Landwards

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The professional journal for the Institution of Agricultural Engineers

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In this issue...

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Dr Emma Wilcox
Chief Executive Officer of the
Society for the Environment

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IAgrE

Contents:

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Landwards is published on behalf of the IAgrE by FarmSmart Publishing Limited.
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Jimmy Wallace (R) receives his 70 year membership certificate from William Waddilove on behalf of the IAgrE (see p5 for more.)

Editors Welcome

A lot has happened since the last edition of Landwards, between US elections, a UK budget and more importantly the Landwards conference.

The impact of some of the items mentioned above will take some time to become clear, but one thing which stands out in this edition is the need for the big problems of society to be tackled. And that's where we, as agricultural engineers come in.

Despite politics and policy, reliable and safe food supplies, responsible and resource efficient farming, and an ever-reducing environmental impact remain at the heart of societies demands from agricultural engineers.

Read on to find out more from the conference and the needs of differing groups from agricultural engineering on page 18 and onwards.

In the wider world Charlie Nicklin and Alastair Taylor recently returned from the Pan African Society for Agricultural Engineering Annual Conference in South Africa, read Alastair's report from page 32 for a global perspective.

The editor sadly had to miss this year's Landwards conference in favour of the VDI's Landtechnik conference in Osnabruck, Germany that week, but the EurAgEng report from page 16 plus practice on page 26 give a flavour of the range of current agricultural engineering research on the continent.

It's a real pleasure to see the 70-year membership certificate being presented to Jimmy Wallace, on page 5, and to reflect on Jimmy's decades long contribution to the discipline.

I hope you can enjoy a restful break over Christmas and return refreshed in the New Year.

Andy Newbold

Andy Newbold Hon FIAgrE

Editor

andy@farm-smart.co.uk

Reminder: Associate Members can upgrade free to Member grade

If you are an existing Associate Member you have the option to upgrade to Member grade providing you have completed 5 or more years in a relevant career.

However, if you prefer, you can remain as an Associate member for as long as you wish.

For more information please see https://iagre.org/upload/1621421462.pdf or contact Alison at membership@iagre.org

Engineers recognition *David R White FIAgrE, CEng CEnv, ARAgS*

On Tuesday, October 15th 2024, David was inaugurated as an Associate of the Royal Agricultural Societies (ARAgS) in recognition of his distinguished achievement within the agricultural industry. The awards ceremony event, hosted by the Rt Hon Lord Taylor of Holbeach CBE FRAgS, was held at the House of Lords. The awards are made to "individuals who have gone above and beyond, driving change in sustainable farming, supporting charities, and pushing the boundaries of research and technology". There were 29 recipients. David's sponsors were Professor Dick Godwin, HonFIAgrE and Dr David Llewellyn, CBE, FIAgrE.

David (centre) receiving his award from Nick Green FRAgS, Chair of The Council for Awards of Royal Agricultural Societies (CARAS) (left) and the Rt Hon Lord Taylor of Holbeach (right).

A historic first for the Institution

On Wednesday 11 September 2024 James (Jimmy) Wallace was presented with his 70 year membership certificate.

He joined the Institution just 16 years after it was formed; this is the first 70 year membership certificate that has been presented. He is also our oldest member at 99 years, some two years older than anyone else.

He was presented with the certificate by William Waddilove representing the President who was unable to come. William was supported by Stuart Martin also from the West Midlands branch. Jimmy now lives in Town Thorns Care home, a motor industry fund benevolent home near Coventry and they arranged for us to have the use of a special lounge area and laid on drinks and cakes.

Although he was born and brought up in Ayrshire and served as an apprentice with a switchgear manufacturer he soon moved to an agricultural dealership and then to the Massey Harris Kilmarnock factory where they were importing and building combine harvesters. There, amongst other work, he was instrumental in adapting the Canadian built machines to be used on the much denser crops grown in Europe.

When Massey-Harris and Ferguson amalgamated he relocated to the Midlands as part of the Massey Ferguson manufacturing group, to be based in the engineering department at their Banner Lane factory.

Upon retirement he became an instructor with the ATB, Agricultural Training Board, offering training on workshop design and operation as well as combine harvester maintainance and operation. He also maintained his engineering interests and one particular project he was proud of was the design of supporting steelwork for rehanging the peal of bells in his local church.

The certificates give an insight into his continued interest and enthusiasm for engineering subjects and especially combine harvesters.

His continued support for the Institution of Agricultural Engineers is also recognised in two certificates, one the West Midlands Branch 'Meritorious Award' and one for his contribution to 'The Land Based Industries'.

At the presentation he was surrounded by three of his sons and family, their friends and neighbours. It is an honour to have known and worked with him over the years.

William Waddilove
September 2024

A celebration – Jimmy Wallace was recently presented with his 70 year IAgrE membership certificate by representatives of the West Midlands Branch

AMRC Cymru: Retrofitting diesel

The Advanced Manufacturing Research Centre (AMRC) Cymru, part of the University of Sheffield, are looking into the feasibility of retrofitting diesel engines with alternative power supplies to support the UK's net zero carbon strategy, and to prevent perfectly good machinery and vehicles becoming obsolete as diesel is phased out.

An AgXeed AgBot T5 owned by AMRC Cymru will be used as a case study. Rhian Griffith, senior manufacturing research engineer at AMRC Cymru, recently presented at the IAgrE Robotics Special Interest Group, detailing the research that has been carried out so far, looking into the main drivers, challenges and potential alternative technology surrounding retrofitting.

You can support the research by sharing your opinions on retrofitting agricultural equipment, in terms of:

- Do you think retrofitting diesel engines in vehicles and machinery is a viable solution to support net zero strategies?
- What alternative technology do you think would be suitable for replacing diesel engines in agricultural machinery and vehicles? E.g. battery electric, hydrogen fuel cells, hydrogen IC engines, biofuels.
- What benefits and challenges will any of these technologies present to manufacturers and consumers?

If you wish to provide any thoughts about the questions above, or the topic in general, please contact Rhian at;

r.griffith@amrc.co.uk

For more information on AMRC Cymru, please visit; **amrc.co.uk/cymru**


University of Sheffield AMRC
Find out more

Small farmers refrigeration solution wins 2024 Earthshot prize

Keep IT Cool (KIC) provides sustainable refrigeration and smart distribution solutions for small farmers and fishers. It helps extend the shelf life of their produce, reduces spoilage, and creates more stable incomes. By improving profits and cutting down on food waste, KIC is helping build a more sustainable future for these communities.

The Challenge

Food loss from farm to fork is a huge challenge in many markets in Africa. With inadequate cold storage and transport systems in place, fisherfolk on the Kenyan side of Lake Victoria are losing up to half of their catch every day.

The lack of centralised energy grids and limited on-demand cold storage options make it harder to keep produce cool, particularly when transferring from port to market. Localised cold storage provision is one option, but it doesn't address wider supply chain limitations, which will have the greatest impact on spoilage of fresh products.

Their Solution and Impact

Keep IT Cool (KIC) addresses the challenge of food spoilage by providing sustainable, localized refrigeration systems that help small farmers and fishers preserve their produce. They install solar-powered cold storage units where fish are landed, ensuring the catch stays fresh, and then manage the transport to markets. This significantly reduces spoilage and food waste.

In addition to refrigeration, KIC connects farmers and fishers directly to retail markets. By brokering agreements with 1,600 retailers, they ensure timely purchase of the produce. This system provides income security for farmers and fisherfolk, as KIC agrees on a guaranteed price at collection, eliminating the dependence on middlemen and fluctuating prices based on the condition of the catch.

KIC currently works with eight fisherfolk cooperatives representing 4,500 members. As a result of their efforts, they've saved 25% of the catch that would have been wasted, and 3,600 fisherfolk have seen their incomes increase by more than 15%. KIC measures its success through the reduction of food waste and post-harvest losses (PHL), as well as avoided emissions from reducing spoilage, clean energy use, and hybrid trucks. Currently managing 250,000 kg of produce per week, KIC has achieved a 98% reduction in PHL for 1.5 million kg of food since 2022. Their efforts supply over 2,000 small businesses and 40 supermarkets, with demand growing from another 350 small businesses.

The Future

The solution has almost limitless potential in the food storage space. Keep IT Cool is launching Kenya's largest solar-powered cold chain distribution facility for small holder farmers this year. The new facility will have a 70-tonne capacity, which is seven times their current capacity. With plans to grow into East Africa and beyond, KIC is now working to expand their activities in poultry, fruit, and vegetables, with plans to expand its service to more communities and improving the livelihoods of up to 1.6 million people by 2030.

Francis Nderitu, Founder and Managing Director of Keep IT Cool

What is the Earthshot Prize?

Urgency + Optimism = Action

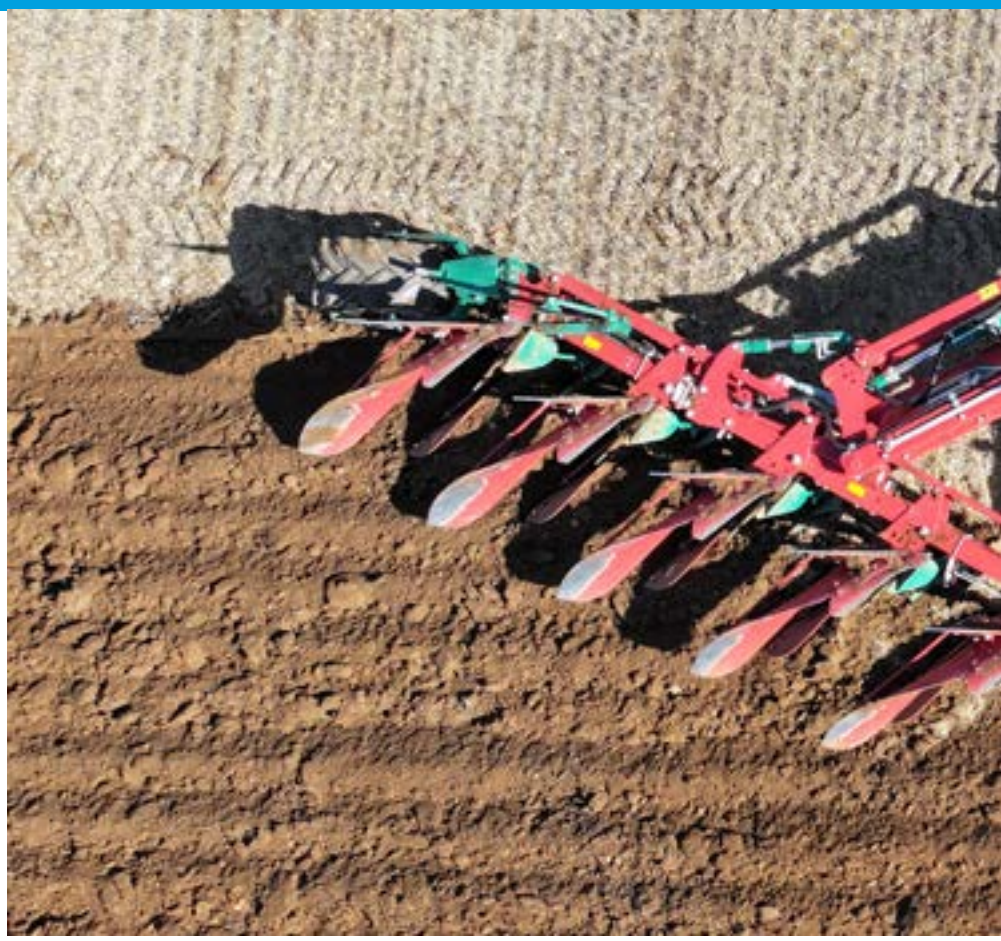
Inspired by President John F. Kennedy's "Moonshot" challenge in 1962 to land a man on the moon within a decade, The Earthshot Prize was launched by Prince William in 2020 to search for and scale the most innovative solutions to the world's greatest environmental challenges.

