/12 Case 16/8 J Deere	15/4 J Deere 23/6 Case 18/9 Ford 18/18 Deutz-Same
PTO speeds[1] rpm	540+1000 (750)	540+1000 (750, 1250)	540+1000 (–)
shift	——— all speeds from one shaft ———		
clutch	dry clutch	——— wet clutch ———	

Note: 1. Optional speeds in brackets.

for municipal operations. Spacing of neighbouring speeds can best be evaluated by calculating 'speed ratios', also called 'speed steps'. An example is shown below:–

10 km/h 12 km/h

———————▶ 20% faster

16.7% slower ◀———————

Clear definition:– Speed ratio = 1.2
Practical demand:– 1.15 – 1.25
(over range 4 – 12 km/h)

The speed ratio of the neighbouring speeds 10 and 12 km/h is 1.2. A related value in % can create confusion, as it results downwards in 16.7%, but upwards in 20%. For the main working range between 4 and 12 km/h the speed ratio should figure 1.15 to 1.25 depending from tractor size and engine torque characteristics (1.25 only for Group I).

Top speed – 40 km/h quite adequate for time being

The maximum tractor speed has been increased in the past decades from 20 to 25 km/h (this was the first EEC approach) followed by 30 km/h (which is the present EEC level) with a breaking through to 40 km/h in the eighties (being now on EEC conference table). Tractors with 50 km/h (offered without any suspension by Schlüter) have not been successful. A suspended front axle could of course improve the driver's comfort and vehicle safety, to run 50 or even 60km/h – the extra costs are, however, very high due to the suspension and the increased standards of higher speed regulations.

Regarding farming economics, it must be considered, that a speed increase from 40 to 50km/h has much less productivity increase than the popular 30 to 40 km/h step. One of various reasons is related to the limited tractor power. A tractor-trailer-combination of, for instance, 30t mass needs for a speed of 50km/h and a slope of 5% a rated engine power of about 450 kW!

Because of such factors, many farmers are even disappointed with the performance at a speed of 40 km/h (mainly for the smaller tractors). Therefore many tractor companies do not exhaust the 40 km/h-limit designing the top speed for instance 37 or 38 km/h (40 km/h then only with engine above rated speed). This is the status over the last 10 years or so and will, in my opinion, also be valid for the near future.

Recent developments favour power shift

A second subject of much discussion is the principle of speed change on the go by the so called 'power shift'. It was first presented for tractors by International Harvester with the well known Torque Amplifier in 1954, but could not convince the farmer in many West European countries. As this attitude is changing, I have tried to analyse the pros and cons in Fig 3 with the result, that many criteria are today more in favour of the power shift than yesterday:–

- The desired shift comfort has increased;
- Productivity became more important with the power increase;
- Electronic drive line management is coming;
- Extra cost in % decreased with the power increase;
- Complexity problems have been solved better;
- Shiftability on the road has been improved;
- Extra power losses could be reduced.

pros	cons
■ Shift comfort field	■ Extra first cost
■ Productivity field	■ Complexity
■ Basis for electronic drive line management	■ Shift comfort road
	■ Power loss

Fig 3. Power shift evaluation.

A comfortable operation depends also on the number of shift levers, which should be as low as possible. Many improvements have been achieved in this subject by electro-hydraulic shift aids combined with synchronised shift elements.

Shift up, throttle down

Full load efficiency of a complete transmission from input shaft to the axle shafts should be at least 85% in the main working range of 4 to 12 km/h with a limited drop at higher speeds.

Fig 4 shows an efficiency map, which has been measured in my Institute by H. Reiter for a very popular Fendt transmission plotting lines of constant efficiency in the performance diagram of the engine. It was found, that the trend of these results is similar to engine efficiencies and it can be seen that the diagram looks a little like an OECD-engine map of the specific fuel consumption with best values in the same area.

The message for the farmer is that the 'shift up throttle down' role is not only saving fuel

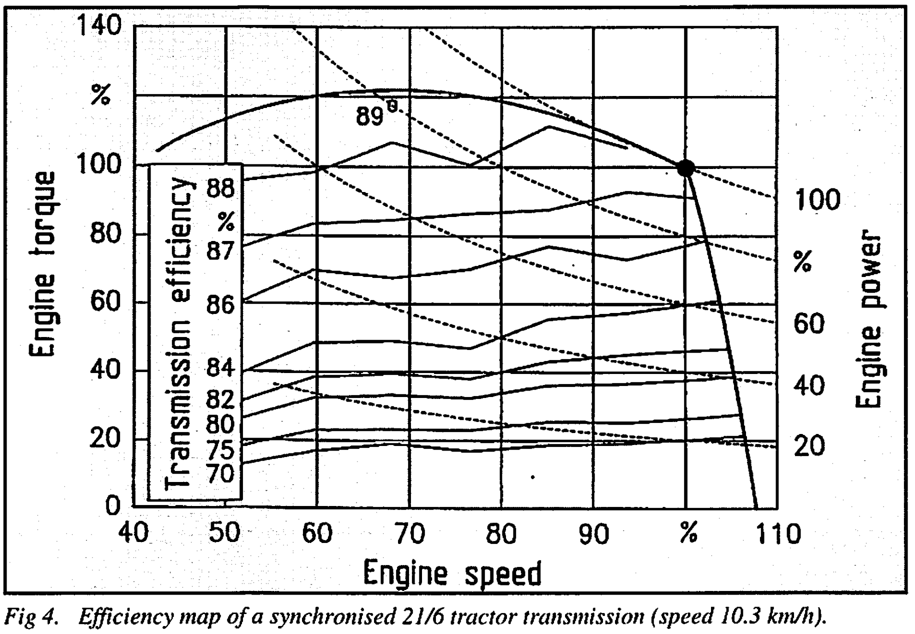

Fig 4. Efficiency map of a synchronised 21/6 tractor transmission (speed 10.3 km/h).

directly in the engine, but also indirectly in the transmission.

Coming back to Table 1 we see examples of the number of speeds (forward and reverse) offered in some popular tractors. The survey indicates that the figures are wide spread in group I and in a smaller band for II and III. Some agronomists have suggested to save first costs by reducing the number of speeds to a lower level for specific farming applications. This strategy is not promising as, for instance, halving the number of speeds by eliminating a synchronised Hi-Lo range or split shift result in a tractor price reduction of only about 1 or 1.5%. First costs are much more affected by the type of shift elements; comparing, for instance, synchronised shift with power shift. A transmission concept should therefore offer both shift versions, mainly in the most popular power range.

One or more PTO shafts?

The last section of Table 1 concerns PTO specifications with the typical West European demand of the 'all speeds from one shaft' – shifting two, three or even 4 speeds from inside the cab. This philosophy is completely contrary to the well known ISO-standard 500 (two speeds, two shafts) and has therefore been the subject of much discussion in recent years. Some health and safety personalities expected accidents due to over-speeding of implements – but nearly nothing happened due to the safety discipline of our farmers. Therefore experts are now working on the question, whether the ISO standard 500 could be adjusted to practical experience of Western Europe.

Computer aided transmission evaluation

A tractor transmission can be very complicated and difficult to evaluate. For comparing the practical requirements with the various offers on the tractor market, we developed a specific computer aided mapping system representing the transmission concept in a simplified way with the main functions. This can be demonstrated by an example.

Case-IH Maxxum

Fig 5 shows the computer output for the Case-IH 'Maxxum' tractor line, which offers in several aspects an interesting technical level. The engine drives a package of 4 pairs of gear wheels and 4 wet clutches giving 4 power shifted basic gears. Power is then passed via the forward-reverse clutches to the synchronised four ranges L, M_1, M_2 and H. Their shift comfort is supported by the central position of the master clutch, which is represented by the shuttle clutch package. This gearbox concept results in a four bar speed pattern, calculated and plotted in logarithmic scale for better readability and improved speed spacing evaluation.

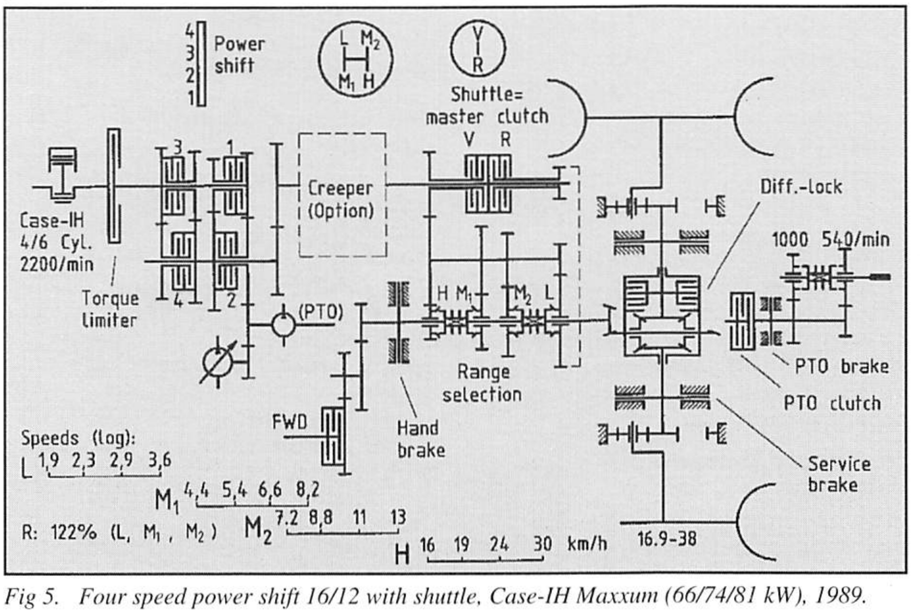

Fig 5. Four speed power shift 16/12 with shuttle, Case-IH Maxxum (66/74/81 kW), 1989.

The ratios of neighbouring speeds figure between about 1.21 and 1.24. If we compare these steps with the mentioned requirements (1.15 to 1.25), we must consider the overlapping of M_1 and M_2 offering the desired concentration of speeds in the main working range.

A certain compromise must, however, be seen in some 'two lever shifts', as the power shift and the range selection are operated independently. This can for instance be a disadvantage in the field, shifting from 6.6 to 7.2 km/h, or on the road with trailers from 13 to 16 km/h. A third lever activates the shuttle. A creeper range with a fourth lever can be ordered as option; 40 km/h-versions are realised by moving the complete speed pattern upwards with the disadvantage of raising also the four 'concentrated speeds' of 6.6, 7.2, 8.2 and 8.8 km/h.

The PTO uses a live shaft going through the complete gearbox and rear axle to the PTO clutch. The standard speeds are offered in two versions: shift by turning the shaft (for North America) and shift by a lever from inside the cab producing the two speeds at the same six spline shaft profile (for Europe). A special 'economy' PTO is not available, although offered by some other manufacturers. The rear PTO clutch position is, however, an excellent basis for driving hydraulic pumps with the live shaft – enabling short pipes and improved draft control dynamics and also providing space for a variable displacement pump to realise an energy saving hydraulic circuit.

Ford 40 with Electro-Shift

On the recent Agritechnica Exhibition end of November 1991 in Frankfurt, Ford presented the new tractor line '40' and also the completely new-designed Electro Shift transmission. This is available in two versions: a highly sophisticated concept with 4-speed power shift and four ranges a little similar to the mentioned Case configuration and a low cost 4 by 3 transmission with synchronised shift. Both versions have a synchronised reverser. Together with two versions for the hydraulic system, this philosophy results in a considerable price flexibility, which is, in my opinion, very adequate to the present farming situation.

Fig 6 shows the shift lever concept and speed pattern of the power shift version. The main shift lever 4+4 has two basic positions, which can be changed by synchronised shift

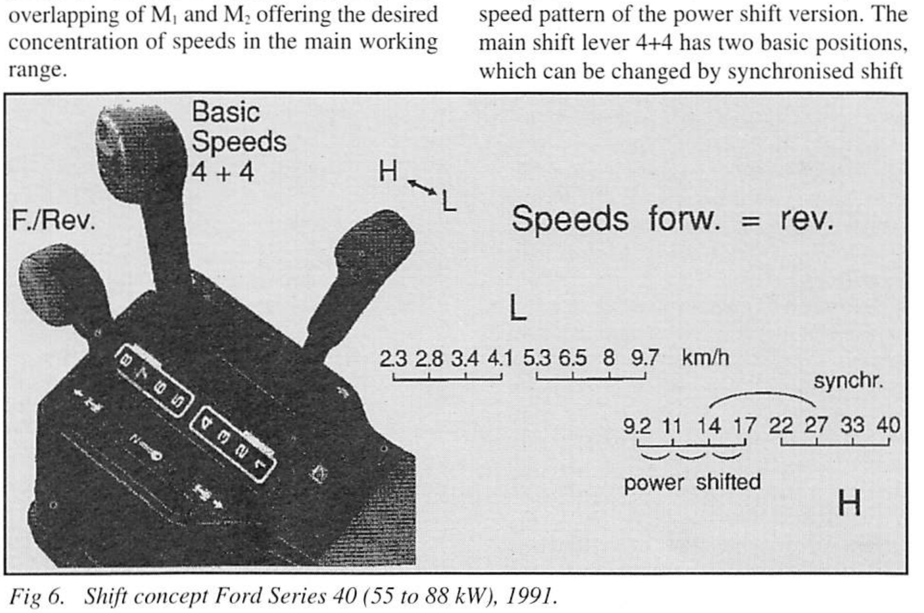

Fig 6. Shift concept Ford Series 40 (55 to 88 kW), 1991.

operating the clutch pedal. Four speeds are power shifted in each of the two positions by pressing 'up' or 'down' buttons. A special process has been developed for the shift between step 4 and 5: While the clutch pedal is operated for the range shift, the power shift is automatically returned to continue in the next speed. This is important for on-the-road operations, as indicated above. Versions with 30 and 40 km/h have the same speeds in the low range L. Also this transmission has no conventional dry master clutch. It uses two of the four wet power shift clutches for starting and range shifting. Main advantage is a longer clutch life. A typical design problem can be seen in the drag of the disengaged clutch due to oil films resting between the discs. Design improvements in this aspect should be evaluated by practical tests.