Change is not yet happening fast enough or at the scale we need. Levels of climate anxiety and despondency are high and political interventions are happening too slowly.

Despite all these challenges, we are optimists. We see genuine pathways to an era of regeneration and abundance.

We want to unleash the urgent optimism required to accelerate and scale the environmental innovations that will repair and regenerate our planet.

From the CEO's desk



Dare I comment on the budget?

Well I suppose its old news now but it has certainly ricocheted through the farming community with much attention being on agricultural property relief and inheritance tax.

It never ceases to amaze me the lack of understanding in government about the agricultural industry, despite having DEFRA and farming ministers. Labour continue to uphold my view that historically they've never done farmers any favours, and at that point my political comments should end!

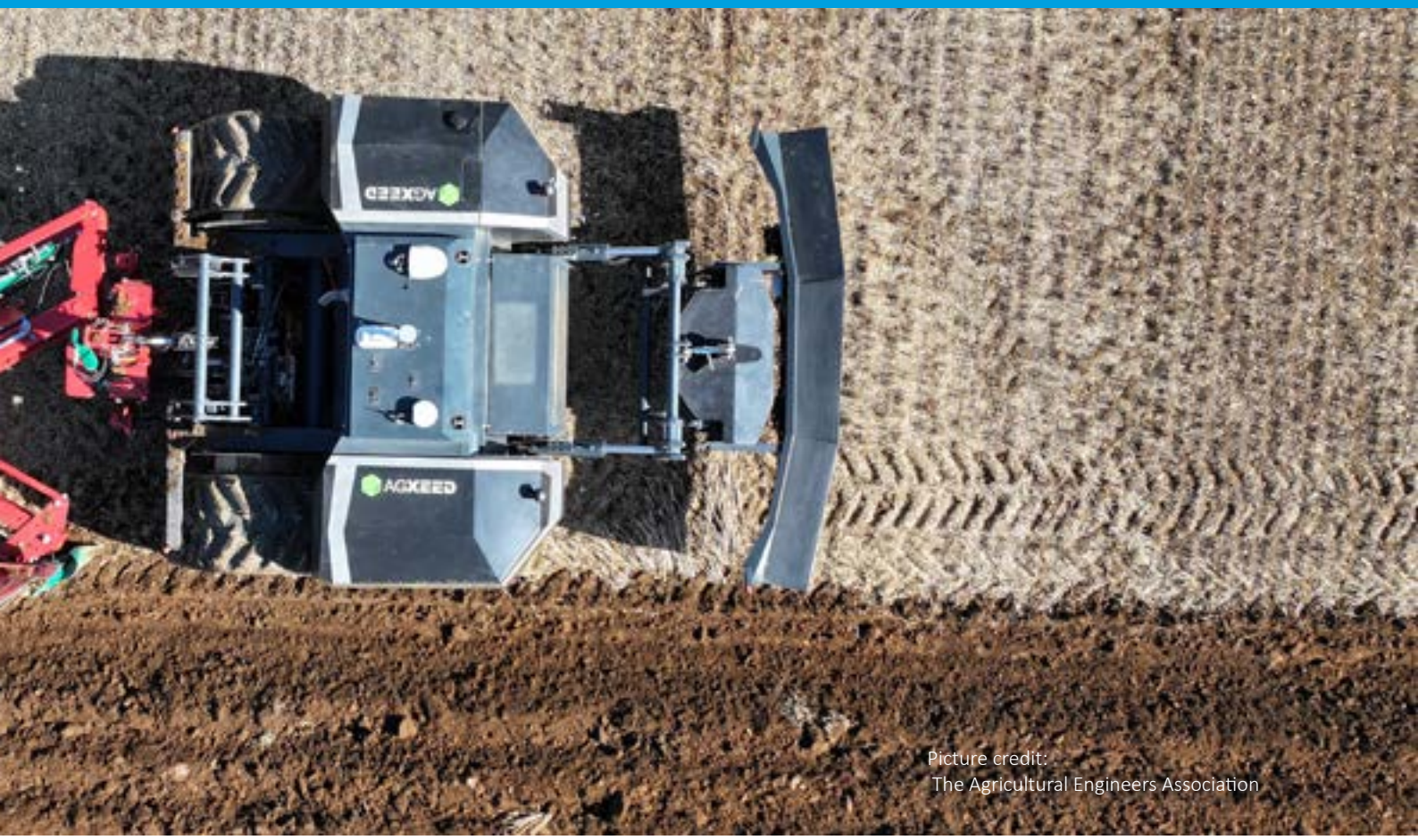
Economic factors

Despite the policy challenges in and around agriculture, the agricultural process continues and what a tough time farmers and growers have had; the weather being probably the biggest one. Associated industries are also feeling the pain, especially the machinery sector and the downturn in sales which has been brewing for over 12 months. People often ask me why has there been such a downturn? you don't have to dig deep to see why.

We had a huge peak in machinery production post-Covid due to the previous supply chain restrictions. There has been significant increases in machinery cost with inflation and energy cost rises. Farm input costs went through the roof with diesel and fertiliser, although these have relaxed somewhat. We then have the big hike in interest rates and cost of borrowing. These plus other things like the poor harvest and political situation have really affected peoples buying decisions, this of course then knocks on to dealers caught in the middle left with high stocks; not a pretty recipe for cashflow. A worry now is that, farms caught in the inheritance tax issues will think twice about investing in farm infrastructure projects, such as buildings for fear of pushing farm values up and not getting a return on that investment.

Exciting times

It's very easy to get downbeat, but in the engineering and technology world we're in exciting times. Seeing agriculture from a different countries perspective certainly gave me a real boost. Alastair Taylor and I were invited to give keynote speeches at the Pan African Society of Agricultural Engineers conference in Cape Town back in October. I've been lucky to have travelled the world in past roles but never Africa, although I've probably been spoilt now starting with Cape Town! The diversity in subject material was mind boggling, one minute I'm in a lecture about identifying disease in maize using multispectral imaging from drones and next it's about the design of animal drawn implements in Senegal for the peanut basin. The technology bandwidth is incredible, but the reality is that farming remains highly un-mechanised and many of the 51 million farms in South Africa



Picture credit:
The Agricultural Engineers Association

are <2 hectares. Yes there are large corporate European style enterprises, with equipment to match, but in the main most are sustenance farming to feed their families. Creating the right mechanisation and more importantly the support behind it ie. dealers, training, parts support, etc. has and continues to elude many major companies. The opportunities for young agricultural engineers in South Africa is huge and the subject area is taken very seriously by government and NGO's, and when the prize is food security, or more specifically getting rid of hunger and starvation then it does focus the mind. As Alastair has covered the conference in more detail in his article on page 32 onwards of this journal I won't discuss it much more. It's certainly an interesting part of the world, full of enthusiasm for the exciting future it has ahead.

Different perspectives

Back in the UK it is IAgrE Landwards annual conference time. Rothamsted Research Centre in Hertfordshire was the venue and with an interesting mix of high-profile stakeholders and industry professionals we explored what is needed from engineers working in agriculture.

I am, of course biased, but what a fantastic event it was, it made a refreshing change not listening to engineers telling us how we should solve the problems but seeing it though different sets of eyes and the problems faced in the whole farm to fork process. We only scratched the surface; the discussions gave a very different perspective with many reoccurring themes; field data/ software system compatibility being a key one (and to be clear I'm not referring to ISObus which many often think covers this). I would have loved for the audience to be full of people from the agri-tech sector so they could see how much low hanging fruit there is, and that it doesn't all have to be hi-tech data-rich solutions to solve some of the sectors problems. The conference is covered in more detail from page 18. More about the speakers, plus their presentations and papers is available on our website.

Membership fees for 2025 will be due soon, we continue to keep our fee increases as low as we can around normal inflationary levels. We do continue to offer great value professional membership for those in the sector with an excellent range of content to suit all. Annual discounted Direct Debit is the most cost effective way to pay, but if you wish to spread your fee over the year the monthly payment scheme continues.

And finally, its maybe getting a little late, but off the back of the registration videos released mid-year we launched a 50% discount on registration fees for applications in by the end of the year. If you are interested, then please do get in touch with Alison at membership@iagre.org and I'm sure we could support you with a discount!

And finally, seasons greetings to you all and best wishes for the New Year.

Charlie Nicklin CEO CEng FIAgrE
ceo@iagre.org

President's Musings

Mark Moore

A good time to be an engineer

The global downturn in the farm machinery sector seems to be the main thing occupying people's minds currently. Some commentators have suggested a combination of climate change, conflicts in Europe and the Middle East, political uncertainty and an increase in interest rates, have created the perfect storm.

In addition, farm commodity prices have continued downward putting further pressure on farm incomes. All these factors have knocked farmers confidence to invest resulting in less demand for machinery and technology. In 2024 tractor sales in Europe are expected to be down by 5% compared to 2023 and combine sales down by 20%, and it's a similar story in other regions of the world. Consequently, many farm equipment companies and machinery dealers are restructuring their businesses to accommodate the downturn.

Positive dynamics

With all this gloom I understand why the downturn tends to be the topic of conversation when you meet people. However, the dynamics of our industry remain positive. As I mentioned in my Autumn 2024

The dynamics of our industry remain positive.

musings – we need farmers to produce food for a growing global population, and those farmers need mechanisation and technology to produce more food in a sustainable way. This rising demand for food is a critical factor driving industry growth, which is estimated to be worth $151.9b by 2032, up from $102.8b in 2023.

With all the advances in agricultural mechanisation, innovation, and technology I still believe there has never been a more exciting time to be an agricultural engineer, and the November 2024 Landwards conference held at Rothamsted Research undoubtedly demonstrated this.

A systems approach

The aim of the conference was to have an open discussion around the need to develop and deliver food production systems rather than individual products, and to get agricultural engineers thinking about the opportunities this presents. Representatives from UK and EU policy, food retail, agronomy, livestock, and farming presented their challenges and what they need to help overcome them. In short, "what we want from agricultural engineers".

Many themes developed throughout the day as all parts of the food chain acknowledged innovation and technology is part of the future of farming and their business. However, a reoccurring topic was the need to pass data seamlessly between stakeholders within the food chain. The current incompatibility between software and data systems is something that was emphasised and must be solved if challenges around sustainable food security are to be overcome.

As a machinery and technology sector we are great innovators resulting in products such as precision farming. However, there adoption rate has been relatively low which is partly due to the lack of systems thinking. To an extent, farmers have become the systems integrators where they "join-up" individual products and services into a usable system which can be deployed on the farm to create additional value. This was outlined very well by James Price, representing the farmers viewpoint at the conference. James suggested the time and energy trying to join bits of technology and data together detracts from the time that could be spent on getting value from it. Keiran Walsh, providing the agronomists viewpoint, outlined instances where tractor drivers have sat stationary in fields while manufacturers and software providers sort out data incompatibility issues. This emphasised the importance of working together to develop products that integrate into sustainable food production systems.