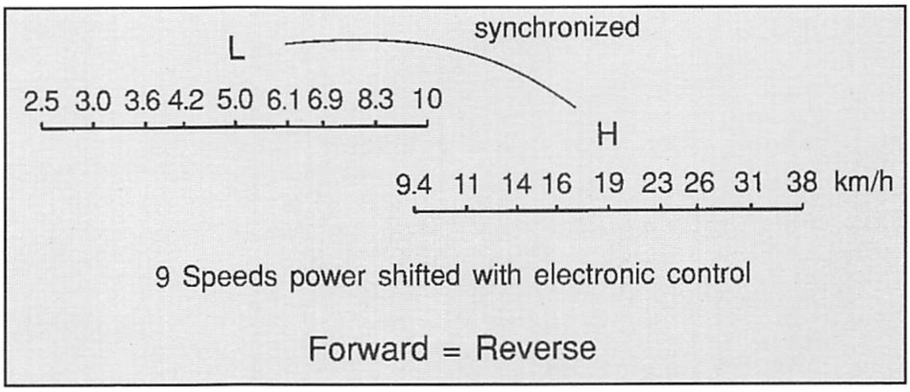

Fig 8. Same Power Shift (1992 for SLH and Deutz).

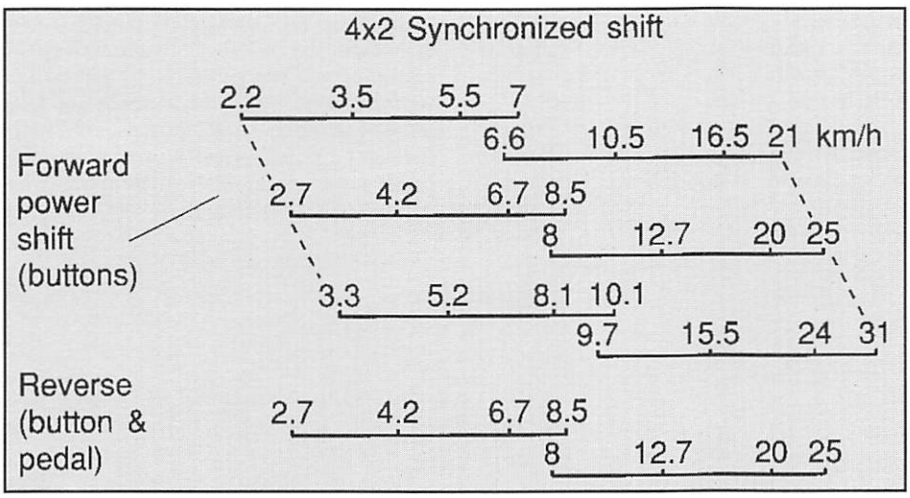

Fig 7. Renault 'Tracto Shift' (74–107 kW), 1991.

Renault 'Tracto Shift'

Another surprising presentation was the Renault Tracto Shift (24/8 speeds) at the SIMA '91 for the upper 6-cylinder tractor line '54' (74-107 kW), Fig 7. Three narrow spaced power shifted forward speeds and a button and clutch operated reverse range are combined with 4x2 = 8 conventional steps. The complete speed pattern offers a considerable speed concentration in the main working range as well as for high speeds.

In order to minimise extra cost for the power shift, only two wet clutches are applied using the so called 'dual clutch' principle: Shifting is always introduced automatically by a synchronised preselection of the desired ratio (within the power shift package), which is then activated by one of the two wet clutches.

The advantage of saving clutches is opposed by three typical characteristics: shift is a little slower, control a little more sophisticated and the lowest ratio works with as much as four loaded gear wheel contacts.

SLH and Deutz – new transmission

For the upper power range, an interesting new transmission had been announced at the end of 1990 by the SLH Group (Same-Lamborghini-Hürlimann), Fig 8. It consists of 9 power shifted basic speeds in two synchronised standard ranges with a synchronised forward-reverse shuttle and optional creeper speeds. A low cost version is restricted to only 3 power shifted speeds.

In November 1991, Deutz announced a co-operation with the SLH Group using the new transmission also for two Deutz models with 118 and 136 kW, which should be ready for production in the second half of 1992. This deal could become an interesting example for improving return on investment – remember the above mentioned £20m to £50m! On the other hand, the high value can make such a new transmission a trump card in company business and long term strategy.

Infinitely variable transmissions

Infinitely variable transmissions have today better chances than in the past because of the following tendencies:–

- Conventional transmissions have become more and more complicated;
- Infinitely variable units have been improved in efficiency and specific costs;
- Automatic drive line management can be realised best with stepless shift;
- Infinitely variable transmissions enable highest possible comfort levels.

Steel belt transmission

We have carried out various research projects in co-operation with tractor and trans-

Fig 9. The Munich Research Tractor with infinitely variable steel belt transmission.

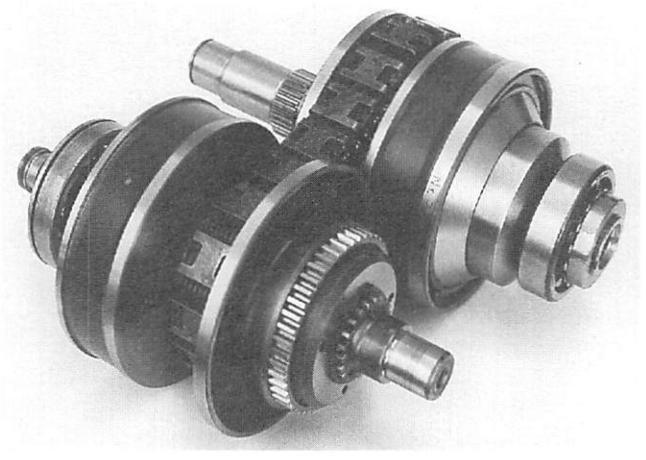

Fig 10. Steel belt transmission by Reimers, Germany.

mission companies over recent years. Fig 9 shows the 'Munich Research Tractor' with infinitely variable steel belt transmission, introduced in 1988 and encouraging Schlüter and Hurth to develop a commercial prototype which was shown at the Agritechnica exhibition November 1991.

The steel belt principle shown in Fig 10 (made by Reimers, a German company) could perhaps cover a power range up to about 70 kW. The unit itself including hydraulic circuit can achieve full load efficiencies above 90%, the complete transmission from engine to axles about 85% in the main working range.

The main research focus is on the dynamic behaviour under shock loads, on fatigue problems and a reliable power transfer control. Efficiency is also excellent at part load due to a torque sensor which enables a precise pressure control for the steel belt avoiding losses by unnecessary high pressure between the bevel discs and the belt.

Summarising all our experience, we see an interesting potential for this concept.

Hydrostatic transmission

For big tractors, the hydrostatic transmissions are again in discussion for some years. The small German company Horsch introduced for their very specific tractor concept in 1985 a hydrostatic 'Three wheel drive', Fig 11, of which about 80 units have now been built.A variable displacement swash plate pump feeds big radial piston wheel motors, shiftable for two constant displacements.

This concept can, however, not be considered for a general use in standard tractors because of poor efficiency, high costs and noise level. Similar reasons terminated years ago in the US the mass production of hydrostatic IH tractors.

Several approaches of recent years concentrate on efficiency improvements. Fendt introduced in 1987 for the upper line a hydrostatic drive 'Duospeed', which got its name from combination with the conventional transmission, Fig 12. Hydrostatic drive is powered by the front end of the engine crankshaft driving the counter-shaft of the basic gears enabling four infinitely variable ranges. This drive is popular for harvesting operations such as maize chopping in reverse operation, as the main power is transferred by the mechanical PTO drive. For heavy pulling operations, the hydrostatic drive can be disconnected completely from engine and transmission to prevent any kind of energy losses. This approach is, of course, expensive, but enables the tractor to operate like a self-propelled harvester.

A second possibility of combining hydrostatic and mechanical elements can be seen in the so called 'hydromechanical transmission'. The general objective of this approach is, to reduce the losses by splitting the power into a mechanical path (with excellent efficiency) and a hydrostatic path (with lower efficiency), then combining both again at output. Highly sophisticated concepts result in a full load efficiency comparable with that of a full power shift transmission. I think that technical solutions can also be found to solve the noise problems.

Finally the costs will decide which concept could be able to compete with the well known full power shift transmissions of John Deere, Case-IH and Ford.

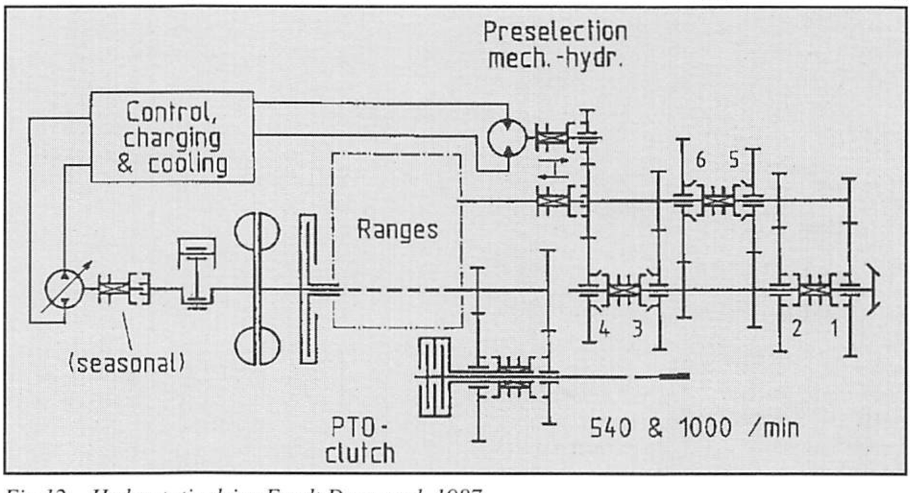

Fig 12. Hydrostatic drive Fendt Duospeed, 1987.

Fig 11. Horsch hydrostatic 'Three wheel drive' tractor.

A review of research into machine stability on slopes

Alastair Hunter

Stability problems arise with all types of machinery when used on sloping land. Overturning accidents cost time and money as well as causing injury and sometimes death. A full understanding of stability on slopes is needed in order to establish safe operating limits which can be accepted throughout the land-based industries.

Considerable research has been carried out worldwide into the behaviour of machinery on slopes, particularly related to agriculture and forestry. Analytical models for predicting static stability and comparing the stability of different types of machine are now well developed. Stability measurement in the field has been fully researched and is being standardised, while a number of models for predicting dynamic stability have also been developed. In this paper, Alastair Hunter reviews the research which has been carried out, describes the present state of development, and defines the direction of future needs.

Agricultural and forestry machinery is required to operate over terrain which can be very steep. Unlike roads, the natural contours of land can vary sharply, and surfaces can be rough and uneven.

In agriculture, the tractor is the most common self-propelled machine. Rough-terrain forklifts and all-terrain vehicles (ATVs) are increasingly used, and most farms have at least one 4x4 off-road vehicle. Trailed machines such as dung-spreaders and slurry tankers are common, and trailers are standard equipment. In forestry, most machines are self-propelled, including skidders, forwarders, harvesters and processors; while, in farm forestry, there is a range of tractor-mounted machines as well as trailed forwarders.

Thus, the range of machines which operate on steep land is very wide and there is great scope for accidents. Safe operating limits are easily exceeded. An overturning machine is dangerous for the driver, and causes unnecessary downtime with consequential loss of earnings. Preventing these accidents is everyone's responsibility from the machinery manufacturer right through to the driver in the field.

Through research, considerable progress has been made in understanding the nature of stability for different types of machine. The process of applying the results of this research to practical use in the form of a new written UK standard is now well advanced, and it is an appropriate time to review what has been achieved. A detailed review has already been published (Hunter, 1991) but this paper will highlight those areas of this work which are of most interest to the AE's readership.

Paper presented at the Symposium, 5 September 1991, of the Institution's Forestry Engineering Specialist Group.

A G M Hunter is Head of the Vehicle Behaviour Unit, Scottish Centre of Agricultural Engineering, Penicuik.

Table 1. Slope and stability limits.

Slope Degrees	%	Gradient	Description	*Unstable machine situation*
0	0		Flat	Tractor, cornering at high speed
5	9	1 in 11	Gentle	Tractor, cornering at full lock, eg with mounted mower
10	18	1 in 6	Medium	Tractor; with big round bale on front loader (tipping sideways). Articulated steer loader (some configurations)
15	27	1 in 4	Steep	Tractor, with heavy mounted sprayer (rearing). Silage trailer, full or unevenly loaded
20	36	1 in 3	Very steep	Trailed equipment, eg lime spreader, dung spreader, or slurry tanker (but less stable when part-full)
25	47	1 in 2	Excessive	Tractor, with standard wheel track
30	58		Extreme	Tractor, with wide wheel track. Transporter, and other specialist mountain machinery

Slope classification

Naturally occurring slopes are less steep than may be imagined. The geographer measures slope by angle above the horizontal and classes all values over 45° as precipitous (Young, 1972). Studies on three steep areas in the UK, in Devon, Wales, and the Pennines, reveal that the distribution of slope values is predominantly in the range 0° to 40°.

Practical limits to operating machinery are much lower than 40°. Schwanghart (1978) estimates the following values for different crops: sugarbeet 7°, potatoes 11°, cereals 14°, forage 17°, and grazing 24°. These limits depend on the machinery used and are

Table 2. Classification of tractor overturning accidents.

Cause of accident	*Equipment* trailed	mounted	none	nr.	*Total* no.	%
Stability loss						
– Slope exceeds tip angle	36	55	2	2	95	17[1]
– Speed high	24	22	10	–	56	10[1]
– Ground rough	12	18	4	–	34	6[1]
Control loss	69	42	12	2	125	22[1]
Driver's misjudgement	50	64	29	2	145	26
Miscellaneous	38	39	28	–	105[2]	19
Total	229	240	85	6	560	
%	41	43	15	1		

Notes: 1 Tractor limitations exceeded in 55% of total accidents.
2 Miscellaneous accidents included traffic accidents (28) and driverless tractors (37)
nr not recorded

Fig 1. Examples of hazards on a slope: (left) tractor rearing when attempting to accelerate uphill, (right) trailer tipping sideways as a result of slope, speed and ground roughness.

mainly related to traction limits for pulling harvesting equipment.

If machine stability is the main concern then a slope of 15° must be classed as steep, and a slope of 30° is extreme (Table 1). For illustration of what can occur, the table also gives some examples of instability but this is not intended to be a definitive list. It is important to realise that tractor overturning can occur on ground which is absolutely flat, for example when cornering at too high a speed. This occurrence is much more likely than for on-road vehicles where skidding occurs instead of overturning.

Accident conditions

Owen and Hunter (1983), studied 560 reported tractor overturning accidents on farms in the UK, and found that there were three main conditions leading directly to loss of stability, Table 2.

The conditions were:–

- exceeding the tip angle, ie exceeding the limit of static stability;
- travelling at too high a speed, and
- travelling over rough ground.

Loss of stability also occurred indirectly after loss of control, which represented a fourth condition; in which case the tractor slid or skidded downhill on sloping ground before overturning.

The four conditions, which accounted for 55% of total overturning accidents, were seen as exceeding the limitations of the tractor. Manufacturers had not provided guidelines on safe slope for any of the machines and therefore it was difficult for the driver to forestall any of these accidents. It was accepted that a number of accidents were caused by driver's misjudgement, for example when the tractor was driven into a ditch, but these amounted to only 26% of the total number.

Hazards on a slope are present when a tractor is travelling downhill, changing direction, crossing the slope, and climbing uphill (Fig 1). Sliding downhill will occur if the ground is too slippery for the tractor to remain under control; this is common on grass fields, and is also likely on loose surfaces. Skidding or overturning when cornering will occur at too high a speed. Sideways overturning will occur on steep slopes and on rough ground. Accelerating uphill will cause rearwards overturning or slipping, while with certain designs the machine will tip forwards when braking during a descent.

Static stability models

Computer models of stability are based on analysing the conditions for equilibrium of the machine on a slope. The static stability limit is commonly taken as the slope on which the load carried by one of the wheels has reduced to zero. This is often computed for the case when the machine faces along the contour line, but the stability limits when the machine is facing along other heading angles are also important. Reichmann (1972) carried out extensive analysis for a wide range of machines at all heading angles, and Spencer (1978) added control loss to the analysis.

The **static** model is ideal for comparison between different machines and provides useful reference information. A number of additional types of model have also been developed (Table 3), of which the simplest are the **quasi-static** models. These take into account constant speed cornering, and constant acceleration or deceleration. Like the fully static models, they predict values of slope where zero wheel load will occur.

Dynamic stability models

The **dynamic** models attempt to predict the conditions necessary for overturning. This is considerably more complex than predicting zero wheel load because it is also necessary to predict the motion of the machine while it lifts off the ground and passes through the point of balance. The simpler models are two-dimensional and consider a tractor rear wheel which is driven over a fixed obstacle such as a flat-topped or sinusoidal bump (eg Grecenko, 1983). The more general models are three-dimensional but still use a geometrical obstacle shape (eg Larson and

Table 3. Types of stability model.

Type	*Model*	*Source*
Static	Prediction of zero wheel load Static conditions Rigid wheels Plane slopes	Blankenship *et al* (1984); Hunter (1985); Reichmann (1972); Spencer (1978, 1988)
Quasi-static	Prediction of zero wheel load Steady state conditions Rigid wheels Plane slopes	Daskalov (1971); Grecenko (1983); McKibben (1927); Newland (1981)
Dynamic	Prediction of overturning Dynamic conditions Rigid/flexible wheels Surface roughness/obstacles on slopes	Daskalov (1971); Feng & Rehkugler (1986); Grecenko (1983); Larson & Liljedahl (1971) Pershing & Yoerger (1969)
Overturning	Dynamics of overturning Dynamic conditions Deformable wheels and tractor structure Deformable ground on banks/slopes	Chisholm (1981); Schwanghart (1978); Davis & Rehkugler (1974a,b)

Liljedahl, 1971). The criterion for overturning is normally whether the rotational kinetic energy of the machine is sufficient to tip it to the point of balance.

There are two main problems in obtaining a good dynamic model. The first is simulating the interaction between the vehicle tyres and the ground, and the second is predicting the behaviour of the whole vehicle in response to random ground inputs.

Table 4. Stability limits of some machines measured at the Scottish Centre of Agricultural Engineering 1988-89.

Machine	*Features*	*Track width, mm*	*Tip angle, deg*
Tractors of different types			
Two-wheel drive	no driver	1630	36
Four-wheel drive	no driver	1840	42
Equal axle weights	no driver	1630	20
Compact	no driver	940	34
	with driver	940	30
Compact (bucket and	bucket down	940	30
digger fitted)	bucket up	940	26
Articulated	steer straight	1020	33
Trailed machinery			
Dung spreader	full load	1700	26
Round baler	empty, door fully open	1910	30/25[1]
Bale transporter	full load, transport position	1620	19
	full load, elevated position	1620	16
Silage trailer	full load, normal wheel track	1780	20
	full load, extended track	2150	24
Other machinery			
Bucket loader	full load, bucket down	1912	32
	full load, bucket up	1912	19
Digger/bucket loader	empty, bucket down	1910	33
	empty, bucket up	1910	22
Forestry forwarder	full load	1960	28

Note: 1 Asymmetrical machine – tip values for left and right sides respect.

Computer models of tyres already exist, and they are standard elements in advanced commercial modelling packages such as DADS, but they are still limited by the availability of field data for real tyres on real ground. The random aspect of the motion necessitates a statistical approach, unlike the deterministic approach used for analysing motion over geometrical obstacles.

The **overturning** models have been principally used to optimise the design of safety cabs by investigating the impacts of the cab with the ground. Chisholm (1981), for example, was able to initiate overturning deliberately on a ramp and carried out full-scale experimental trials for validation of his computer models. The deflection of the cab was predicted, allowing for variations in the initial conditions and deformations of the ground surface.

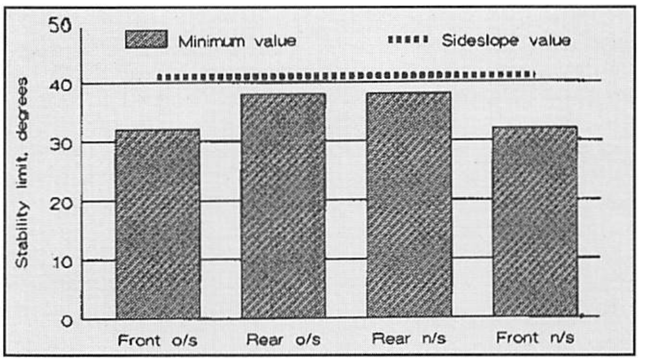

Fig 2. Minimum stability limits for individual tractor wheels compared with the stability limit on a sideslope.

Stability limits

– rigid machines

There are wide variations between the stability limits of different types and designs of machine. The typical two- or four-wheel drive tractor will tip on a sideslope of 36°, while extending the track width by 210 mm can increase this value to 42° (Table 4). By contrast, certain tractor designs, intended for heavy draught work but often used on steep farm and forest land, have the weight distributed equally between the front and rear axles and may have a stability limit of only 20°. Trailed machinery is generally less stable than the tractor, with most stability values in the range 20° to 30°. In some cases, least stability will occur at an intermediate operating position such as when the door is opened on a round baler, or when the frame is elevated on a bale transporter.

The 'walking beam' design of the front axle on tractors leads to distinctive stability characteristics. This is because the support points of the tractor body, at the front axle pivot and the two rear wheels, define a triangle not a rectangle. The minimum stability limits are when the tractor is facing diagonally, rather than directly along the contour line. Typical values for the separate wheels are compared with the sideslope value in Fig 2. In this example, the tractor faces 30° downhill from the contour line for minimum rear wheel stability, and 50° uphill from the contour line for minimum front wheel stability.

The designer also has the option of placing the pivoted axle at the rear of the vehicle instead of at the front; this is seen on combine harvesters, or on materials handling equipment where the aim is to position the fixed axle underneath the loader. The stability characteristics are similar to a 'tractor backwards'; one consequence is that the rear wheels are liable to come off the ground when travelling downhill or during braking.

– articulated machines

Many off-road vehicles such as materials handling machines, bucket loaders and dumper trucks, need to be highly manoeuvrable. This also applies to skidders, forwarders and harvesters used in the forest. A simple and effective way of providing manoeuvrability is with articulation in the vehicle body; steering is then achieved by steering the body rather than steering a set of wheels.

The four wheels can still be allowed to follow the contours of the ground by providing a pivoted axle or, in another case, a pivot between the two articulated halves of

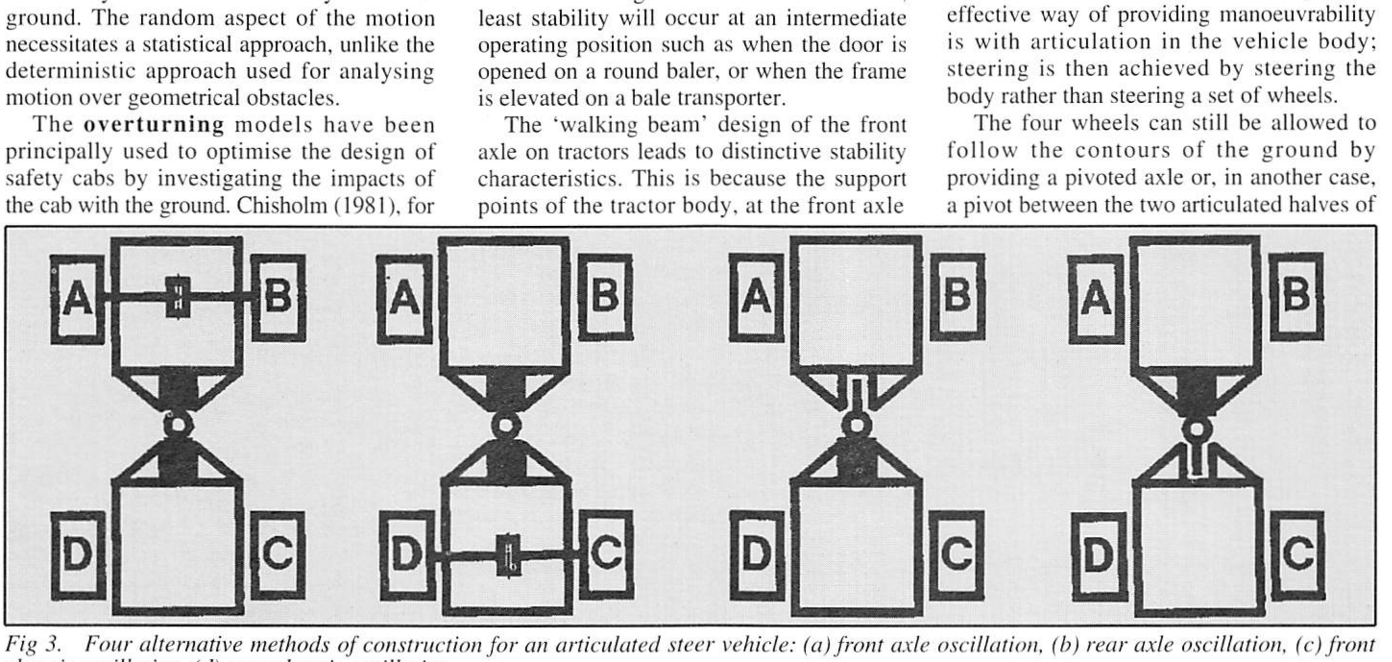

Fig 3. Four alternative methods of construction for an articulated steer vehicle: (a) front axle oscillation, (b) rear axle oscillation, (c) front chassis oscillation, (d) rear chassis oscillation.

the vehicle. To distinguish between them, these cases are known as axle oscillation and chassis oscillation respectively, although the latter is sometimes known as double articulation. The pivot can either be aligned with the front of the vehicle, or with the rear, giving rise to four alternative designs which are respectively known as front axle oscillation, rear axle oscillation, front chassis oscillation, and rear chassis oscillation, Fig 3.

– Loading and steering

One example is an articulated forwarder with chassis oscillation. Provided the steering is straight, it is unimportant whether the pivot is in the front or rear of the vehicle. The stability at all wheels is high, in excess of 39°, and the values at the nearside are equal to the values at the offside, due to symmetry (Fig 4). With a full load of timber, the stability is substantially reduced to almost exactly 26° at all wheels. During loading, however, with the loader extended to 5m, and a grab load of 1t, the stability at one of the wheels is reduced dramatically to only 4°.

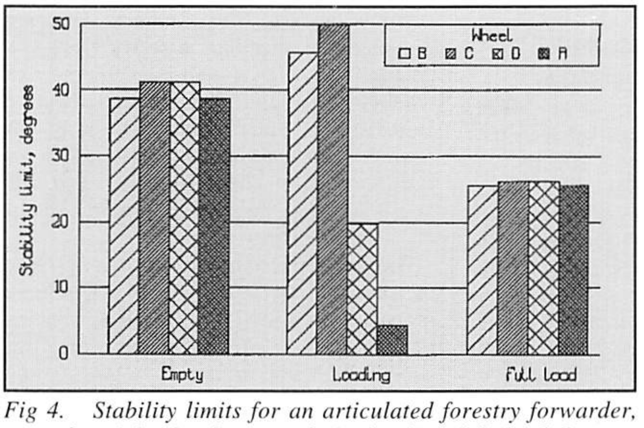

Fig 4. Stability limits for an articulated forestry forwarder, steered straight ahead; empty, during loading, fully loaded.