In my opinion you can judge the success of a conference by the tone of conversations during coffee breaks and over lunch. I could tell people were already pondering over the content of the day and formulating ideas and follow ups. Our message about reaching out to the wider food chain and working together has been very well received.

A critical role

To conclude, I acknowledge the downturn in our industry is of concern, but the clear message delivered by the food chain at the Landwards conference is that agricultural engineering has a critical role in delivering sustainable food security. We need to develop innovation that integrates into food production systems. This means we must continue to reach out and talk to policy makers and other partners to ensure we have the joined-up approach. Moving forward, please keep the conversation going. We are all part of the solution and the more we talk to each other the more aligned we will become as we all work on the task of delivering sustainable food security.

Finally, I would like to thank Charlie, Sarah, Marion and Alison on behalf of the entire IAgrE membership for organising a very successful Landwards conference. Events like this don't just happen! There is a great deal of planning and organising that went into the Landwards conference and I would like to recognise this effort. Thanks should also be extended to the presenters, Kate Halliwell, Jelte Wiersma, Jake Pickering, Keiran Walsh, Claire Morgan-Davies, and James Price, who all prepared and presented excellent presentations.

Dr Mark Moore FIAgrE

Biosystems Engineering

Biosystems Engineering, owned by the IAgrE, and the official scientific journal of EurAgEng, is published monthly with occasional special issues.

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Biosystems Engineering

Volume 244, August 2024, Pages 122-133

ERoots: A three-dimensional dynamic growth model of rice roots coupled with soil.

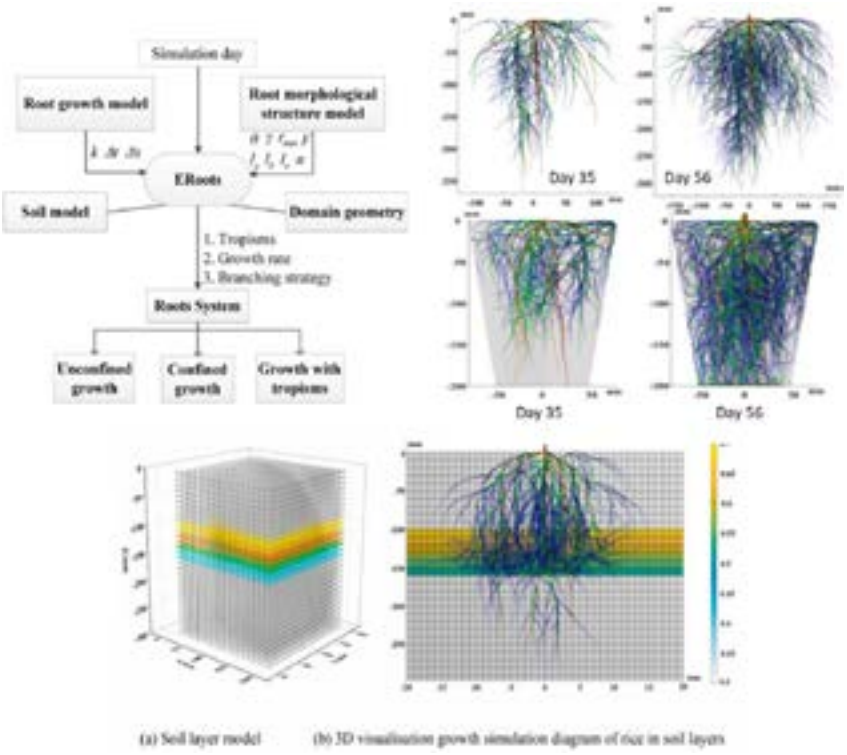
Le Yang, Panpan Wu, Zhengkang Zuo, Lan Long, Junlin Shi, Yutang Liu

School of Computer and Information Engineering, Jiangxi Agricultural University, Nanchang, China

Highlights

- A 3D rice root growth model, ERoots, was proposed based on parameter L-System.
- Root-soil integration was realised by ERoots model.
- 3D visualisation ability of rice roots under three soil conditions was verified.
- Three indicators reflected the flexibility in coupling with soil.

In this paper, a 3D visualisation model of rice root growth based on the parameter L-system is proposed, and called ERoots. The basic morphological structure model of the root system was constructed from the aspects of root branching, growth direction and radius, and the law of the change of total root length with time was determined by the logistic function as the growth function of the root system. ERoots combines a root morphological structure model with a growth model and defines L-system grammar iteration rules with the unit time and unit step length as parameters. At the same time, the basic growth parameters of rice roots were obtained via destructive detection, and 3D growth visualisation of roots was realised via MATLAB. In the soil coupling process, a soil nutrient simulation map was constructed based on the spatial soil characteristics per unit volume, and an adjustment strategy for roots reaching the growth boundary was designed. This permits the model to be run under various constrained conditions, both physical and chemical and to reflect the tropisms of root growth, growth rate and root branching strategy under constraints. Two aspects were mainly studied: root development under the superposition of multiple nutrient concentrations and the adjustment strategy of the growth direction when the root growth reaches a growth boundary. The dynamic growth of the root system was affected by the soil properties and mainly reflected the following three aspects: (1) tendency; (2) growth rate; (3) branching strategy. Compared with existing root growth models, the ERoots model freely combine these three features to permit the 3D visualisation of root growth in different environments. Although designed and validated with rice roots, this study provides a reference for 3D growth modelling and visualisation of other crop roots.



Top left: Flow chart of ERoots model showing the sub-model coupling; **Top Right:** Examples of unconstrained root development at two time stages (35 and 56 days) and a comparable example within a constrained environment (plant pot) ; **Bottom:** ERoots applied to 3D root modelling in the prescence of a subsoil constraint.

Biosystems Engineering

Volume 245, September 2024, Pages 12-23

Multi-detector and motion prediction-based high-speed non-intrusive fingerling counting method

Jialong Zhou, Zhangying Ye, Jian Zhao, Daxiong Ji, Zequn Peng, Guoxing Lu, Musa Abubakar Tadda, Abubakar Shitu, Songming Zhu

College of Biosystems Engineering and Food Science/Ocean College/ Shenzhen Research Institute, Zhejiang University, China

Key Laboratory of Equipment and Informatisation in Environment Controlled Agriculture, Ministry of Agriculture and Rural Affairs, Hangzhou, 310058, China

Hainan iAQUA Technology Co. Ltd., Hainan, 570100, China

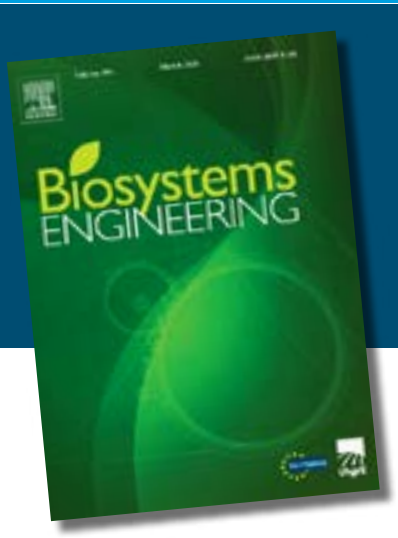
Hangzhou Xiaoshan East-Sea Aquaculture Co. Ltd., Hangzhou, 311200, China

Highlights

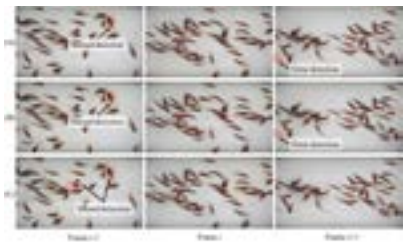
- Combined Mixture of Gaussian segmentation and blob detection for fingerling counting.
- Integration of a motion prediction model achieved over 99% average counting accuracy.
- Open access to a dataset containing

biosystemsinformation for details of the preferential rates for both paper and electronic versions.

Over the past three months (August – October 2024), Biosystems Engineering published 49 articles, including 3 review articles. The following three articles, one from each volume, have been chosen to illustrate the diversity of work in the journal.



annotation files for fingerlings counting.



Results of fingerling detection and counting across consecutive frames using three different YOLO-based models (A) YOLOv7-tiny, (B) YOLOv5N and (C) YOLOv5-Lite

Fingerling counting is a basic operation in fish farming and provides an important guideline for many aspects of aquaculture. However, most of the current counting methods are inefficient or computationally cumbersome. This study proposed a high-speed, non-intrusive fingerling counting method based on multiple detectors and a motion prediction model, which achieved high-accuracy counting under the condition of low-frame rate. Firstly, to effectively detect and locate the adherent fingerlings, the detector was accomplished by combining the Gaussian-based (MOG) segmentation algorithm and the local extremum-based blob detection algorithm. Secondly, three different functions were used to construct a motion prediction model to predict the approximate probability of the fingerlings at each position in the previous frame. Lastly, the cost matrix was constructed to associate the fingerlings in consecutive frames, so that the newly appeared fingerlings were counted in real-time. Through testing and analysis on 52 collected datasets under low-frame-rate (10 fps) acquisition conditions using two different fish species, the best motion prediction model reached over 99% average counting accuracy for both species. This method provides a low-cost, high-speed, and stable application solution for computer vision-based fingerling counting addressing the issue of counting quickly moving objects in video streams.

Biosystems Engineering

Volume 246, October 2024, Pages 248-262

Attention-driven next-best-view planning for efficient reconstruction of plants and targeted plant parts

Akshay K. Burusa, Eldert J.van Henten and Gert Kootstra, Gert

Agricultural Biosystems Engineering, Wageningen University & Research, Wageningen, Netherlands

Highlights

- Method to plan the next-best viewpoint to reconstruct the nodes of tomato plants.
- Adding attention mechanism improves the efficiency of next-best-view planning.
- Performed systematic evaluations with both simulation and real-world tomato plants
- Effectively handles occlusion in complex greenhouse environments.

Robots in tomato greenhouses need to perceive the plant and plant parts accurately to automate monitoring, harvesting, and de-leafing tasks. Existing perception systems struggle with the high levels of occlusion in plants which often results in poor perception accuracy. One reason for this is because they use fixed cameras or predefined camera movements. Next-best-view (NBV) planning presents an alternate approach, in which the camera viewpoints are reasoned and strategically planned so that the perception accuracy is improved. However, existing NBV-planning algorithms are agnostic to the task-at-hand and give equal importance to all the plant parts. This strategy is inefficient for greenhouse tasks that require targeted perception of specific plant parts, such as the perception of leaf nodes for de-leafing. To improve targeted perception in complex greenhouse environments, NBV planning algorithms need an attention mechanism to focus on the task-relevant plant parts. Through simulation experiments using plants with high levels of occlusion and structural complexity, this study showed that focusing attention on task-relevant plant parts can significantly improve the speed and accuracy of 3D reconstruction. Using real-world experiments, it was further shown that these benefits extended to complex greenhouse conditions with natural variation and occlusion, natural illumination, sensor noise, and uncertainty in camera poses. To the best of the authors' knowledge, this is the first work to test the advantage of an attention mechanism for NBV planning using a robotic setup in a real-world greenhouse environment. The results clearly indicated that using attention-driven NBV planning in greenhouses can significantly improve the efficiency of perception and enhance the performance of robotic systems in greenhouse crop production.

Top: Generic pipeline of a volumetric next-best-view planning algorithm with the three major stages – (I) extraction of information from current viewpoint, (II) sampling of a set of candidates for the next viewpoint, and (III) estimation of information gain and determining the next-best viewpoint. **Bottom:** a) The real-world setup with a robotic arm using a Realsense L515 RGBD camera. (b) Front and top views of the 100 viewpoints used for collecting data of tomato plants for reconstruction exercises and (c) Example images of tomato plants collected by the robot, showing the level of occlusion that is common in this situation.

Profession

EurAgEng Report

Conferences are like trains..

For the first time in decades the Secretary General missed the IAgrE's Landwards conference due to a diary clash.

I recently attended the VDI Landtechnik conference in Osnabruck, Germany.

This was a great opportunity to get involved with like-minded engineers and find out the latest thinking across a wide range of internationally significant agricultural engineering developments.

Historically the Landtechnik conferences are very close to industry, and this one did not disappoint, with excellent presentations around AI, perception systems, autonomy and optimising production systems. An immersive few days focussing on the practical applications of innovation.

Young professionals

The Young Professionals Network of EurAgEng was very well represented with an afternoon parallel stream on the first day which combined both research and industry sessions. The stream also included the chance to talk and meet with international researchers and network amongst colleagues. Well done to all involved.

I would like to thank and recognise the Young Professionals Network for their hard work with this conference and encourage all EurAgEng members to support the community.

The latest thinking across a wide range of internationally significant agricultural engineering developments

Applying some engineering to an age old problem

One fascinating paper from Landtechnik titled *Active tillage – Potential for increasing the efficiency of active soil tillage in crops, which are cultivated in ridges.* Presented by Kai Dernjak who conducted the research whilst working for Grimme.

The work stemmed from the need to reliably produce the optimum soil crumb size for potato crops using rotary bed tillers. Traditionally potato seed beds have been smashed to bits with power harrows and rotary tillers, without much thought given to what is the best soil crumb dimension for fuel efficient

Kai Dernjak

operations, crop growing and resource use.

It turns out that a soil crumb diameter of 8-12mm is ideal to provide the best soil structure for potatoes with the optimum soil pore volume for holding water and nutrients close to the roots. As an aside its recommended to avoid crumbs greater than 40mm diameter.

The work analysed rotary tiller rotor shaft design and torque requirements, to identify an optimal tine design, arrangement and working speed to produce the desired soil crumb effect.

Soil engaging tine design also influenced the torque requirement and the soil crumb results, and it became clear that different designs either cut or hit the soil, with consequent outcomes.

One headline from the work was that torque, and hence fuel use with the optimised rotor design in the rotary tiller reduced to approximately 70% of the original amount.

The optimised rotor design is now incorporated in Grimme's production models.

Other papers

There was a lot of work presented regarding AI and data management, specifically an excellent paper from product engineer and PhD student Frederick Eichhorn of John Deere.

Titled *Low-cost, rapid development of object detectors for automation in Agriculture* which looked at incorporating AI large language models (LLM) into the detection of corn cobs and hence crop density and yield via camera sensing on combine headers.

Elsewhere in the Autonomy stream there were several papers focused on the developments of the Krone/Lemken Combined Powers autonomous field machine. The author was interested in an insightful paper presentation entitled *Integration of a safety concept for an autonomous agricultural machine.* Presented by Timo Shulte from Krone and Joost Roelse from Lemken.

Whilst the wider world will be wondering how the results of the US elections will play out, I came away from Osnabruck excited about the future for agricultural engineers. With a vibrant research community and embedded industry innovation and development, we have a lot to be grateful for, and plenty to work on.

Further information

For reports of recent sponsored international events and forthcoming ones.

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Don't forget if you would like to get more involved please contact the secretariat at;

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EurAgEng

Profession

IAgrE Conference

"We have to ensure food security, but we have to be able to make money doing it." Dr Mark Moore, IAgrE President

Don't just talk among yourselves

Agricultural engineers need to talk to a wide circle of people to help the world to solve the closely linked problems of achieving a secure food supply and protecting the environment.

IAgrE President Mark Moore opened and closed the IAgrE's annual Landwards conference, held at Rothamsted Research Station with a succinct message about the industry's role: "We have to ensure food security, but we have to be able to make money doing it.

"The United Nations' Food and Agriculture Organisation says we will need 60% more food by 2050. Achieving that will be an enormous challenge.

"We cannot work in the silos we have worked in during the past.

"We're really good at talking among ourselves and there's nothing wrong with that, and we have made great progress.

"There is a growing desire to talk to people outside our sector. That is what this conference is all about. "We have a great opportunity to work as a team and resolve some of the challenges we face".

He echoed those thoughts in his closing remarks:

"There has never been a more exciting time to be an agricultural engineer when you look at all the opportunities we have to address some of these challenges".

The key to success is for different sectors to work with each other to develop applications of the technology:

"If we can do that we have a winning formula for sustainability and food security".

Jelte Wiersma, secretary general of the European Agricultural Machinery Industry Association (CEMA)

Meeting the challenges

Everyone involved in agricultural machinery is facing a multi-part challenge – but meeting it successfully could reap huge rewards.

Jelte Wiersma, secretary general of the European Agricultural Machinery Industry Association (CEMA), explained the challenge thus:

"Farmers, politicians, food chain stakeholders, civil society and consumers expect our engineers to develop and build tools that enable farmers to stay in business, be competitive, provide affordable and safe food for Europe and beyond, decrease the environmental footprint, maintain the countryside and improve the work-life balance of farming families".

To emphasise the point he repeated the entire paragraph twice, followed by to comment "No pressure then, aye?"

CEMA is now the voice of Europe's farm machinery industry and plays a key role in ensuring politicians have accurate information at their fingertips when considering legislation:

"We are consulted and give advice on agriculture and technology legislation and engage in EU research projects".

For the future he suggests the sector is similar to the rest of society in facing the twin challenges of energy and data:

"If we can produce cheap, plentiful, clean energy, and make better use of data we should be able to solve many of the world's problems. Our industry is leading in both".

In its lobbying activities it urges authorities to let the industry solve its own problems:

"Give us the liberty to develop solutions for farmers. We advocate for the 'Freedom to Farm' principle. It's up to farmers to decide how they want to farm.

"They work in different circumstances, produce different foods and have different preferences. It's not up to anyone to tell them how to farm."Knowing farmers as I do, I would suggest it is better not to do that anyway".

Advances depend on a healthy dialogue between farmers and suppliers, with farmers deciding what they want to grow and the machinery sector giving them the tools to do it.

"This interaction between farmers and us is one of trial and error and success. We are not perfect and our engineers sometimes come up with solutions that work in theory but not in practice".

Not all innovation is readily accepted he says, pointing out that many motorists prefer simple on/off buttons to the multiple options presented by some modern vehicles' control systems.

Hindering progress?

He criticised legislation for sometimes slowing down progress, citing EU and UK plans to ban combustion engines for cars:

"Any ban would block innovation. We produce combusting engines that can run on fuels that do not emit greenhouse gases.
"We have solutions that enable farmers to produce electricity and fuel on their own farms to power their machines. These solutions are being sold commercially.

"We also make battery powered vehicles".

Data's role

Other innovations will also help reduce the industry's chemical usage and improve animal health monitoring.

He cited spot spraying as a key benefit:

"The president of Europe's young farmers association (CEJA) told me he bought one and now uses 95% less product. It combines cameras, AI and big data to only spray where needed, which is a win for the farmer's purse and the environment".

Similar systems were enabling dairy farmers to spot small changes in behaviour that reveal the onset of disease, enabling them to intervene earlier and cure the animal faster using less medicine.

He believes the data should also enable farmers to gain better prices for food grown in more environmentally friendly ways because technology that improves farm practice also meets the demands of the supermarket's customers.

Data collected by these machines should also give the agri-food chain a clearer picture of how the food it offers customers has been produced. The legislative background has changed, he added:

"After years of punitive legislation, the new European Commission seems more open to working with farmers and it's supporting industries like ours to move forward".

US election

He was speaking the morning after Donald Trump regained the American presidency, and hoped his pre-election threats to introduce huge tariffs might not be realised:

"It is worrying but 'the soup may not be served as hot as it's being cooked' as we say in the Netherlands.

Kate Halliwell, Chief Scientific Officer of the Food & Drink Federation

"Much depends on the relationships between the individuals involved as much as the politics, although that always plays a role.

"Tariffs are meant to encourage more domestic production, but history shows that in the long run everybody is less well off than if we all trade freely".

Where do we stand?

The new Labour Government's attitude to the food and farming sector is not yet clear, but early signs are worrying.

That warning came from Kate Halliwell, Chief Scientific Officer of the Food & Drink Federation:

While the Government wants the sector to invest and grow, its exclusion from its list of key priorities worried her:

"Funding tends to follow those top priorities and food was not among them".

At the time of the conference – four months after the General Election - the Federation still hadn't been able to talk to the Department of Business and Trade on the issue.

The sector also struggles to recruit as many people as it needs, having a 4.9% shortfall (v 2.6% for all manufacturing):

"We don't have enough people or people with the right skills. That makes it very hard to be productive and make the changes we need".

She sees a clear benefit in the new Government's efforts to forge a closer relationship with Europe:

"It's not clear what that means, but there would be clear benefits from closer alignment and less disruption at the borders".

She sees some benefits of a post-EU UK being able plot its own course on issues like genetic engineering, precision breeding and novel proteins, and how they are regulated:

"If we can become a global leader we could develop and grow crops which we could export".

"EU regulations are not set up to move swiftly. It's currently the opposite of an agile system".

The role the industry could play in helping the nation feed itself better was also under discussion:

Jake Pickering, Waitrose Senior Agricultural Manager.

"The Government is concerned with food quality as it impacts the NHS and the economy.

"We are looking at how companies can produce healthier foods and how we encourage consumers to eat healthy food and more fruit, veg and protein".

That effort had to be combined with seeking greater environmental sustainability – an effort in which she says the entire food chain needs to work together.

And the Government must recognise that investment which achieves those aims must be rewarded by better returns to farmers.

Clear communication

Ensuring clear communication with the customer is key for retailer Waitrose, said Jake Pickering, the company's Senior Agricultural Manager.

That means transparency over where products are sourced and how they are produced.

That should be communicated by clear labelling so customers can make informed choices.

He sees that as the way to ensure customers feel comfortable paying more for food produced using environmentally sound methods.

Waitrose believes in developing long term relationships with suppliers and paying them fairly:

"We are not the easiest retailer to supply and we ask them to jump through hoops".

"It is important to have stable, long-term relationships with farmers and growers. It is important they make a profit and can hand the business on to the next generation".

Changing costs

But setting fair prices is hard when costs change rapidly.

The supermarket is keen to cut food waste, and saw re-introducing livestock to arable rotations as a good way to ensure crop residues were not wasted.

While some question the logic of putting a wrapper on cucumbers that already have a protective skin, he points out it extends shelf life from three to 12 days, which cuts food waste.

The company encourages a 'community' atmosphere among its suppliers: "They discuss things between themselves and share best practice ideas".

That includes those with specialist knowledge of specific topics sharing that with less knowledgeable colleagues.

Using reliable, real-time data is also important, he added: "Anything the industry can do to supply us with information on costs helps us pay fairly.

"It is important to be competitive and fair so we do not leave farmers with no profit but we also don't over-pay and have to charge customers more".