During steering, the geometry of the vehicle alters and symmetry is lost. With rear chassis oscillation, when the forwarder is empty and steered left to the maximum articulation angle of 50°, the stability *reduces* at three of the wheels by up to 12° and *increases* at the fourth wheel by 7° (Fig 5). With a full load, the stability of the offside front wheel falls as low as 13°; this occurs when the machine is travelling uphill and starting to turn onto a sideslope (Fig 6). With front chassis oscillation, the forwarder proves to be unstable both empty and full; the wheels which are unstable do not generally correspond to those with rear chassis oscillation, and it is even possible to find that one *rear* wheel is unstable when travelling *uphill.*

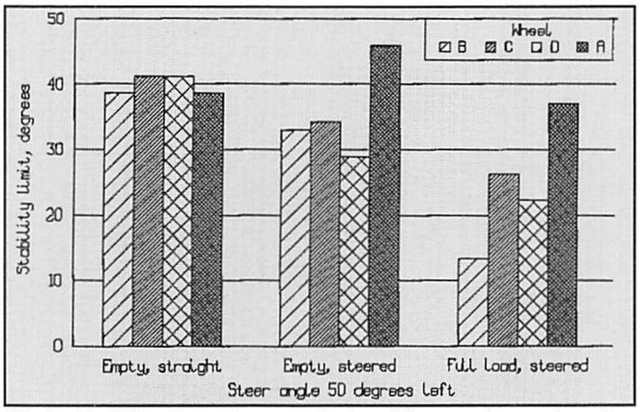

Fig 5. Stability limits for an articulated forestry forwarder when steered and loaded.

Assessing stability

– stability measurement

Static stability can be measured on a tilt table. A tilt table is expensive to install and, so far as is known, such testing is not required under official test procedures except in Norway. The OECD official test codes for tractors do provide for measuring the centre of gravity coordinates, which could be used for calculating stability, but the test is not used for machinery other than tractors.

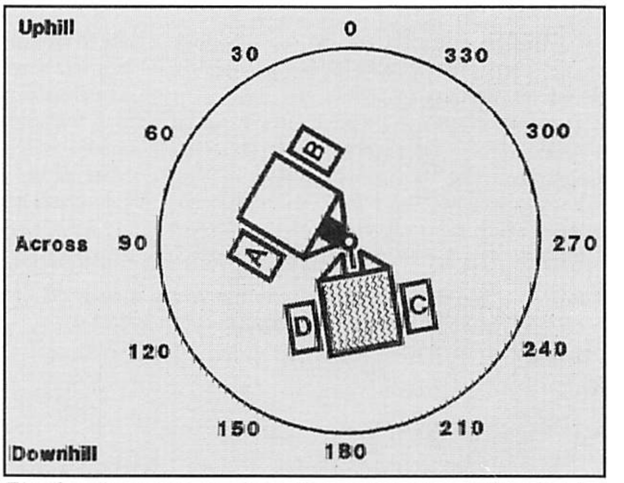

Fig 6. Diagram to show the orientation of the loaded forwarder when the front wheel is at minimum stability.

The new test of static stability (Owen *et al*, 1991) is now being drafted as a British Standard. The method does not require a tilt table, only portable weighpad equipment and an inclinometer. It is based on measuring weight transfer on a moderate slope and then predicting the slope angle where an uphill wheel will carry no load. Considerable experimental work was carried out to assess the accuracy of the method and to determine the optimum test procedure.

– dynamic conditions

Dynamic conditions normally degrade the stability of a machine relative to what is measured in a static test, but the limit of static stability does provide the basic reference value from which other limits may be calculated. The dynamic effects of cornering, acceleration, and deceleration, can be calculated directly in terms of adjustments to the static stability limit, provided these effects remain constant.

Dynamic tests have also been proposed in a number of countries, which involve driving the vehicle over an obstacle of a standard shape and noting the response. Inherently, these tests will take into account the effects of moment of inertia of the machine and behaviour of its suspension, which are not measured in static tests or quasi-static calculations.

As yet the tests are not in common use in any country, and there is an urgent need to determine their reproducibility before they can be standardised. Providing that the tests are realistic, for example that the standard obstacle is representative of obstacles on real terrain, the tests will provide a valuable guide to dynamic stability on comparable terrains.

– stability index

Testing the stability of machines leads to the concept of determining an index of stability for the machines. One proposal is that the index is a slope value, defined as the minimum slope on which a dynamic test causes the machine to tip halfway towards overturning. By this definition, the index also becomes a property of the machine and is therefore suitable for comparing stability between machines. For example, two apparently similar tractors can be compared, or two dissimilar machines which operate together such as a tractor and trailer.

A machine with a high stability index will be more stable than a machine with a low stability index. Thus, the index will be a valuable indicator of machines which are safer to use on slopes, and it can be used to propose maximum operating slopes for individual machines. However, the index will not in itself define a safe slope because it will always be possible to cause an overturn, even on level ground, by violent manoeuvres and harsh driving.

Conclusions

All overturning accidents are expensive and dangerous, from the trailer which tips onto its side and has to be righted to the tractor which goes into a multiple roll down a long slope. Serious damage to the tractor is secondary to the driver's injuries which may be fatal. It is because drivers lack information to determine the stability of their machines that research has continued to investigate where the limits lie.

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REVIEWS

Introduction to Agricultural Engineering (A problem solving approach) 2nd Ed by L O Roth and H L Field

Publ: Van Nostrand Reinhold, New York (1991) pp.346

As a first introduction to agricultural engineering problem solving particularly for students and improvers in developing countries this is a first class book. The structure of the work is excellent; each chapter starts with the educational objectives and an introduction which explains the place and importance of the topic to the agricultural system.

The topics dealt with vary from mechanics, and mensuration, to economics, hydrology and electricity. In each case they are considered in an easy to understand style with numerous examples to aid comprehension. The text is supported with clear diagrams and a good index.

It is sometimes a danger in this style of book that some topics may be over simplified. There are few instances where this is, in fact, the case, nevertheless I feel the work has mostly achieved a good balance. It is perhaps unfortunate that it uses entirely imperial units, otherwise, I have no hestitation in recommending this as a first primer for those wishing to improve their basic agricultural engineering problem solving skills.

MJH

Recruitment – are you doing your bit?

Barry Sheppard, Hon Editor

As well as the recession hitting journal copy, it is also having a severe effect on our level of membership. With more people leaving the profession than entering it, our membership was bound to suffer. However, it is crucial for the Institution, the industry and the country that we maintain standards in the profession and we will only do this by maintaining a viable, healthy and active Institution. I commented last time about the success of the relatively new Forestry Engineering Specialist Group and as you see from this issue, they are going from strength to strength in both activities and attracting new members. However, there are other areas within the Institution where we could do better and, as the retiring President, Doug Walker recently stated, if each of us recruited one new member this year what a difference it would make. I would only add that this is hardly an onerous task as I am certain that we all know at least one potential and eligible member.

Help find proposer and seconder

One recruitment procedure that always concerns me is that of finding a proposer and seconder for membership application. For the potential member who may be working as an individual or in a small company or indeed new to a larger company, it can be daunting to first, find someone who is a member, then ask them and someone else to be proposer and seconder. This is an item we must address in future, and be aware of when we are recruiting; i.e. don't just give a person a recruitment leaflet or membership application form, offer to propose them and help find a seconder too!

Why not affiliate?

As you will see on page 48, we now have eight organisations affiliated to the Institution. There are many more out there who would be eligible to affiliate and you probably work for one, so why not get your company to apply? For a nominal fee which is related to the size of the organisation, the Affiliate obtains a wide range of benefits including:–

- a nominated representative to conferences, meetings and other events;
- all publications and information sheets – access to technical information;
- entry fee discounts for fee paying events;
- use of the Institution Crest;
- free marketing of company literature at Institution events;
- acknowledgement in each issue of the journal and in displays;
- up to 25% discount on advertising.

By helping the Institution in this way, you will also be helping your company to participate more fully in and get more out of the profession.

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Theoretical determinations of stability have revealed the complex interaction of effects resulting from the wide range of machine designs, loading conditions, methods of operation, and types of ground. A simple inclinometer in the cab is helpful, but insufficient to warn the driver when overturning is likely.

Practical tests on individual machines will give the best indication of whether they meet adequate minimum levels of stability and this is the purpose of the new UK standard for measuring static stability, which is now being drafted. Allowance can be made for dynamic effects such as cornering, acceleration, and braking, to indicate the degree of slope where the driver can confidently work.

More extensive dynamic tests will also be needed to give more complete information about a machine's slope capabilities. Standardising these tests is now urgent. The dynamic tests will lead to a stability index for each machine. For the first time, this will allow drivers working on slopes to make sensible comparisons between machines and to make the best use of in-cab inclinometers.

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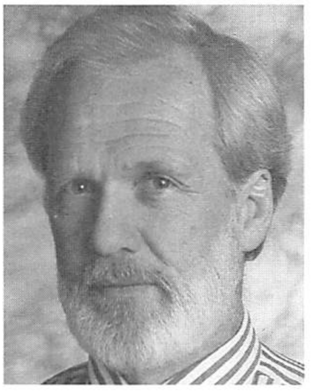
Specification of a forestry forwarder



Jim Christie looks at the design parameters of a forwarder and sets out to explain the advantages and disadvantages of the various options.

As with most items of mobile machinery there are three factors which govern the specification of a forestry forwarder. These are called the design parameters and they are:–

- the job which the machine is required to do;
- the terrain on which the machine is expected to operate;
- the constraints placed upon the machine by the legislation of the country in which it is required to operate.

The job parameter

The working practice most commonly used in the UK by the larger harvesting operators is that the tree is felled, the branches removed, and the stem is cut into lengths (which are dictated by market forces and the tree diameter). These lengths are then 'extracted', that is taken to the roadside.

Before the introduction of the forwarder the main method of timber extraction was by skidding. The timber was dragged out of the forest by some form of winch, either a Skyline winch which was stationed at the roadside and extracted the timber all the way from the stump to the roadside, or, more commonly, by a mobile winch mounted on a tractor. The method of using this particular winch was to pull the timber close into the tractor and form a suitable bundle. The bundle would then be dragged by the tractor to the roadside for stacking and eventual transference on to a road-going vehicle.

Other unsuccessful methods were tried involving metal chutes or fixed monorails.

These methods all had the disadvantage of incurring considerable downtime as they were moved from rack to rack.

If we look at early forwarders we can see the similarity between the forwarder and the tractor/trailer combination with which most people are familiar and we can see how it has evolved from this source.

J Christie is Fleet Engineer with the Forestry Commission, having responsibility for purchase specifications of all vehicles, machinery and equipment.

We can, therefore, sum up this first design parameter and state that:–

a forwarder is required to pick up timber from within the forest and carry it in its various lengths to a hard standing at the roadside where it can stack the timber to await road-going transport.

The terrain parameter

We tend to grow timber on ground which has been rejected by the farmer for cultivation and we are generally competing in terms of land use with sheep, deer and sporting moors. We are, in fact, growing timber on land which is not capable of supporting anything more valuable by virtue of a combination of its wetness, its steepness or its roughness. This immediately dictates that the forest forwarder must have considerably more cross-country ability than an agricultural tractor and trailer combination (see Fig 1).

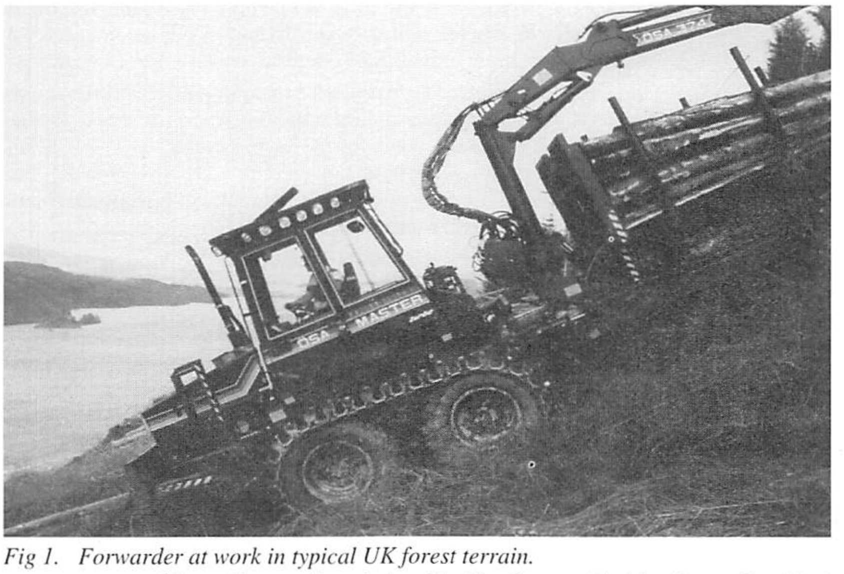


Fig 1. Forwarder at work in typical UK forest terrain.
(Photo: Forestry Commission, Machine Operator Training Centre, Dumfries.)

The ideal configuration for a cross-country vehicle is probably one of four wheels with an articulated chassis to allow it to steer, and each axle capable of pivoting independently on the centre line of the machine. A wheel, provided it is big enough, can offer as low a ground pressure as we want. It will also surmount any obstacle which it may find in its way, again provided the diameter is large enough, and above all it has an extremely low rolling resistance.

If we look at the forwarder market we will see that there are very few 4-wheeled models available and most offer either 6 or 8 wheels, so let us consider why these configurations are more practical than the ideal.

Large wheels require a wide wheel base to obtain cross-slope stability. If, however, there are constraints on the width to which we can build the machine, we could end up with a machine tall and narrow and therefore unstable on a cross slope. So let us now consider briefly the third design parameter which is that of legal requirements and view the restrictions which this imposes.

The constraints parameter

Although forwarders are primarily designed for use off the road and in the forest, it is obvious that from time to time they will be required to go on the public road, either under their own power, or more likely transported by some suitable carrying vehicle. Unless we are prepared to involve the police we have to keep our forwarders within an overall width of 2.9 metres when carried on the back of a low loader.

Although there is no legal precedent it is generally understood that provided forwarders do not carry timber they can be driven on the public road regardless of width.

It should also be borne in mind that the forwarder may well be required to work in thinnings where timber has to be extracted from between rows of a standing crop. This too puts a limitation on the width to which we can build the machines.