Tech needs to earn rewards

Farmers need to ensure their investment in new technology earns a reward, said agronomist Keiran Walsh, one half of the Cotswold-based consultancy Grounded Agvice:

"A lot of technology has been introduced and added a huge volume of cost. But much of it isn't really affecting net margins.

"It may all look very pretty but you must ask what it achieves"

Fast results

For the future he suggests it should focus on doing things better and providing quick, actionable data:

"As an agronomist I am constantly taking leaf samples, but if I only get an analysis back from the lab 10 days later that's too late.

"I need tools I can use every day so I can advise the farmer what to do that afternoon or tomorrow. That is how tight the window is".

The same applied to things like yield maps, which he says should be produced as soon as the vehicle making them left the field.

Tools that aid early detection of disease ingress have real value: "If I have information like that to hand I can save the farmer £40/hectare – and current crop margins can be less than that".

He wonders whether someone could develop a glove that could analyse a leaf the moment it was picked – while admitting that might be 20 years in the future.

"For the moment we need lightweight; cost-effective; easy-to-maintain tools that are accessible to all farmers however big or small they are, and cross-platform compatability".

And he urges farmers to value the data all this technology produces:

Agronomist Keiran Walsh from Cotswold-based consultancy Grounded Agvice

"As an industry we are very good at giving our data away for free. It's your data and as soon as you give it away its worthless. People should pay you for it".

He expects automation to make an increasing impact, which would help the industry's dire labour shortage:

"We have a huge labour problem and nobody wants to sit on a tractor all day or work on a farm generally".

A request from the machinery industry

Farmer James Price, who farms 3,600 acres near Woodstock, Oxfordshire, is aiming to reduce growing costs – and especially diesel usage – by employing controlled traffic and camera-guided hoes.

His 'utopia' would be to be able to sit in a control centre and manage all farm operations from it, although he admits to enjoying driving the sprayer too much for that to become reality!

He echoes Keiran's point about lack of compatibility between different control systems, pointing out that recording essential data such as fuel usage is not standard across platforms.

And much of the data gathered - while valuable to the manufacturer as they try to predict errors and foresee problems – is pretty irrelevant to the driver:

"All this technology has to be a benefit to me and provide me with information that I can use".

At the same time some technology can cause problems, he added, recalling an incident with a malfunctioning AdBlue monitor on his sprayer:

"It left me stranded on a dual carriageway and I crawled home at 3mph. That's really expensive down-time and a cost to fix it".

He identifies four key things that he would like manufacturers to offer in future:

"ANYONE designing a tractor must put a decent tool-box on it.

"I need a roll of spanners; a socket set and some spares as well as an airline hose to clean out radiators and a grease gun.

"You can't get all that in a small toolbox and I don't want them rolling around under my feet".

"I also need BETTER GPS SECURITY. I have three different systems and three different ways of securing them. And every night the driver has to climb up remove the unit so it doesn't get stolen", something he sees as a needless risk.

"If I had DIRECT INJECTION for the sprayer I could make massive spraying savings, which would help me prove to customers that we're doing the right thing".

"And CAMERA GUIDED spraying that enabled me to spray only where there is a weed would also be valuable.

"The looks people give you when you are spraying are awful. If I could use only 5% of the chemical by using camera guided spraying it would be fantastic".

James Price, Oxfordshire farmer

Robust tech for livestock

Technology for livestock farms need to be robust, because sheep will try to destroy anything, says Claire Morgan-Davies.

She is a livestock scientist based at the Scottish Rural College (SRUC), Crainlarich research farm in the West Highlands.

Using technology that relies on a 4G internet signal is often impossible for livestock farmers in remote areas:

“At Crianlarich we only have one tiny slither beside the road that has 4G coverage. We have to download the data every night rather than constantly monitoring it”

That lack of accessibility explains why the majority of livestock farms use no technology even though most of them say electronic identification (EID) would help them.

Key roles include locating and managing stock; monitoring health and providing early disease detection; helping effective selection for breeding and measuring performance.

Like the other farmers, she finds lack of compatibility and difficulties in syncing systems a problem, as is lack of after sales support.

The sector’s needs are simple, she said: tools need to be cost effective; able to be installed across the whole herd/flock; easy to understand; provide real time or downloadable data and must work outdoors”.

Power supply – whether by battery, wind or solar - is an issue, as was unit size and durability:

“For lambs units must be small enough for them to carry; for sheep they need to be really durable because they have a habit of rubbing everything”.

Claire Morgan-Davies, Livestock Scientist, SRUC

Practice

Carbon Farming

Carbon cut and fill

What if there was a proven, straightforward method to improve soil fertility and ramp up carbon sequestration at the same time? Presented at the VDI Landtechnik Conference in Osnabrück in November 2024 was a paper on Ameliorative Fractional Deep Tillage (aFDT). Andy Newbold got his head around it.

The idea of swapping a slice of low carbon subsoil with an equivalent piece of higher organic matter (and hence carbon) topsoil is sensible, but how to do it?

The Leibniz Centre for Agricultural Landscape Research(ZALF) in Germany are partway through a German Federal Ministry of Food and Agriculture funded project to do just that.

ZALF In collaboration with international manufacturer Lemken, are developing a carbon farming plough.

The objective being a series production ready machine for soil carbon enrichment.

Backstory

Professor Dr Michael Sommer, ZALF project lead, says that Ameliorative Fractional Deep Tillage (aFDT) is not a new idea, and has been around since the 1960's, when it was originally developed in the former East Germany.

Carbon remains in the subsoil decades after the original work

This 1979 experiment was revisited in 2021 and the effect of the ploughing is still evident.

ZALF revisited sites where the work had been originally done from the 60's onwards with a modified plough with alternating depth furrows. The first furrow running deeper and the second furrow throwing the topsoil down into the first, thus swapping the soil profile over.

Living history

Next these sites had a soil profile dug to identify the different soil layers. In one case from a 1979 experiment, 42 years after the original work, it is still possible to see the mixed soil layers in the profile pit. At least 50% of the original soil organic matter from the operation in 1979 is still present in the ploughed profile.

Carbon measures

The results showed that the gain in carbon sequestration in the formerly low organic matter subsoil, is now consistent with the surrounding higher organic matter topsoil.

In sandy soils there is a net accumulation of 1t of CO_2 /Ha/year over a ten year period before the field reaches carbon equilibrium. In medium loam soils this accumulation is more like 3t of CO_2 /Ha/year over a 10 year period.

How does it work in practice?

Carbon ploughing is not an annual activity, as research has shown that there are long lasting benefits of a single pass. Growers should treat the procedure as a repair exercise say once every 10 years. The process has the ability to alleviate soil compaction in the same pass.

The ploughing can be controlled via RTK, to ensure the same pathways as previous activities, or (assuming you can remember the direction you ploughed the field in, 10 years hence!) at a 45% degree angle to ensure further mixing of the profile.

The carbon plough

Lemken's solution has a front furrow running 25cm deeper that the 2nd furrow, which then fills the first deeper subsoil furrow with topsoil. There is about 25% soil exchange between the different depths.

The plough has a furrow width of about 75cm point to point.

What about the cost?

Now hold on a minute, the finished plough is a substantial piece of kit, a hybrid reversible subsoiler plough (to coin a new machine sub-genre) and clearly takes some pulling down the field.

Professor Sommer explained that trials work has shown an additional diesel bill of about 10l/ha, which equates to c 40kg/Ha of carbon cost. Small change in comparison to the 10t/Ha minimum CO_2 sequestration benefit of the procedure.

Benefits

The breaking up of compacted soils and the ongoing increase in soil organic matter is showing yield increases of up to 5% from the first year.

Additionally with income streams becoming available for growers to demonstrate carbon sequestration, the technique and the carbon plough will open up new income streams.

What is not to like about a ploughing process which increases soil fertility, crop yields and resilience to drought whilst creating a stable CO_2 sink?

About ZALF

The Leibniz Centre for Agricultural Landscape Research (ZALF), an institution of the Leibniz Association.

The mission of ZALF is to deliver solutions for an economically, environmentally and socially sustainable agriculture – together with society.

As a contribution to overcoming global challenges such as climate change, food security, biodiversity conservation and resource scarcity, we develop and design crop systems, integrated in their landscape contexts, that combine food security with sustainability. Therefore ZALF processes complex landscape data with a unique set of experimental methods, new technologies and models as well as socio-economic approaches.

ZALF research is integrated systems research: starting from processes in soils and plants to causal relationships on the field and landscape level up to global impacts and complex interactions between landscapes, society, and economy.

SHAKE programme secures £845k for next cohort of climate-tackling entrepreneurs

Unique combination of investment and mentorship for agri-tech start-ups attracts new funding partners.

The SHAKE Climate Change entrepreneurship programme has secured £845K to invest in new projects that will help deliver the next generation of climate friendly farming.

Based on a unique funding model, SHAKE helps entrepreneurs and start-ups who are combating climate change with science or tech-based ideas in the areas of agriculture and food production.

Those ventures that progress through all three phases of the programme will receive up to £125k funding and two years of expert mentoring to help build their business.

Now in its fourth year, the Programme is hosted and led by Rothamsted Research as part of a consortium with three leading universities – Cranfield University, the University of Hertfordshire and University College London.

Original funding for the initial 4 Cohorts came from the Societe Generale UK Foundation, who are now joined by three more investors to enable SHAKE 2024 - Climate Change Cohort 5: Beeches Capital, the Lawes Agricultural Trust, and The Novo Nordisk Foundation.

"Having witnessed the breadth of ideas, entrepreneurial spirit and dedication of the ventures involved, as well as their scaling-up potential, the Foundation is proud to have been part of SHAKE's origins and we are pleased to continue to support it alongside new partners", said John Oberman, Chair of the Societe Generale UK Foundation.

Director of Innovation for Rothamsted Research and member of the SHAKE Programme Steering Group, Rob Hill said: "SHAKE is unique in the UK as the only research-led seed investment programme for Agri-tech ventures with a positive impact on climate change."

The programme focuses on closing the gap in business development between the early start-up stage and investable ventures, through provision of expert care and advice, sourced through the high-profile consortium and its associated network of mentors.