General design features

Wheel equipment – ground clearance

Thus having established a maximum width and since we are also anxious to maintain a cross-slope stability it is obvious that the machine should be as low as the ground clearance considerations will permit.

Two wheels mounted on a bogie is preferable to one big wheel mounted on an axle since the space above the 2 small wheels can be utilised for load carrying. The bogie wheels will require room to rise and fall as they cross obstacles but there is no requirement for that rise and fall dimension to be greater than the ground clearance of the machine since either one of these factors effectively controls the roughness of the terrain on which it can operate.

This argument applies to the load carrying end of the machine but some manufacturers still prefer to use a single large wheel at the front end, where the constraints of load carrying space do not apply. This of course gives rise to the 6-wheel configuration which is popular with many manufacturers.

When considering purchasing a 6-wheeled machine, especially if it is intended to use wheel chains or extra-wide tyres on the front axle, one should also ensure that the tilt cab can still be tilted to allow access for servicing. Some machines on the market, when fitted with large wheels or wheel chains, foul the cab when tilted and restrict access.

It is claimed that the 6-wheel design has the advantage that it is better able to roll across ditches because of the large radius wheel. They have also gained popularity on steep ground since the lower resistance of the large wheel makes better use of the power available on steep slopes.

When working on steep slopes and in rutted conditions, the power absorbed in steering a 6-wheeled machine is considerably less than that required of an 8-wheeled machine. This further enhances the performance of a 6-wheeled machine where the power is limited.

However, when plenty of power is available, and where the rocking movement of the front bogies is controlled by a hydraulic ram, the machine is thus able to step across ditches or up onto a tree stump. It also effectively enables the bogies* to increase the ground clearance and reduce the turning circle by reducing the length of the wheel base.

Operators much prefer the 8-wheeled machines since the rise and fall experienced by the operator and the arc of lateral movement when the cabin end of the machine passes over an obstacle is greatly reduced by using two wheels on a bogie as opposed to a single wheel on an axle.

Most frame-steer forwarders also have a bearing which allows independent rotation of the front and rear halves of the machine, although Valmet (Fig 2) offer a range of machines which have a swinging front axle instead of this axial swivel joint. As a result of this system the operator and his cab experience the rise and fall originating from the axle under the load carrying end of the machine. It is claimed this gives the operator a better awareness of the overall stability of the machine and since the load carrying end has twin wheels on a bogie system the rise and fall experienced by the operator is of a lower order than that experienced by the conventional 6-wheeled design.

Fig 2. Valmet forwarder with swinging front axle.

Interpretation of sales literature – the meaning of Scandinavian conditions

Most common forwarders used in this country are carrying between 7 and 11 tons payload and since there is a tendency to move towards the 11 ton load we shall take as an example, the 11 ton payload machine.

If you look at the manufacturer's specification for a machine capable of carrying 11 tons you will see that the unladen weight of the machine is in the region of 12-13 tons. However, we must bear in mind that those machines are, with very few exceptions, designed in Scandinavia for Scandinavian conditions.

The term 'Scandinavian conditions' seems to conjure up in most people's minds the fjords of Norway; vertical walls of rock rising from the sea, topped with extremely steep pine forests. This is not at all typical. The timber producing areas of Sweden and Finland are remarkably flat, although extremely rough and liberally scattered with small lakes and rivers. A machine designed for such conditions clearly will require some modification before we can put it to work in the UK where timber production is on considerably steeper ground.

Admittedly they do have timber on steep ground in Scandinavia but they have so much timber that when the ground becomes difficult they can afford to leave the steep ground and harvest elsewhere.

We cannot afford that luxury and must take the timber from where it is found. Nor do we have long winters with sub-zero temperatures which enable bogs, rivers and lochs, to be used as highways. We also have to work in very wet and rutted conditions.

Specification for British conditions

In order to adapt a Scandinavian forwarder to extract timber under British conditions we have to consider the effect of prolonged working on steep slopes.

Tilting table for steep slope working

When a forwarder is sitting on a slope (normally nose down when loading timber) the kingpost of the loader is of course at right-angles to the slope, rather than perpendicular to the forces of gravity (see Figs 1 and 3). This means that when the loader is asked to slew it has to do so against the forces of gravity. Also, if it is reaching across the slope, at right-angles to the axis of the machine; the instant that the load in the grapple loses contact with the ground, a considerable twisting moment is generated in the main boom of the loader.

It is therefore advisable that when importing machines from Scandinavia we should ensure that they are fitted with a tilting table onto which we mount the loader. This enables us to tilt the kingpost and therefore offset the effect of the slope which the loader experiences. This adds weight to the machine.

Longer reach loader more versatile for steep work

It will also be found that the loader specified in the leaflet has a somewhat limited reach

**One point that must be stressed when talking about wheel equipment is the importance of following correct operating procedure in making height adjustments.*

When a bogie is compelled to move under the action of a hydraulic ram, the half-shaft connected to that bogie must rotate in order to allow the bogie to move. If the wheels of that bogie are in contact with the ground, as one wheel raises and the other moves forward relative to the axle centre-line, that wheel is caused to rotate by its reaction on the ground. This too causes a rotation of the half-shaft. Dependent on the bogie gearing these two movements may augment each other to cause the half-shaft to rotate.

If the brakes are locked on on the machine, then either the braking torque must be overcome by the bogie manipulating ram torque, or the relief valve on the bogie manipulating system must blow. ***It is thus imperative that when operators are adjusting the height of their bogies, they should do it when the machine is sitting without the brakes applied.***

but that a longer reach version of the same loader is available. In our conditions, where we can avoid going on to the steepest snaps of a banking, by having this additional reach, it is sometimes not advisable to go for the longer reach loader.

However, since the loader is normally mounted on the rear-half of the machine, behind the axial swivel bearing, the longer reach cannot be used effectively at full reach until the bunk has already some timber on board, since without the timber it is too light to offer stability for the long reach. To overcome this problem a 'stabiliser brake' is offered. This is in effect a large disc brake which locks out the axial swivel bearing when the loader is in use, thus stabilising the loader by the total weight of the machine as opposed to the rear end only.

Fig 3. Forwarder descending a banking onto a forest road. Due to the steepness of the gradient the automatic difflock would be engaged making the sharp turn onto the roadline damaging to both machine and road. Great care is required to avoid overturning.

If, for reasons of economy, this stabiliser brake is not specified and rear end roll overs occur, severe prop-shaft damage can result. When a machine is on a slope and loading timber, the brakes effectively lock all the wheels. If the rear end rotates relative to the front end, since the wheels are locked, the prop-shaft sees the torque generated by the length of the loader's reach and the load it is lifting.

The stabiliser brake is therefore virtually a necessity in UK conditions.

Bandtracks for improved traction in soft conditions

In order to enhance further the machine's performance on steep ground we require to give better traction by means of fitting bandtracks round the bogie wheels. These tracks give excellent additional flotation in soft conditions as well as improved traction, but they must not be over-tightened.

It is essential when specifying bandtracks to ensure that they are supplied compatible to the tyres fitted to the machine. Chains attached diagonally on the underside of the tracks enable the tyres to grip the bandtrack, while leaving the bandtrack relatively slack. Tight bandtracks absorb a lot of engine power and shorten the life of the wheel bearings and bogie boxes.

Bandtracks commonly weigh around half a ton each and therefore when a machine is in full bandtrack kit we have added 2 tons to its weight. Thus our nominal 11 ton machine has grown into a 17 ton machine before we have put any timber on board.

Limiting performance factor should be traction – not engine power

Remember when we buy a car which is capable of 120 mph and can offer a fuel consumption of 35 mpg we do not expect it to return 35 mpg while driving it at 120 mph. Similarly, when buying a forwarder capable of operating on a 40% slope and of carrying 11 tons of produce, we should not expect it to carry 11 tons of produce up a 40% slope. It is essential, when operating forwarders in adverse conditions, that the loads carried are reduced as appropriate from the maximum.

These factors have all contributed in the past to Scandinavian machines being underpowered for British conditions.

Until recently the Scandinavian manufacturers have enjoyed a healthy demand from their home market which more or less absorbed all they could produce. They had therefore nothing to gain by adding expense to their design to make it suit the relatively small market which is the UK.

Recently, however, the Scandinavian market has become saturated and the manufacturers are now looking to new markets. Realising the potential sales in Canada and Russia, where a more rugged type of machine will also be required, the UK is being considered as a testing ground for more robust machines.

For a forwarder to carry 11 tons in British conditions it can be expected to weigh a minimum of 15 tons. It will require to have an engine of at least 130 HP with a climbing ability of between 65 and 70%.

Obviously on such slopes some reduction in the 11 ton nominal payload must be expected, but its performance should not be limited by engine power as is the case with most currently available machines. The limiting factor should always be traction when either considering the brake performance or the climbing performance of the machine. A forwarder with bandtracks all round working on a good brash mat can obtain excellent traction.

Transmission – hydrostatic or torque converter

In order to obtain the level of performance we require it is most important to consider the type of transmission which the manufacturers have on offer. Basically they form into two types.

Hydrostatic transmissions are very popular with operators, since they give excellent control of the machine's movement over the ground and have the advantage of positive engine braking. There are two penalties one pays when specifying a hydrostatic transmission, the first is their tendency to be slower when used on a forest road; and secondly, in the experience of the Forestry Commission they incur a higher repair cost per hour than that of the torque converter and power shift alternative.

The torque converter system with power shift is extremely reliable when compared to the older hydrostatic systems and provided there is ample engine power, offers reasonably good engine braking. They are relatively maintenance-free and spare parts are more easily available than for their hydrostatic counterparts.

Benefits of automatic difflock – but manual disengagement needed

Most forwarders on the market today have incorporated in the axles limited slip differentials and wet brakes. The limited slip differential is preferred to the manual controlled system commonly used on agricultural tractors. It has the advantage that engagement and disengagement is done with considerably more sympathy than many operators will exhibit, and can often sense the need for locking up before an operator could respond.

Where the automatic systems do show a disadvantage, however, is when descending steep slopes (see Fig 3), at the end of which it is necessary to do a right-angle turn. This situation most commonly occurs when descending a steep banking onto a forest road. The steep banking demands that the difflock be engaged, but on arrival on the forest road, with the difflocks engaged, it is extremely difficult and therefore damaging to the road to execute a right-angle turn.

In an ideal world the difflocks would be automatically engaged but manually disengaged. This is a problem for the designers of the future.

Cast bogie boxes for greater strength

The bogie boxes were traditionally fabricated structures which contained either gear trains or chain drives. More modern machines have now got cast boxes which have a much higher mechanical strength. This higher strength allows the machine to be fitted with wider tyres without imposing destructively high bending stresses on the bogie boxes.

Bogie boxes can become distorted when a machine is operating in existing ruts.

The weight of the load presses down onto the bogie boxes which in turn are pressed into the ruts forcing the bogie boxes outwards away from the machine centre line, thus causing a bending effect in both the horizontal and vertical planes.

Where a bogie is chain driven slight distortion of the bogie box can be tolerated. In gear driven boxes slight deformation of the box can result in expensive gear failures.

Current trends in design indicate that cast gear boxes with gear trains is the best solution.

Chassis design for weight transfer

The design of the chassis should obviously be adequately strong for the task in hand bearing in mind that the stresses imposed on the chassis by the loader are traditionally the stresses which cause the chassis most distress. It is when designing the chassis that the fording angles both at the front and rear of the machine should be considered. Obviously too much overhang in the tail or at the nose would lead to grounding when the machine descends off a steep banking onto a flat surface.

If it is the intention of the designer to make the forwarder chassis suitable for a harvesting base machine application or for scarification work where it would tow a soil engaging implement, it is necessary to have the articulation joint in the centre of the chassis capable of withstanding load transfer between the two halves.

If, however, the machine is being designed purely as a forwarder it is imperative that when in operation no load transfer between front and rear takes place since this causes instability and can lead to overturning. It would always be prudent, however, to design the chassis with reasonable weight transfer capabilities even though conditions which impose such a weight transfer are not advisable when forwarding.

The loader – a development of the winch

The loader is an extremely important part of the forwarder in that, if there were no loader on a forwarder, the life expectancy of the forwarder would be greatly enhanced. It is the stress imposed on the forwarder chassis by the loader that is the major consideration for the chassis designer.

On the size of forwarder we are discussing, ie 11 ton payload, the most commonly fitted size of loader is a 6 ton metre. As the name implies this basically means that the loader is capable of lifting one ton at a 6 metre radius of 6 tons at one metre radius.

The other important feature of the loader is its total reach and this is commonly of the order between 8 and 10 metres. We are always extremely emphatic when instructing operators on the use of the loader that they must not endeavour to lift any significant weight at anything like maximum radius. They are trained to regard the loader as a means of reaching out and attaching a grapple to the timber, pulling it in close to the machine, and then lifting it aboard. Thus we encourage operators to think of the loader as a development of the winch and chokering system which it basically replaces.

Bear in mind also that the longer the reach of the loader, the greater the chance of damage to the kingpost and main boom assemblies.

Overload release – the loader is not a crane

The Swedish word for loader is 'Crane' and therefore when instruction books are translated into the English the word loader tends to be reproduced as crane. This error must not be ignored because in law a loader and a crane are totally different pieces of equipment.

A crane, when overloaded, will by means of a warning device signal the operator who must then take corrective action. He then chooses where and when to lower the load to safety. A loader, when overloaded will automatically lower the load or refuse to lift the load. This is done independently of the operator.

It is permissible when using a crane to have other personnel working within the radius of its operation. A loader, however, must only be used in circumstances when no other personnel is within the radius of operation designated the 'risk' zone which is displayed on the side of the job. Of necessity cranes therefore have much higher safety factors built into their design and are therefore much heavier when compared to a loader of similar lifting capacity.

Forwarders could not operate economically if equipped with cranes rather than loaders.

Location of loader

The loader is normally sited on the front of the timber carrying bunk of the forwarder but some machines have the loader mounted on the rear of the cab end of the machine while others, usually of a smaller payload, carry the loader on the roof of the cab.

The two latter methods have the advantage that they remove the weight of the loader from the payload carrying end of the machine and also the machine has reasonable stability regardless of the load in the bunk. The operators also like to be closely seated to the kingpost centre line since this makes their job of judging the operating radius much easier.

One minor disadvantage of the front mounted loader is that when the machine is empty there is very little weight on the rear end and this can give problems when attempting to steer in slippery conditions.

As previously discussed, loaders should be mounted on tilted platforms but care must be taken that the operator's sight line to his bunk must not be impeded by either the slewing pods of the loader or the tilting platform mechanism. The inability of the operator to see the near corners of his bunk greatly hampers the smoothness of his operation and can result in grapple and headboard damage.

A forwarder will quite commonly require to have the loader replaced half-way through its useful life.

Thirty per cent of all repairs required on a forwarder will, in fact, be attributable to the loader. Fifteen per cent of the repairs attributable to the loader will be on the hydraulic hoses. The hoses which are particularly vulnerable to snagging in branches are obviously those near the grapple end of the boom. Telescopic extensions come basically in two formats. The first type carries the hydraulic hoses externally in large loops. This has the disadvantage that they are particularly vulnerable to snagging on branches especially when working in thinnings or when working with an inexperienced operator. The advantage of this system is that when the hoses need to be replaced they are immediately accessible and easily changed.

The second configuration of telescopic extension carries the hoses within the telescopic extension members where they are tensioned by a pulley system. The advantage of this system is that the hoses are much less vulnerable to snagging but when they do require replacing access is a greater problem.

Variable displacement pumps for smoother operation

Two types of loader pump are available for supplying the hydraulic power to the loaders. Traditionally, fixed displacement pumps were common-place and, as the name implies, these pumps delivered a fixed amount of oil per revolution, thus the total oil flow could only be controlled by varying the engine revs. These were expensive in terms of fuel consumption and tended to make loader control difficult especially when multi-functioning (ie using more than one loader function at the same time). This system also resulted in fairly harsh loader movements which effectively shortened the life of the loader components.

Forwarders currently on the market commonly offer variable displacement pumps which have the advantage of operating at lower engine revs and being able to respond to the demand of the hydraulic systems so that they can better match oil delivery to that demand. This has the advantage of being more fuel efficient and also prevents erratic responses when multi-functioning. The variable displacement pumps being more sophisticated than the fixed displacement pumps cost more initially and make maintenance procedures more complicated.

Loader controls – more response

On older forwarders the hydraulic controls for the loader were by means of manually controlled spool valves. This involved bringing all the hydraulic pipes in through the cab, through the spool valve block and then out again to the loader. This made the cab a noisy and very warm environment for the operator.

The next development was to leave the main spool valve block outside the cab and operate the spools by means of a pilot hydraulic system. In effect this meant that the operator worked a lever which operated a small pilot hydraulic spool, the power from which operated the main spool, which in turn operated the loader function.

The system was quickly further refined by moving the pilot valve block on to the main spool block and operating the pilot spools by electrical solenoids. Thus the operator worked switches which operated the pilot valve, which in turn operated the main valve. This development enabled the working environment within the cab to be greatly improved.

However, compared to the original system where the operator directly controlled the main valve, the remote control was found to be lacking in fine control, since the actuation of an electrical switch, which is either on or off, resulted in an oil supply which was either fully on or fully off.

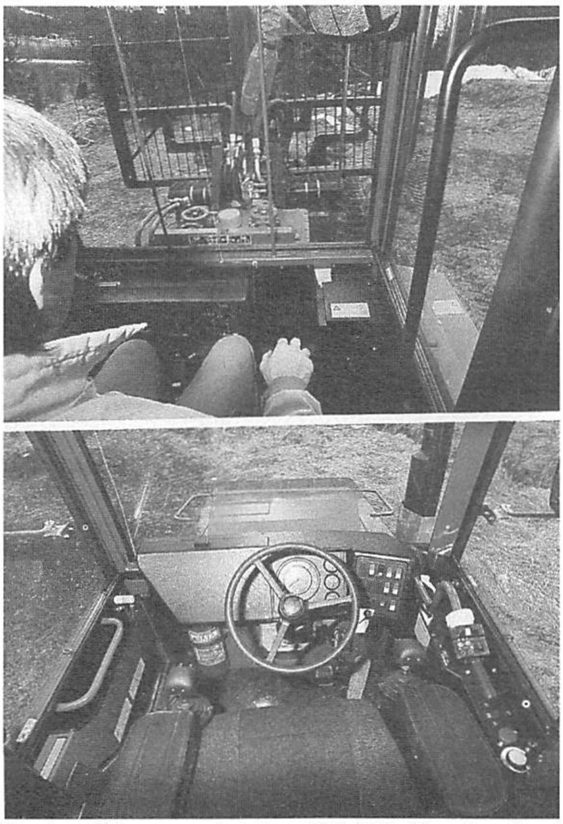


Fig 4. Drivers workstation OSA 250. Top: Loading/ Unloading mode, facing the back. Bottom: Normal driving mode.

The next development was to replace the electrical switches with electrical rheostats giving an output voltage which was determined by the movement of a joy stick. This variable voltage output allowed the pilot valve system to be operated to give a variable hydraulic output, thus giving the operator the facility to use his main hydraulic spool valve as a control valve instead of an on/off valve. So again we have given him 'feel' in the operation of his loader.

This current system, coupled with the previously mentioned variable delivery pump, enables the loader when properly tuned to be operated very smoothly and with no harsh actions which would induce high stress levels.

No individual loader function should, however, be set to operate at speed since overall speed of loading and unloading is dependent on the operator using more than one function at any one time. It is essential that this type of sophisticated control system be adjusted properly otherwise no benefit will accrue from its extra cost of installation.

There is no doubt, however, that a skilled operator with a well tuned system can not only increase the output of the machine, but also reduce downtime due to repairs.

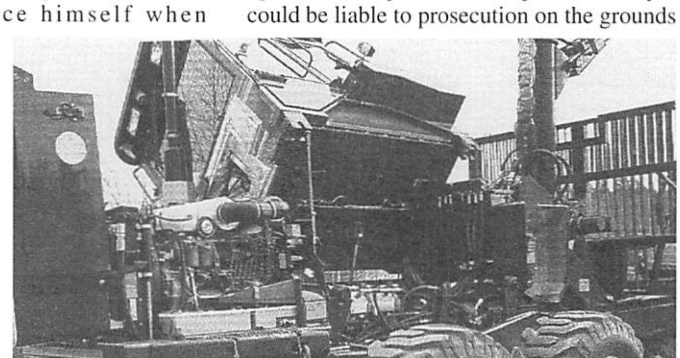
Cab design

Current forwarder cabs offer air-conditioning, electrically heated seats, hydrostatic steering, stereophonic sound and a bank of controls which the operator can reach without so much as moving his wrists. The seat is reversible since the machine is inevitably loaded and unloaded with the operator facing rearwards or towards his load carrying end. Many of the controls are located on the seat itself and therefore remain to hand regardless of the seat's mode. Controls not mounted on the seat are commonly duplicated so they are in reach in either operating mode.

Steering in the forward mode is normally by conventional steering wheel but in the reverse mode the operator can steer by electrical switches designated for this purpose or by means of his loader controls which can be switched from function controls to steering controls (see Fig 4).

The control layout in cabs allows for the operator to be able to drive his machine with one hand only, thus freeing the other hand with which to brace himself when traversing rough terrain.

Fig 5. Good accessibility is needed. This OSA 280 master forwarder shows the bonnet and cab tilted well clear and securely locked; the belly plate is lowered. Note the hand rail on the steps to avoid any temptation of using hot engine components as a hold.



Hydraulically retractable steps

In our experience steps which allow access into the cab and are retrieved by pulling them up by a chain and clipping them into position are extremely vulnerable to damage. Inevitably sooner or later, the operator will forget to retrieve the steps and they will be damaged against tree stumps or brash. Since access into the cabs of these machines is extremely difficult without the steps the continual replacement of steps is expensive and can at times tempt the operator into dangerous acrobatic feats.

It is therefore worth the expense of equipping the machine with hydraulically retractable steps and interlinking the retracting device into the control system so that the machine will not drive off when the steps are in the lowered position. This may seem a bit gimmicky but over the life of the machine can be cost-effective.

Cab legislation – offer 'best available'

Under the Health and Safety at Work Act the noise level in the cab should be less than 85 dB(A) but there is no specific legislation which demands that the cab should be subject to Roll-over protection, Falling Objects protection and Operator protection. Such legislation only applies to agricultural tractors and the forestry forwarder does not come into that classification since it is not primarily designed to pull implements but to carry a load. Scandinavian forwarders, available in this country do, however, have cabs designed to meet the Swedish legislation which includes roll-over protection, operator protection and falling objects protection. Since these are available on the market then the responsible employer is advised to purchase the 'best available' cabs in order to minimise the risk to his employees driving the machine.

If a forwarder were to come on the market with a 'soft' cab and if during its subsequent operation an operator was injured, the buyer could be liable to prosecution on the grounds that he did not supply his employee with the 'best available' equipment.

Guarding – against damage and fire risk

In a hostile environment, such as forestry, guarding of the vulnerable parts of the machine and the operator is extremely important. Starting at the front of the machine it is obviously necessary to guard the radiator. This is commonly done with a heavy mesh, backed up by a finer mesh which filters out pine needles from the airflow entering the cooling matrix. Blockage of this mesh can affect the airflow through the matrix and cause overheating, so it is essential that the heavy guarding can be easily removed so that the finer guarding can be cleaned on a regular basis.

Under-guarding or belly plates must be boat-hull shaped so that the machine does not get hung up on tree stumps. The plates must also be strong enough to withstand the weight of the machine when it impacts onto a stone or tree stump. This dictates that the plates must be very heavy in construction. Thus shaped, the plate has the disadvantage of being a collecting receptacle for all sorts of debris from the forest floor, spilled engine oil and fuel oil and thus it entraps a very combustible mixture of material.

Since such trash also accumulates around components such as brakes, which commonly run at a temperature much higher than the flashpoint of this mixture, fire risk must be a consideration. To reduce this risk the operator must remove the guard-plates and clean out the debris on a regular basis (see Fig 5).

In order to encourage the operator to remove the plates for cleaning, they must be extremely easy to raise and lower. As previously described the cab is capable of being tilted aside to allow for maintenance access to the transmission which lies beneath the cab and many manufacturers have incorporated a small hand pump and ram which is used to tilt the cab. By incorporating a simple diverter valve in this circuit they can have a second ram which raises and lowers the belly plate. The cost of this is well justified in the life of the machine.

The complete guarding of the machine also gives rise to another problem. Should the machine catch fire it is extremely difficult to reach the fire with a fire extinguisher without removing the guards. However, if the guards are removed then air is allowed into the fire and this frequently exacerbates the situation. Responsible manufacturers therefore identify the various apertures through which a fire extinguisher can be usefully deployed. It is essential that while the operator is under training on the machine that appropriate fire drill is included in the training course.

Variety of bunk configurations

Most forwarders offer a variety of bunk configurations and the manufacturer's agent can easily advise as to the bunk configuration most suitable for a particular range of crops. Bunks with movable headboards enable a wide range of produce to be carried on the one machine. When specifying bunk details it is absolutely essential that whatever the load carried its centre of gravity must be above the rear axle of the machine. Large overhanging loads must be avoided both in terms of the damage that they can cause to the machine and in relation to the resulting instability of the machine on cross slopes.

Operator training/safety measures

Forestry machinery represents a very high capital investment; it operates in a very dangerous environment and has the ability to self-destruct. Any prospective purchaser of a forwarder should be aware at the time of purchase that his operator will require thorough training so that the machine can be a viable proposition.

Most responsible dealerships are able to offer suitable training packages on delivery of the machine. The package should include routine maintenance and adjustments, loader operation while loading and unloading, steep terrain driving techniques and wet terrain driving techniques. As mentioned previously fire-fighting should also be covered.

The operator should also be aware of the correct methods of righting a machine after it has been rolled.

Current legislation demands that when that part of a forwarder which includes the loader rolls onto its side it must be reported to the Health and Safety Executive. My own opinion is that this should be modified so that the report should be required when that part of the forwarder containing the operator overturns.

It is a relatively common occurrence for the bunk end of a forwarder to roll over and the operator should be aware of where he can safely attach ropes without damaging the machine's structure. He should also be instructed in the correct procedures in relation to the stabilising brake. Similarly when a machine requires to be debogged the operator must know where he can safely attach hauling ropes and if the machine has been drowned, he must be aware of what oils will require to be changed in order to avoid damage due to water ingress into the various transmission breathers.

Future trends – forestry extends into less arduous terrain; development of a 'walking' forwarder?

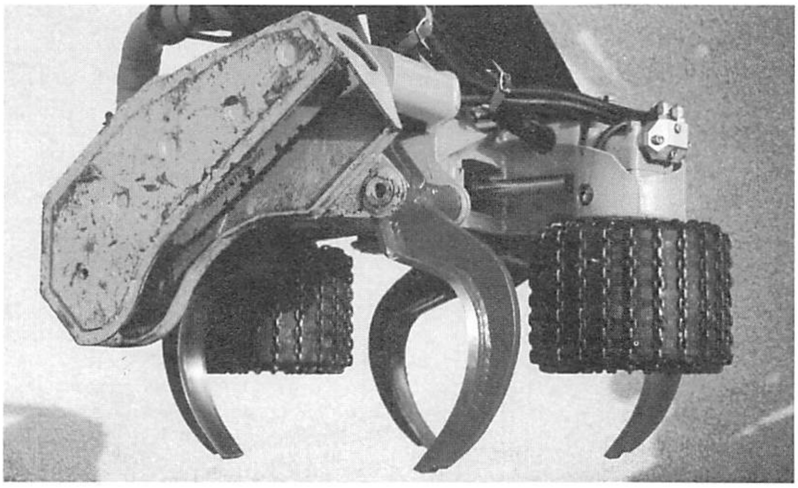
Recent reports on forestry have indicated that timber should be grown on a better quality land previously used by the sheep farmer. This may reduce the need for the extreme terrain ability that we expect from current forwarders. In the meantime, however, we do have to harvest the trees which are currently planted on steep ground.