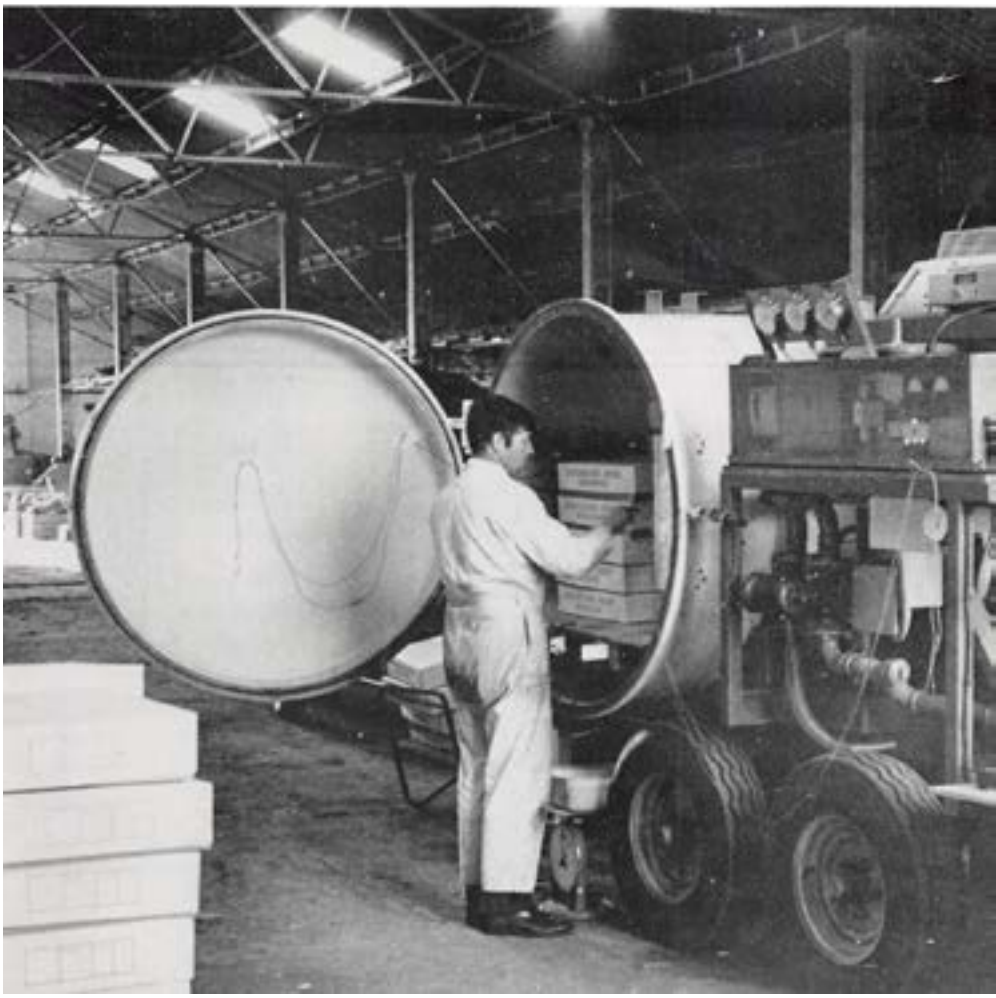
The first four cohorts, from 2019 - 2022 involved a total of 64 entrepreneurs with 11 successful ventures ultimately selected by SHAKE for investment.

Practice

Archives

Learning from the past to keep farmers safe in the future

The launch of a 'National Farm Safety Year' in 1970 was the catalyst for the current regular annual safety week in our sector. IAgrE member and health and safety professional Mike Whiting reflects.



The results in terms of reducing fatalities and serious incidents are significant. One of the biggest challenges back in the early 1970's was "we didn't know what we didn't know". An article from the popular farming press from this decade refers to how an operator sets up a wood cutting saw bench to avoid the immediate hazard of serious cuts and lacerations. There is no reference to the use of personal protective equipment which would have prevented the inevitable onset of hearing loss and depleted lung function.

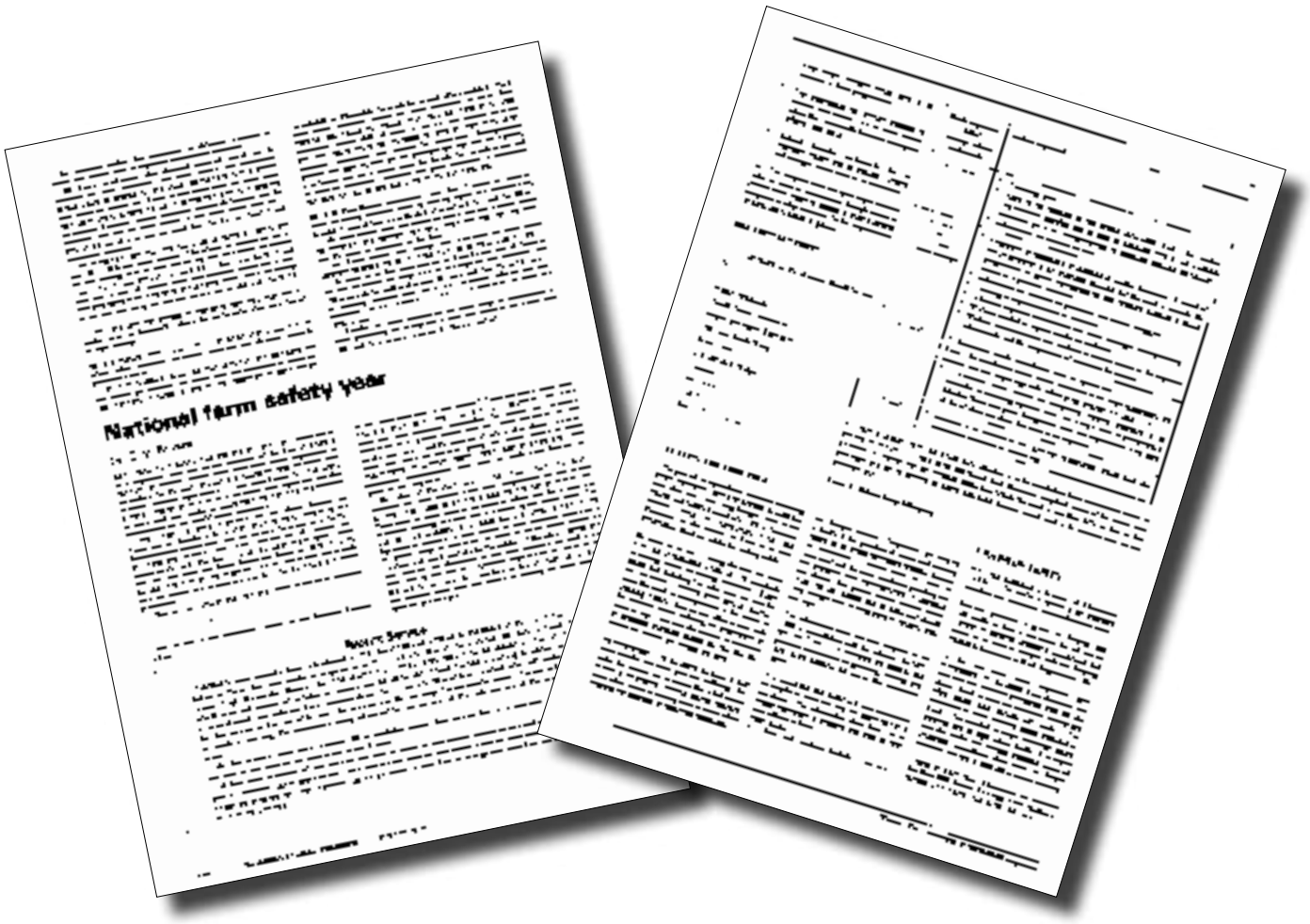
Agricultural Engineers have been pivotal in ensuring the primary method of risk reduction have been applied as part of the development process. 'Inherently safe design measures' are the result of engineering controls to prevent injury. Whether this be specifying hydraulic drives as a replacement for power take off shafts or drop floor systems on round balers to clear blockages. Internal workings of harvesting machinery are now enhanced to extend operational hours and continually improve the quality of the sample produced.

Technology allowing the operator to remain safe in the cab whilst systems are exploited to their full potential.

So where should our skills be focused as we move ever more rapidly towards an autonomous environment? Given the recent effects of heavy rainfall on seeding equipment there's every chance that swarms of smaller equipment will face the same treatment. A post on social media referred to a conventional tractor which had been configured to work without an operator. The decision to add a front

hopper meant that all the sensors had to be re-positioned, and the calibration process repeated. Our 'crystal ball' will need to consider what operators will expect from their machinery in the future. The panel at the recent IAgrE annual conference gave their precision farming 'likes' to auto guidance as a game-changer in machinery efficiency. Whilst 'dislikes' were targeted towards coding errors in software which can bring an abrupt halt to operations when available weather windows are constrained.

Regarding safety, somebody will be required to repair one or multiple 'bots' which have stopped. It will be wet, and dark, and it's probable one may be in a ditch somewhere as that headland slope was just a bit steeper than the sensors calculated. The priority amongst the logarithms and data capture is ensuring the subframe can withstand the forces applied from a tow chain attached to 300 horsepower.



About Mike Whiting

Mike is a Chartered Agricultural Engineer, specialising in machinery safety and compliance. He is the chair of the Institution of Occupational Safety's Rural Industries Group, and slaves away as the secretary of the Western Branch of IAgrE.

Mike is also a trustee and Executive Board member of the IAgrE.

Practice

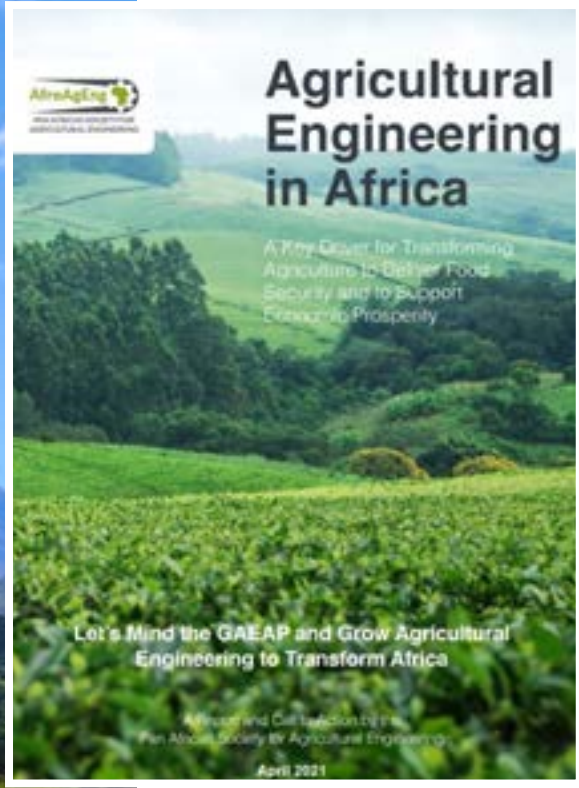
Pan African Society

Pan African Society for Agricultural Engineering Annual Conference

Imagine a Conference for Agricultural Engineers where there are around 100 delegates with about a significant number under the age of 30 and about a quarter female. That was the case at the recent Pan African Society for Agricultural Engineers (PASAE) conference which took place in the Western Cape in October. Alastair Taylor HonFIAgrE, IEng, CEnv reports

There were delegates from South Africa, Kenya, Ethiopia, Ghana, Nigeria and various countries from across the African continent. The conference was run on line as well. All of this demonstrates the traction being made to showcase the importance of our discipline in keeping Africa fed. Wouldn't it be great if we had such enthusiasm here in the UK?

IAgrE have been involved with PASAE for many years, mainly as part of a Royal Academy of Engineering project to support the development of Agricultural Engineering across the continent. At present there is



Showcasing the importance of agricultural engineering in keeping Africa fed

a one-year project focusing on "Raising Public Awareness and the Profile of Agricultural Engineering to Grow and Sustain Agricultural Engineering Professional Engineering Bodies in Africa" and I have been involved as the UK point of contact along with the IAgrE's CEO Charlie Nicklin. We have hosted a visitor to find out how we engage with members and in October we attended the conference to share our thoughts.

In my case, it was the fulfilment of an old promise which was scuppered by the Covid Pandemic, and I was delighted to be a key note speaker talking about the report I produced in 2021: ***Agricultural Engineering in Africa: A Key Driver for Transforming Agriculture to Deliver Food Security and to Support Economic Prosperity.***

The report gives 25 recommendations and it was my opportunity to summarise these. It was not lost on me that the same recommendations would not go amiss here in the UK. In summary they are:

- Raise the Profile (awareness, media, partners, advocates, showcase our contribution)
- Reform and Modernise (education, policy, curriculum, standards, share, collaborate, industry, partnership)
- Grow the Profession (professional bodies, promote, clear value proposition, get out of the silo)
- Create New Opportunities (Link to the SDGs, talk to stakeholders, collaborate, identify the barriers)
- Sustain the Contribution (engage with NGOs, promote professionalism, be proud, meet, talk, share)

I was very struck that the attentive audience were very much on side, and it was great to see examples of the report recommendations being shared with government ministers and others of influence. It was even better to hear of universities prioritising Agricultural Engineering qualifications and degrees.

Changing attitudes

My lasting impression is that the project is making good progress in changing attitudes with the young people of Africa (and there are a lot of them with an average age of under 20 – such energy to be harnessed).

We only have to see the Earth Shot and African Prize for Engineering Innovation to see that modern day Agricultural Engineering and association technologies is at the top of the African agenda. It was a pleasure to be part of it.

Technical

Blog Brash

Together i

Drea

Together in Elec-Trak dreams

What the Rise and Fall of an Electric Pioneer Teaches Modern AgTech Innovators

in Elec-Trak

ams...

What can such a short lived company tell us about developing new technologies?

Elec-Trak was a General Electric (GE) company that was the result of some experiments GE had been carrying out into electric cars in the late 1960s.

GE noticed that some of the drawbacks of electric cars, weight, range and speed could be beneficial in a tractor design. After some initial R&D work the first few Elec-Trak prototypes were shown to dealers in 1969. The GE team started with a very modest 40000 square foot production facility and by 1973 this had grown 20X in size.

The tractors themselves had a variety of electric motors for propulsion (the highest power being 16hp) and six 6v batteries to provide a total of 36v. GE developed a huge variety of different attachments including mowers, chainsaws, inverters, sickle bar mowers and even agricultural sprayers. With most of the attachments being electrically driven from the battery, making the most of the portable battery power and modularity of the system. Elec-Trak was a relatively short lived company with the company ultimately sold off in 1974 to the Wheelhorse company.

Short lived technology?

So why was Elec-Trak so short lived as a company and what can it teach us about developing new technologies?

- Market conditions in 1973 were not ideal, inflation was running at 6.2% in 1973 and this jumped to 11% in 1974 (this makes the inflation figures of today look very tame). This put huge pressure on household budgets and serious limits on consumer spending power. This led to a period of deep economic recession that dampened sales.
- GE sold the Elec-Trak tractors on consignment to dealers and had to wait for dealers to sell machines before any cash made its way back to GE.
- Electric vehicle technology was in relative infancy and while the concept and use case made a huge amount of sense, consumers were too used to the performance and use case for gasoline (petrol) powered equipment.

Lessons learned

How does Elec-trak compare to modern electric tractor companies such as Monarch tractors? Well in some ways it is an unfair comparison, while both machines are electric, the markets they are selling into are quite different.

Elec-Trak was aimed at consumers and hobbyists where-as Monarch sells to farmers and growers running businesses. Meaning that the use-case, financing and sales strategy will be very different too.

However there are some lessons that can be learned from a comparison between Monarch tractors and the Elec-Trak:

- **Implements -** The Elec-Trak had a range of different attachments that were ahead of their time, with extremely efficient electric motor drives. This however limited the interoperability with existing PTO or hydraulic drive machinery. Monarch on the other hand has a PTO and hydraulics systems, allowing the tractor to be used with existing machinery, making the most of machinery farmers already have, making adoption much simpler.
- **Additional Value Propositions -** Monarch tractors don't sell tractors solely on electric propulsion, they combine capabilities such as fleet management software and autonomy with their product offering allowing the sum of the parts to be greater than the individual pieces. Elec-Trak was simply a hardware offering that was able to capitalise on a compelling use case for batteries and electric drive.
- **Battery technology -** Elec-Trak was limited by the lead acid battery technology of the era meaning a comparatively low power density when compared to the lithium-Ion technology being used by the likes of Monarch tractors. Lithium-Ion batteries could have raised the operational time for the Elec-Trak and perhaps helped to secure the Elec-Trak as a legitimate competitor to gasoline powered garden tractors.
- **Funding -** Monarch Tractors have recently received a Series C investment of $133 Million that is set to propel the company to new heights. Elec-Trak had the benefit of being an internal GE start-up funded with a generous but comparatively modest $772000 ($6.6Million in today's money). Perhaps Elec-Trak would have fared better if it had been able to raise external funding rather than being dependent on GE to stay afloat?
- **Cash flow strategy -** Elec-trak was burned by consignment sales to dealerships and the loss of margins and limits to cash flow that this caused. Monarch has a direct to farmer sales cash flow strategy that means Monarch can retain good margins on hardware sales. Monarch also has a subscription strategy for some of its software products and services.

Ahead of its time

So, to conclude Elec-Trak was a technology ahead of its time with a range of electric tools and technology designed to make the most of an electrically driven tractor platform and a very compelling use case. However, the company was caught out by harsh economic conditions that exposed fragile business models that limited cash flow.

Today's electric tractor manufacturers have had over 50 years of battery development to help propel their machinery. Companies like Monarch tractors have been able to see the upsides of blending new technology such as autonomy with old technology such as three point linkages, PTOs and hydraulics to provide versatility between tools and tasks. While at the same time offering direct sales offerings that help keep margins high and cash flow positive, even in harsh economic times.

Check out:
https://myelec-traks.com/

for more information about the history of Elec-Trak and the tractors themselves.

About Ray King CEng MIAgrE

Ray King is a Chartered Agricultural Engineer with a particular interest and expertise in autonomous farming systems, design and development, alongside the day job he is the co-presenter of the Brash-Ag podcast.

Ray King CEng MIAgrE
Agricultural Engineer I Technology Consultant I Ag-tech Podcaster

Listen again

Watch again

All the monthly lunchtime lectures are recorded and available via the Institutions own YouTube channel.

One recent presentation is:

e-Agri– integrating sensors to deliver Low Carbon, Smart Agriculture & Crop Phenotyping – Dr Bruce Grieve, e-Agri Sensors Group Leader, Electrical & Electronic Engineering, University of Manchester,

e-Agri may be defined as the fundamental device engineering, electronics and sensor system design to help deliver future sustainable agriculture and food systems.

The presentation introduces the concepts and motivations behind e-Agri and illustrates these with a series of research examples from the group, of the same name, based at the University of Manchester (UK). This is the only dedicated agri-sensors engineering group to be based within a significantly-sized School of Electronic & Electrical Engineering (c.80 academic staff).

The presentation draws upon existing industry sponsored research in the group, notably related to platform technologies in: Sub-surface electro-impedance tomography, Networked fungal pathogen sensing, Mass producible low-cost wireless nodes for soil monitoring and Close-proximity active hyperspectral imaging. These are used to exemplify how engineering research can be translated from non agri-food duties, re-engineered and then integrated with plant science and agronomy research to create novel ‘smart farming’ technologies and laboratory-to-field crop phenotyping.

Professional

DBT

The Douglas Bomford Trust

A hectic few months for people receiving financial support from the Douglas Bomford Trust. Technical Secretary David White reports.

Roger Hoxey, ex-Silsoe Research Institute, attended two conferences to present work on measurements in the atmospheric boundary layer (ABL). The first was the 9th International Colloquium on Bluff Body Aerodynamics and Applications 29th July – 2nd August 2024 held at the University of Birmingham.

Paper: *Fluctuating surface pressure measurements on the 6m cube.*

The second was the Wind Engineering Society WES2024 14th UK Conference on Wind Engineering 4th – 6th September 2024, held at the University of Southampton.

Paper: *Reference pressure for wind load measurements in a turbulent boundary layer.*

"I would like to thank the Douglas Bomford Trust for financial support enabling me to present our work at a National and an International conference".

Kit Franklin (IAgrE President Elect) and Ray King recently launched their series of podcasts, Brash Ag, aiming to help inform those working in the agricultural engineering sector as well as attract new people to the agricultural engineering space. The co-hosts discuss new and existing agtech topics as well as interviewing some of the key people in the industry.

"We are very grateful to DBT for making this possible. At this point, we have 11 episodes. The feedback has been very positive. Hopefully, we are spreading the word about the importance of Ag Engineering."

The podcasts have already gained over 50 followers and over 500 streams across Apple music, Spotify and other leading podcast platforms.

A trip to Finland

The DBT funded 6 engineers to attend a 2-night educational visit to Finland in August. The trip included 2 company visits, including PONSSE Forestry machinery and the Valtra tractor factory.

Attendees learned about and saw new machine technology in the agricultural and forestry industries. Building personal networks was another key aspect. Attendees were Rhodri Williams, Henry Lapworth, Dom Neal, Sam Withers-Lewis, Rob

Weston and Charles Cooper.

"Finland is a beautiful country, and it is always great to meet new people, learn new skills and experience cultural differences. Thank you for the financial support ", Dom Neal.

A Japanese experience

Harper Adams University PhD student, Aimee Tonks, attended the 27th International Congress of Entomology (ICE), Japan, 25th – 30th August 2024.

ICE is one of the largest conferences for the science of entomology. Over 4,000 individuals from 82 countries and regions gathered at the Kyoto International Conference Centre.

"Attending and presenting my research at ICE 2024 was a truly incredible opportunity. The conference explored research across all areas of entomology, including pest management and pesticide application technologies. I gave an oral presentation of my PhD research exploring the potential of physically acting bioinsecticides for use in open-field agriculture. It was an honour to present my research at such a largescale, esteemed international congress and build my network as an early career researcher. I want to thank The Douglas Bomford Trust for their support and contribution towards this once in a lifetime opportunity".

Prize giving

On 26th September, Nick August (DBT Chair) attended the Royal Agricultural University's (RAU) Graduation Ceremony and Vice Chancellor's Lunch. Nick presented the Douglas Bomford Trust prize to MSc Agricultural Technology and Innovation student, Mansour Haken, for the best agricultural engineering dissertation, "A Fungal Challenge to Autopoiesis: Exploring a Novel Biology-Push Biomimicry of Mycorrhizal Fungi". Congratulations, Mansour.

"On behalf of all of us at the RAU, thank you for being a Prize Sponsor. We value your support and hope that you will continue your involvement in the future". Melissa Spagnoli, RAU, Development Office.

RAU Student Mansour Haken collects the DBT prize from Chair Nick August

Just Giving

Finally, if you wish to donate to the Trust to support its work, the Trust is now registered to accept donations through Just Giving, please follow the link on the DBT website. Just Giving will collect the donations on behalf of the Trust, and GiftAid can also be claimed on donations made by those who pay UK tax.