I believe we are getting very close to the limit where we can expect wheeled or tracked machines to negotiate safely and if one eliminates airborne craft as being too expensive the only way forward is the walking machine. Indeed, the modern 8-wheeled forwarder with bogie actuating rams could be regarded as the embryo walking machine.

Our current hydraulic technology and our current microprocessor technology could be easily combined to produce a machine which will walk on ground too steep, too wet, or too susceptible to damage to accommodate conventional traction systems. No doubt this will cost money and therefore whether or not this development comes about, must be determined by the price of timber.

Delimbing knives for tree processors and harvesters

Correctly sharpened and profiled delimbing knives are crucial to the performance of tree processors and harvesters. In this technical note, Stewart Coombie shares with us the benefits of his extensive knowledge on this subject. This paper was presented to evening meetings of the Institution at Perth and Aberystwyth.



The basic requirements of tree processor and harvester delimbing knives are to:–

- remove all branches from the tree;
- minimise damage to/or removal of bark;
- minimise damage to the stem;
- minimise power absorption from resist ance to feed.

The advantage of good quality delimbing knives made from high grade steel with ground and polished cutting edges and hollow ground and polished centres include:–

- **Higher output:** Delimbing is achieved in a single pass with a faster feed through. Reduced maintenance times result in increased availability for production;
- **Better quality produce:** Cleaner delimbing, minimal removal of/or damage to bark, more accurate measuring, tighter specification, minimal damage to produce, reduced weight loss;
- **Less wear and tear:** Achieving delimbing in a single pass results in less wear and tear to the head or bed and their mountings and also to the various pivot points, rams, feed rollers and motors. Undesirable stresses, shock loadings and pressure peaks can be generated throughout the complete machine if several passes or shunting back and forward takes place in order to delimb cleanly. Oil temperatures are also reduced;
- **Lower fuel consumption:** As less power is required to feed the tree through, and delimbing is completed in a single pass, fuel consumption per tonne of wood harvested is significantly reduced. Pressure on knives and feed rollers may also be reduced in certain conditions;
- **Lower maintenance time**: The use of hardened and tempered alloy steel gives a reduced maintenance and re-sharpening requirement;
- **Longer machine life**: Reduced wear and tear on the machine will increase the length of its working life and will also enhance the re-sale value.

S Coombie is Training Officer and Team Leader at the Forestry Commission Machine Operator Training Centre, Dumfries.

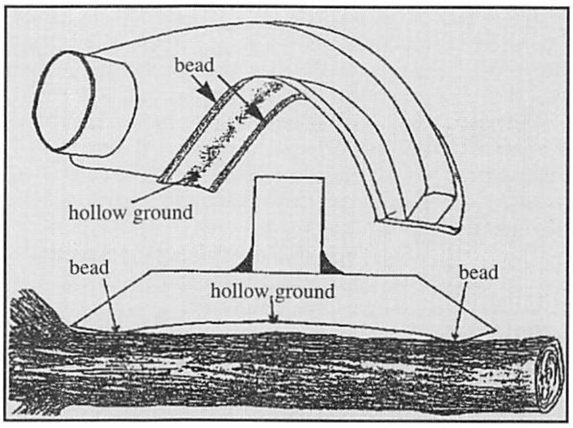


Fig 1. Double edged knife profiles.

Knife profiles

All delimbing knives benefit from some degree of hollow grinding as this minimises friction between the knife and the tree surface. Hollow grinding should be deeper towards the centre of the knife where it will be between 2mm and 4mm and taper towards each edge (Fig 1).

Two beads must be formed at the leading and trailing edge of the knife which minimise bark removal. These beads must be carefully formed so that no sharp ridges or steps are noticeable.

When grinding, great care must be taken not to overheat the knife as this will affect its hardness. Once the desired profile is achieved, the knife should be highly polished to minimise the build up of resin and other materials. If the knives are ground and polished correctly they will maintain their shine with use. An anti-rust coating should be applied to these knives when the machine is not in use.

As well as the face of the knife being important, the cutting angles of the leading and trailing edges are also crucial to the harvester's performance. These angles are shown in Fig 2.

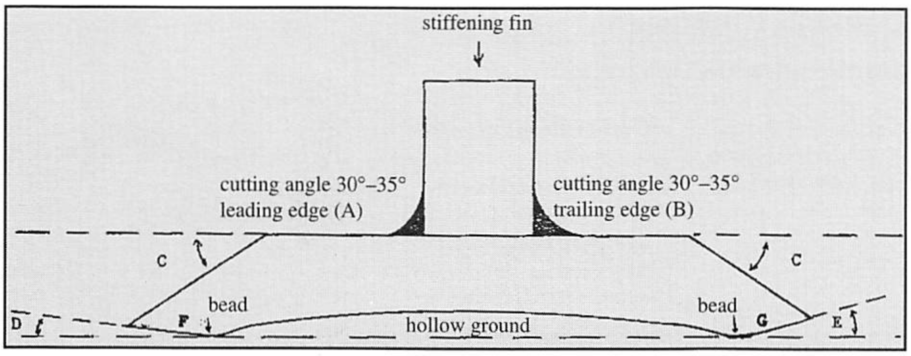
Ideally, the leading edge of the knife should be longer than the diameter of the branches that are to be removed (Fig 3), otherwise branches will be torn from the stems rather than cut. This increases power consumption and creates many other problems. Alternatively branches may be folded over by the knives which are forced back from the stem and so miss other branches.

As well as the leading edge being important in the removal of brash, so is the shape of the stiffening fin. If this is square in profile then brash will impact upon it rather than flow around it. A rounded shape as shown in Fig 4 will again reduce power consumption.

Finally, it must be stressed that to avoid unnecessary down time and to ensure good clean work, proper equipment should be available on site to carry out the care, main-tenance and adjustment of delimbing knives and their cutting edges. The panel on the next page lists the minimum requirements.

Alloy steels for knife blades

Delimbing knives manufactured from special alloy steel can offer superior hardness, resistance to chipping combined with very high strength.



Angle D is the negative angle of the leading edge and will vary according to the crop. As a guide for a base setting D = 5° –10°. However, this angle is not the same all the way round the curvature of the knife to allow for differing thicknesses of tree to be de-limbed.

Angle E is the negative angle on the trailing edge and is equally important – this will also vary according to crop conditions, working method, etc. A base setting of approximately 20° should ease reverse feed and enable debranching of unbrashed stems.

Width of face: C = 20mm F = 5mm-10mm G = 5mm-10mm Width of bead = 5mm-10mm

Fig 2. Cross section through double edged knife.

To achieve these superior qualities this special alloy steel is heated to temperatures of up to 1000°C during the manufacture of the knives. Hardness and strength of this heat treated alloy steel can be up to 350% greater than that of ordinary mild steel.

Although it is perfectly possible to weld some alloy steels in their hardened state, softening of the steel will occur locally around the weld area where the steel has been heated by the welding process. Any welding of alloy steel should be done with low hydrogen electrodes, but consultation with the manufacturer is recommended prior to any welding.

When sharpening cutting edges, care must be taken not to overheat (burn) the steel when grinding since the heat generated in this way can soften the steel.

Knife pressures

Regardless of machine type is it desirable to be able to adjust and vary knife pressures. There are various ways and means of adjusting and controlling the hydraulic oil pressure of the delimbing knife rams; some being easier to alter than others.

On some circuits accumulators are used. Others use the differential pressures of ram areas. Some machines offer adjustable pressure relief valves in order to obtain this feature. Some have pre-set cartridges which can readily be exchanged. On others it may be necessary to change the ram dimensions, eg rod diameters.

On the more sophisticated machines a simple and quick adjustment can be made via the control computer. These may also have the facility to continuously vary the pressures, eg pulsing the knives open at the start of the feed, or to switch them to high pressure when felling or cross cutting.

On occasion it may be necessary for the knife to assist with clamping operations, therefore there has to be compromise and it is necessary to balance the minimum acceptable standard of delimbing and quality against stem damage, presentation and output.

Feed roller closing pressures

The opportunity to vary feed roller pressures is of equal importance to knife pressures. More so when using steel or spiked rollers. The methods of adjusting or controlling their pressures are very similar to those of the knife pressures and do not need to be repeated.

There are two main types of feed roller; steel, or rubber tyres, with or without chains. Their function is to drag the tree through the delimbing knives. Some makes of machine have chain or band drives instead of the rollers or wheels.

Irrespective of which type of feed mechanism is developed it must be sufficiently aggressive in order to maintain a grip on the tree thus overcoming the friction generated when pulling the stem through the delimbing knives. Where pneumatic tyres are fitted their pressures can also be adjusted to enhance their gripping capability.

If the pressure on the rollers can be reduced the crushing effect on the stem will be minimised, thereby reducing damage and bark loss. The most significant feature in reducing damage is the single pass since multiple passes do a disproportionate amount of damage to the bark.

Standard or custom-built knives

A 1990 quote from a Swedish manufacturer's agent was as follows:–

Two top knives £1,078 + VAT
Two bottom knives
or clamps £826 + VAT each.

A comparable quote from a local source was £380 + VAT for a set of four knives!

There is obviously a considerable saving to be made on the purchase price but there are other more important factors. Swedish top knives have only one cutting edge on the leading edge and clamps have no cutting edges. Therefore on grapple harvesters having the configuration of one fixed top knife, two movable top knives and two bottom clamping arms/knives there are only three cutting edges. From experience in the UK conditions this set up is not successful.

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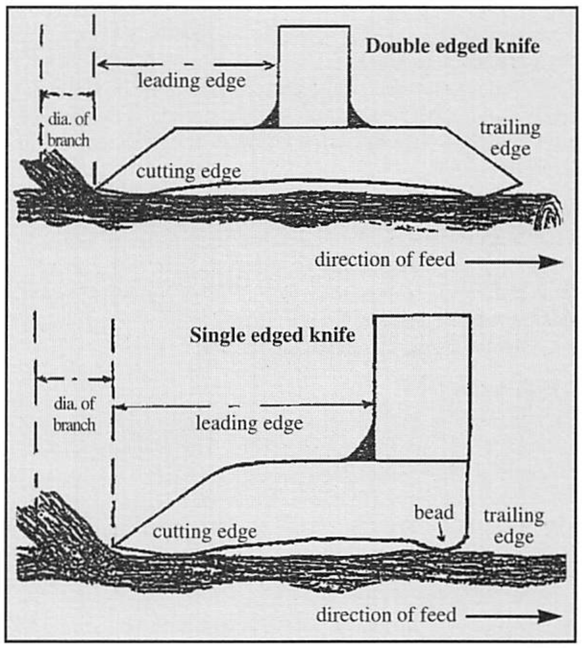

Fig 3. Leading edges of double and single edged knives.

Equipment required on site for knife maintenance and adjustment

Portable generator or compressor.

200mm and 100mm hand held angle grinder (the size may vary depending on machine) with spare discs and tools to remove/replace them (also the relevant training to perform this task).

Steel straight edge, protractor or gauge/pattern to check grinding/filing angles.

200mm or 250mm double cut, round edged or half round mill-saw files.

Oil stones, double sided, coarse and smooth, round or oblong, oil can.

Flap wheels are ideal for polishing and they are available in a range of sizes and grades, ie coarse to smooth, but they do require to rotate at very high speeds (approx 16,000 rpm).

Leather gloves/gauntlets/eye protection/protective clothing. First aid kit, fire extinguisher.

The European Society of Agricultural Engineers

– the opportunity for agricultural engineers throughout Europe

The European Society of Agricultural Engineers, or EurAgEng, was formed in January 1992. The aim of the Society is to enhance, within a Pan European framework, the capability and achievements of both the Agricultural Engineering profession and the industries which it serves.

Range of activities

An ambitious range of activities is well under way and holds the key to attracting a large membership. Currently, the largest European based professional organisation with similar aims to EurAgEng is the Institution of Agricultural Engineers (IAgrE) which has already confirmed its active participation. Many of the activities of EurAgEng represent a European dimension of IAgrE activities which will serve as examples of the potential benefits to EurAgEng Members.

– the AgEng Conference

The AgEng conference series, currently held every two years in a different European country, provides the main technical forum for the Society at preferential rates for Members. These conferences were established in 1984, the first one being held in Cambridge, and subsequently in Paris, Amsterdam and Berlin. The AgEng 90 Conference attracted 600 participants from 34 countries with 250 posters and papers accepted. Agreement has been reached already to hold further conferences in Uppsala in 1992, Milan in 1994 and Madrid in 1996.

– National Chapters and Specialist Groups

Members of the Society are encouraged to form a National Chapter (where no National Society presently exists), and also to form Special Interest Groups responsible not only for the organisation of parallel sessions at the AgEng Conference but also to promote additional Technical Seminars in their subject area.

– Publications

High priority is attached to the publication of general and specialised information of interest to Members. The primary publication is the EurAgEng Newsletter containing relevant items of interest transmitted by a panel of national correspondents from countries with Members in the Society. There is also strong support for a refereed scientific publication.

– Membership Register

An alphabetical listing of all Members with sector of activity, complete mailing address, telephone and facsimile/telex numbers will be maintained in such a way as to comply with data protection legislation. This Register will be available solely to Members on a non-profit basis.

– Career development

Special attention will be given to encourage the participation of younger engineers and students in the technical activities sponsored by the Society and to provide careers information for European employment.

Eur Ing Prof Brian D Witney

Recognition and Registration

The Society will seek to establish an internationally acclaimed, professional identity for its Members through the use of the designatory letters: M EurAgEng. Registration as a European Engineer (Eur Ing) through FEANI, the Fédération Européenne d'Associations Nationales d'Ingénieurs is already available to professionally qualified engineers throughout Britain.

Membership

There are four grades of membership:– **Founder Member, Member** (in two grades – either as member of a National Society or as a direct member of EurAgEng) and **Affiliated Organisation**. Subject to the approval of Council, membership is open to any professionally suitable person, active or interested in the pursuit of agricultural engineering, who is already accepted into the membership of a National Society, or proposed and seconded for membership by two existing members.

A number of key people in Agricultural Engineering have already demonstrated their commitment to the Society by becoming Founder Members and the Institution of Agricultural Engineers (by formal agreement of Council) became the first National Society to join EurAgEng en bloc. Affiliated Members to date include British Technology Group, Forestry Commission, Royal Highland and Agricultural Society, Scottish Centre of Agricultural Engineering and Silsoe Research Institute.

The launch of EurAgEng will serve Europe in the same way as the American Society of Agricultural Engineers (ASAE) and the newly formed Asian Association for Agricultural Engineering (AAAE) serve America and Asia respectively, under the worldwide umbrella of the Commission Internationale du Génie Rural (CIGR).

The Secretary-General for EurAgEng is the IAgrE Secretary, Jim Dennis and the address of the Secretariat is: European Society of Agricultural Engineers at West End Road, Silsoe.

Brian D Witney, Senior Vice-President Designate,
European Society of Agricultural Engineers.

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continued from overleaf

With some modification the number of cutting edges can be increased up to nine or ten according to machine type.

The replacement knives are doubled edged and are made from high quality hardened and tempered alloy steel which require the minimum of maintenance.

When purchasing a harvester head or processing bed it will normally be supplied with knives already fitted. It is possible to have them delivered minus the knives but no discounted cost ensues. This being the case it is as well to accept the manufacturer's knives as fitted since they can probably be modified well enough to do a reasonable job for at least a short term period. It may be advisable to replace them with knives which have been custom-built for UK conditions and retain the original knives as a standby.

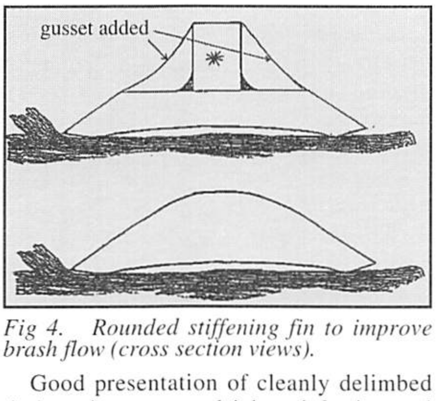

Fig 4. Rounded stiffening fin to improve brash flow (cross section views).

Good presentation of cleanly delimbed timber gives personal job satisfaction and boosts the output rate of the extraction team. All these factors help to ensure a continuing demand for your services. Can any contractor therefore afford not to set up his machine to do the best job possible?

Conclusion

Correctly profiled and polished cutting edges on delimbing knives combined with hardness for durability, give cleaner delimbing, require less hydraulic power and will produce many benefits: increased output, better presentation, higher quality and value end product, less waste, less wear and tear, lower fuel consumption, lower maintenance times, all resulting in increased availability for production.

The replacement of some existing harvester and processor knives with high quality alloy steel knives with extra cutting edges has indicated that British made knives can be superior to those fitted by some manufacturers.

Agricultural Machinery Law

Our thanks to the bi-monthly publication, *Farm and Garden Machinery Law*, for allowing us to reprint the following abstracts:

Collusion on labour rates: French syndicates fined

Hit by the recession, large French dealerships involved in the sale and repair of farm machinery have regrouped into three syndicates.

One of these syndicates produced a report on the costs, region by region, of mechanics' labour, showing the mean, highest and lowest labour charges discovered by their survey. The other two syndicates produced guidance notes for their members based on the same survey material, advising members what might be charged per hour for labour.

The Competition Council held that in cases where it was usual of such organisations to advise their members on labour rates, they should not do so in such a way that they exercised a direct or indirect influence on competition in the farm machinery repair sector. The circulation of the report, in which an hourly rate was stated in terms of a recommendation and other peripheral matters were dealt with as though they were an agreed decision on the syndicate, constituted a concerted practice with effect of restricting competition. Circulation of the document by the other syndicates was also capable of being interpreted as anti-competitive.

All three syndicates were fined.

Re- practices in the heavy agricultural machinery repair sector – B.O.C.C. 227 (Cons. de la Concurrence, 9.7.91).

Lawn mower noise: new SI to consolidate and replace existing regulations

The EC Directive 84/538/EEC harmonised the law in Member States relating to lawnmower noise by introducing various permitted sound power levels for rotary mowers. This Directive was adapted to technical progress by 87/252/EEC.

Both of these Directives were implemented in the UK by the following Statutory Instruments:–

- Lawnmowers (Harmonisation of Noise Emission Standards) Regulations 1986 (SI. 1986 No.1795).
- Lawnmowers (Harmonisation of Noise Emission Standards) (Amendment) Regulations 1987 (SI. 1987 No.876).
- Lawnmowers (Harmonisation of Noise Emission Standards) Regulations (Northern Ireland) 1990 (SI. 1990 No.41).

Two further Directives introduced in 1988 extended the scope of 84/538/EEC to include cylinder mowers (88/180/EEC) and to lawnmowers with a cutting width exceeding 120cm (88/181/EEC). Both of these Directives were to be implemented in Member States before the 1st July 1991.

The Government is now to introduce a new Statutory Instrument which will have the combined effect of consolidating and replacing the existing SI.s listed above and of implementing the two 1988 Directives. Consultations have been taking place with the industry concerning the points of detail to be covered by the new regulations. This fusing and, it is hoped, simplification of the regulations is to be welcomed.

BS for grain dryers

BSI has published a new British Standard describing the methods for evaluating the drying performance of continuous flow and batch grain driers and correcting the results to standard conditions. The method is based on wheat drying but a guide is also given to the performance for other grains. The Standard supersedes BS 3986 : 1966.

BS 3986 : 1991 Methods of test for drying performance of agricultural grain driers.

Amber warning lights: high speed tractor anomalies

Spare a thought for the manufacturers of high speed tractors. As soon as technology makes an advance, dense hanging vines of legislation have to be negotiated before the market can be conquered and the customer is able to take advantage of the product with a relaxed confidence.

For the most part the new fast tractors have been manufactured within the framework of existing law. However, the adroit Dr Steven Smith, Transport Adviser to the NFU, has unearthed a small problem that may well need an amending paragraph in a future SI.

Under Regulation 17 of the Road Vehicles Lighting Regulations 1989, any motor vehicle with four or more wheels having a maximum speed not exceeding 25 mph, or any trailer drawn by it, *must be fitted* with at least one operating amber warning beacon when the vehicle is on an unrestricted dual carriageway road.

Regulation 11(2) of the same Regs. permits *the optional use* of amber flashing warning beacons in a number of circumstances relevant to agriculture:–

(a) a vehicle having a maximum speed not exceeding 25 mph or any trailer drawn by such a vehicle;

(b) a vehicle having an overall width (including any load) exceeding 2.9m;

(c) a vehicle used for escort purposes when travelling at a speed not exceeding 25 mph.

Maximum speed is defined as "the speed which a vehicle is incapable, by reason of its construction, of exceeding on the level under its own power when fully laden".

Because high speed tractors are capable of speeds greater than 25 mph, Regulation 17 does not apply to them. They are not required to have amber warning beacons fitted when being driven on an unrestricted dual carriageway road.

Conversely and even more absurd, again by virtue of the speed they can travel, they are *not permitted* (ie is not in a category of vehicles which is able) to elect to fit and use amber flashing beacons (11(2)). Hence, as Dr Smith points out, even though they may be at slow speeds on rural roads, hauling laden trailers or with mounted hedgecutting equipment, they are not permitted to fit and use amber flashing beacons to warn other road users of a hazard.

The Agricultural Engineers Consultative Committee and the National Farmers Union Commercial Services and Transport Committee have made appropriate representations to the Department of Transport.

Farm & Garden Machinery Law
is published bi-monthly by
Farm Law Publications, 6 Buckingham Gate, London SW1E 6JU. Tel: 071 828 6337
Subscriptions: £40.00 pa (UK). £45.00 (overseas)

NEWS AND VIEWS

Stripper harvester earns Queen's Award for Silsoe Research Institute

The Queen's Award for Technological Achievement 1992 has been granted to Silsoe Research Institute. The Institute gains this, their second, Queen's Award jointly with Shelbourne Reynolds Engineering Ltd, of Bury St Edmunds, for the development of this unique stripper harvester for combines.

The stripper harvester uses a comb-like mechanism to enable grain or seeds, with little chaff and leaf material, to be stripped from the plant stalk, while leaving almost all of the rest of the crop standing in the field. This system allows much faster operating speeds and increased work-rates to be achieved. The stripper harvester can also be much lighter overall, leading to less soil damage, as well as being cheaper and using less fuel. The principle of stripper harvesting actually dates back to Roman times, and has since been the subject of much research worldwide, but Silsoe Research Institute is the first organisation to develop a working system.

Farms get support from geotextiles

Once part of the old Miln Marsters Seeds Group, MMG Civil Engineering Systems Ltd of Kings Lynn, Norfolk (Tel: 0553 617791), is still very evident on British farms for its work with geotextiles in agriculture.

Christopher Gillett, Managing Director of MMG, says: "Every day more geotextile products are finding a useful place on the farm, replacing the more traditional labour intensive materials.

"Permanent or temporary roads, lagoons, silage clamps, pollution control, retaining walls and drainage are just some of the applications covered by our range of high quality products."

Scottish farmers recently attended meetings organised by SAC, to examine new regulations on the control of noxious effluents produced as a result of farm activities, and here MMG has a particular contribution to make with respect to earth bank silage clamps.*

In 1988 to prevent the percolation of earth bank silage effluent into adjacent land or water courses, MMG's Nicotarp impermeable liner was installed in a trial on a Kincardineshire farm by the SAC's Centre for Rural Building. Here it received the approval of the Scottish Department of Agriculture and Fisheries, and it is now in its fourth year and functioning normally. Nicotarp is based on a woven geotextile and although it may puncture on impact with a machine blade it will not readily tear.

A 6m high earth wall constructed using Fortrac geotextile creates space for an effluent tank on Lancashire County Council's Smiths Farm.

Its simple repair procedure makes it well equipped to meet the 20 year life demanded by new regulations.

At Lancashire County Council's Smiths Farm, Hutton, near Preston, a steep 6m high curved reinforced earth wall has been constructed using an MMG geotextile to create space for a 195,000 gallon effluent settling tank below a dairy unit. Using Fortrac, a soil reinforcing grid made from polyester, Dale Contractors of Colne have built a permanent, cost effective and environmentally acceptable earth wall. The construction method and the design, which was approved by Lancashire County Council's Director of Property Services, enabled the wall to green up naturally with indigenous flora rapidly blending into the landscape.

*Earth bank silage clamps are only approved in Scotland.

FROM THE PRODUCTION EDITOR

A last minute word! and an apology

The Spring 1992 issue was regrettably late in being published and this issue is running the same way. My apologies to all members on this account.

The problem is basically that new technology (a desk top publishing unit) has been introduced at our printers and it does not immediately comply with instructions and give us the same results as we enjoyed from the earlier, more manual system. Or perhaps the problem is that it is too keen to comply with instructions?

Anyway, the teething troubles are being steadily identified and overcome and we hope to be on time with our next issue.

However, a further apology is due and is herewith humbly presented on behalf on the new technology unit – A sincere apology to our Hon Editor for the three different spellings of his surname in the last issue and also to the member of our Editorial Panel for changing his membership status. The errors were inexplicably introduced even after the final proof stage! The more automatic system does not in itself guarantee correct results – as I will now relate.

Years ago – in the early days of farm mechanisation – a Scottish farmer was in discussion with his old shepherd, no doubt about sheep in particular, but also about farming in general. "We need to mechanise," he said, "to become more automatic. We'll have a combine harvester for the cereals."

Come the summer the farmer was again in conversation with his sheppard. Down below, in the valley bottom, the combine harvester was stationary in the half-finished field. "Some problem down there," said the farmer, "the combine seems to be broken down." "Aye, that's the trouble with these machines," said the shepperd. "When they're no' being a' tae'matic they're being a' tae' buggery."

Geoff Baldwin, Production Editor

ADVERTISERS INDEX

Overseas Trade Missions

The Agricultural Engineers Association are organising two trade missions to important overseas markets:–

USA and the Canadian Maritimes – Potato-oriented
29 August–4 September 1992

The mission is aimed at promoting British expertise, products and equipment for potato production from seed to potato crisps, through bedforming, planting, harvesting, sorting, handling, bagging, weighing, plant protection and processing. The areas of greatest potential have been identified as Prince Edward Isle, New Brunswick, and Presque Isle in Maine.

A DTI travel grant of £500.00 is available to eligible companies and a competitive travel package will be provided.

Japan – Agricultural and related industries
2/3 October–10 October 1992

Following the success of their first mission to Japan in 1991 the AEA will lead a mission of British companies in the agricultural and related industries (machinery and inputs for agriculture, horticulture and forestry, primary food processing, municipal and green space maintenance, etc) to Japan in October 1992.

A competitive package based on economy travel and accommodation at The New Otani Hotel in Tokyo has been negotiated costing from £1,345 per person and a DTI travel grant of £705 is available to eligible companies taking part.

To register your interest and to ensure that you receive further information as and when it becomes available please contact:

Jan Neish, Overseas Department, AEA, Samuelson House, Paxton Road, Orton Centre, Peterborough PE2 5LT.
Tel: (0733) 371381 Fax: (0733) 370664 Telex: 329201 AGRENG G

Water management in the next century

15th ICID Congress

The 15th Congress of the International Commission on Irrigation and Drainage (ICID) is to be held in The Hague, The Netherlands, from 30 August–11 September 1993 with the theme Water Management in the Next Century. Running parallel with the Congress there will also be the 7th International Exhibition on Irrigation, Drainage and Flood Control.

Printed by Trafford Print (Colour) Ltd and Trafford Typesetters at Trafford House, Holly Street, Doncaster DN1 3RG. Tel: (0302) 367509
and at 112 Bermondsey Street, London SE1 3TX. Tel: 071-378 1579

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Members: £40 + VAT
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Non Members: £45 + VAT
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Students: £10 + VAT

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