JustGiving

For further information, see the Trusts website:

www.dbt.org.uk

Or contact the Secretary David White via:

enquiries@dbt.org.uk

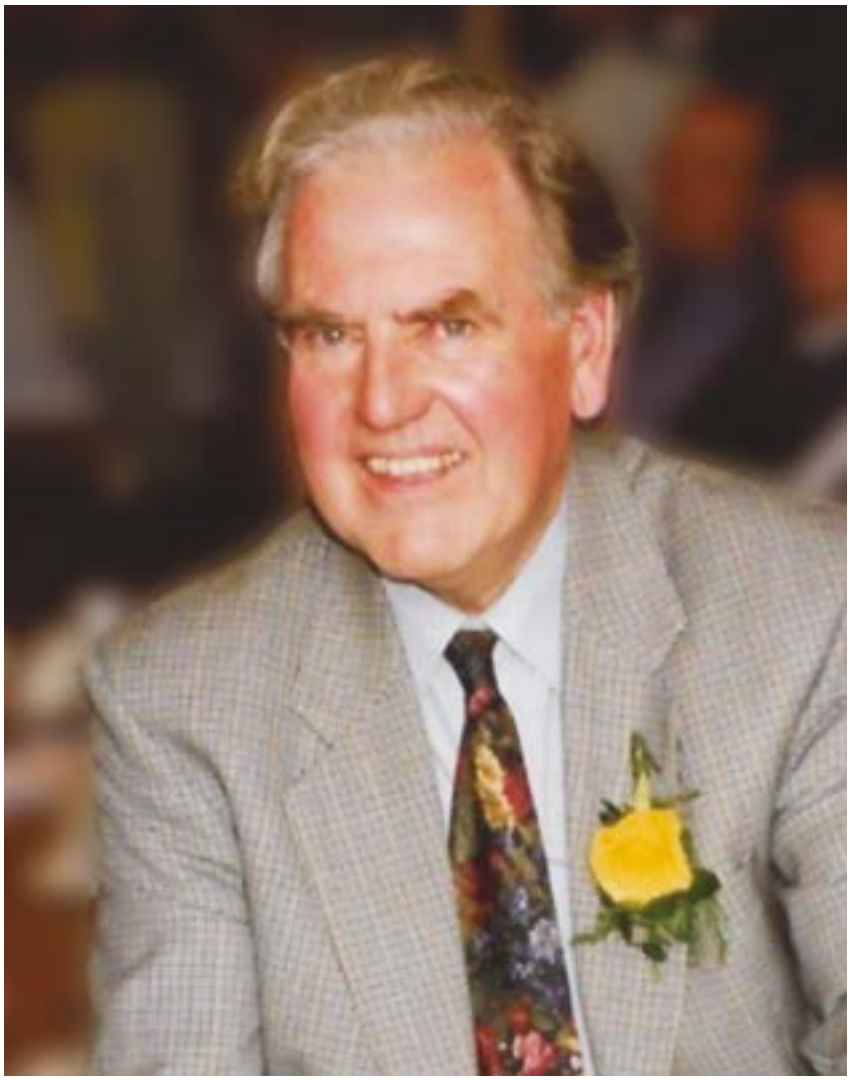
You can also follow:

@BomfordTrust

on 'X' and 'LinkedIn', for news , opportunities and events

Membership Matters

Obituary John Hubert Neville, CEng, Hon Fellow IAgrE



John Neville died on the 2nd of August 2024; he was born in Walsall in November 1931. His father died when John was 2 years old leaving his mother to bring up John alone through the difficult times in the 1930's and the 2nd World War. Fortunately, John won a scholarship to Queen Mary's Grammar School and worked on farms during vacations saving enough money to buy his fist motor bike. Igniting both his love of agriculture and anything with wheels!

John graduated with a BSc degree in Agriculture from Nottingham University, an NDA from Sutton Bonington and a MSc in Agricultural Engineering from King's College, University of Durham, Newcastle. Upon graduation he served for 2 years as a 2nd Lieutenant in the Royal Electrical and Mechanical Engineers, recovering and repairing Centurion tanks.

In 1959 John took up a Lectureship in agricultural engineering at Writtle Agricultural College in Essex. Transferring to the newly established National College of Agricultural Engineering (NCAE, later known as Silsoe College) at Silsoe in 1963 where he was to work for the remainder of his career. During which, based on his lecturing skills and support for student activities, he developed a reputation among the students as "a good guy to know".

In 1967 he was seconded to Karaj, Iran for 2 years to aid in the development of mechanisation for irrigated agriculture, where he trained postgraduate students from Iran, Pakistan and Turkey and managed the Training Centre Farm. This was the first of many overseas secondments for NCAE staff. John also assisted with the first SAFAD (Student Aid for Agricultural Development) expedition to Karaj in 1968. Upon his return to Silsoe he resumed his lecturing role together with a number of further overseas consultancies. For example, to Swaziland where he was External Examiner and advisor to the University of Botswana, Lesotho and Swaziland in the development of the Department of Agricultural Engineering.

In the 1970's John's career changed direction with his appointment as Academic Registrar at the NCAE the post he held until his retirement. In this role, he was responsible for the academic administration of the College and was well regarded by his colleagues as he was always "keen to help resolve any problems". His team describe him as "a kind and caring colleague", "a sort of father figure" and "the best boss I ever had". He was always cheerful with a wonderful sense of humour.

John was totally committed to the agricultural engineering profession serving as a member of both the Education and Training Committee of the British Agricultural and Garden Machinery Association and the National Joint Apprentice Council for the Farm Machinery Trade. He was the Chief Examiner, for the City and Guilds of London courses in Agricultural Engineering in Tropical Countries. He joined the Institution of Agricultural Engineers (IAgrE) in 1956, gaining CEng in 1981, after which he served as Chairman of both the Chartered Engineer Registration Committee and the Membership Committee. He also served as Vice-President (1983-1986). In 1995 John received the award of Honorary Fellowship for his outstanding services to the Institution. Upon his retirement from the College, John undertook the role of Acting Secretary of the IAgrE until a permanent appointment could be made.

John's contribution to the NCAE/Silsoe College and the IAgrE over many decades did much to establish the professional reputation of agricultural engineering both in the UK and internationally.

His love of wheels was valuable when he had to replace the clutchplate on the family Ford Cortina in Greece on the 4000 mile drive back to Silsoe from Karaj, as the local garage was not sure how to do so. This love continued to be a major feature for his hobbies where he would regularly help maintain and co-pilot a friend's 1904 De Dion Bouton on the London to Brighton run, enjoy being an active member of the MG club and in retirement repair motor vehicles at the Shuttleworth Collection.

John's wife Val who he married in March 1959, pre deceased him in 2006. Their son Mark, daughter Louise and their families, to whom we send our sincere condolences, survive him.

A tribute to Martin Chester

Martin's father farmed a sizeable dairy farm near Leek in Staffordshire. Martin was accepted into Silsoe College to read Agricultural Engineering, graduating with Credits across the board in due course. Fellow students at the time will remember the 'Nine Minis into the Foyer' Rag-week incident! Martin would never be drawn on his involvement (but he knew how to get them out!). Think about it, 5'-wide Minis through a 4'-wide doorway....

His aim was to let father continue to run the farm and he to enjoy a career in agricultural engineering – JCB were just round the corner so to speak and were expanding. But even before he'd graduated from Silsoe, and regrettably for Martin's career aspirations his father was diagnosed with muscular dystrophy and Martin was obliged to return to and run the home farm.

He joined the Institution even before leaving Silsoe and was assigned to the Wrekin Branch, and despite the 30-odd miles between Leek and the Harper Adams College near Newport, Shropshire where most of our technical meetings were held he rarely missed a meeting or a social gathering. His support for the Branch was noticed so it wasn't long before he was co-opted onto the Branch Committee and served for many years thereon. He was a stalwart Committee member but declined 'offers' of Branch Committee office because of his commitments at home - by that time his father had succumbed to his disease so Martin was in sole charge.

Martin was diagnosed with cancer some 10 – 12 years ago and fought the affliction with immense resolve and strength of character but in September after many 'false hopes' the inevitable happened.

I'm sure that the many IAgrE members who knew Martin will join me in saying: "Rest in Peace"

Denis Cartmel

This image depicts a tractor simulation towing a trailer on a road with oncoming traffic. The inset picture illustrates the simulated driver's perspective, showing a passing car and an approaching lorry. The display panel indicates the operating conditions of the simulation: the tractor is moving at 10 km/h, the engine is running at 1,500 rpm, the steering wheel angle is 10 degrees, and the throttle position is at 10%.

West Midlands Branch

Technical presentation

Simulation solutions for agricultural vehicles & precision farming - Steven Child, Senior Technical Sales Manager – IPG Automotive and Claudio Maroni, AgriSI product manager

Report by Stuart Martin

West Midlands Branch hosted an on-line technical presentation from IPG Automotive on 17th September.

Steven Child opened the presentation by outlining the history of IPG Automotive and the products which they offer in the domain of digital simulation for the automotive industry.

IPG Automotive was founded in 1984 as a spin-off of the Karlsruhe Institute of Technology and now extends to a team of 400 spread across 16 offices round the world from which they serve over 250 customers with simulation software. IPG Automotive simulation is based on three variants of their software package, CarMaker, TruckMaker and MotorcycleMaker. The presentation focused on the use of TruckMaker to provide a "Closed Loop Simulation Environment" for the development of off-highway and agricultural vehicles. By creating a sophisticated model of the vehicle and operating that within a "Virtual Environment" any combination of operating conditions can be simulated. The virtual vehicle is controlled by the "IPG Driver" which operates the vehicle in the same way as a human driver does – reacting to the conditions presented by the simulation. The simulation software has applications in a range of technology development up to and including full autonomous vehicle systems.

TruckMaker serves to integrate existing simulation software packages to enable multiple test scenarios to be evaluated for a robust analysis or assessment of the models in a multitude of operating scenarios. The simulation can be used in a wide range of ways ranging from a pure "Model In the Loop" (Entirely computer based simulation) to "Powertrain In the Loop" where a physical powertrain is run on a dynamometer in association with the model.

By making use of simulations in this way, development in any combination of environmental conditions can take place at any time and the same test can be repeated in exactly the same conditions time and again – i.e. in agricultural terms you can plough the same furrow in the same field on the same day repeatedly with variations in the model between runs to assess the effects of small changes.

Claudio Maroni continued the presentation by setting the context of the global agricultural industry and its role in feeding 3 billion more people by 2050 against a background of depopulation of rural areas and the need to reduce demands on resources such as water, pesticides and fertilizers. The innovations associated with precision farming clearly have an important role to play in the future. Examples of the application of simulation include helping the manufacturer to carry out process development in a timely manner or helping the farmer to select the optimal machine and technology for his particular application. Simulation can also be used as a training tool, for example to help the tractor driver learn how to use his machinery in a safe environment.

AgriSI integrates the vehicle and tyre model with an implement model – this simulation can then be operated in various scenarios which can be defined based on a specific geographic location and / or terrain conditions. A prescription map can be applied to distributing implements and different sensors can be integrated into the process.

Within AgriSI the tractor model may be built from experimental data or from a multi-body model. The powertrain can be configured with an internal combustion engine, a hybrid system or a fully electric power source and operating through a specified gearbox and driveline model. Power train characteristics can be applied including a power and torque curve or a fuel consumption map. The model then operates on a simulated surface accounting for soil plasticity and tyre characteristics. The attached implement is fully simulated, e.g. in terms of PTO connection and loading and any physical geometry or spread distribution. The tractor simulation can communicate with the implement simulation by means of the vehicle specific communication protocol e.g. CANBUS, ISOBUS or TCP/IP. In the case of an attached plough the soil characteristics and plough body are simulated to inform the calculation of the forces and moments exerted on the tractor.

The simulated tractor and implement can be operated in any field in the world based on the definition of boundary and shape. The simulation can be extended to include all of the fields on a particular farm – thus creating a "Digital Twin" of the real operating environment. By adding prescription maps and distribution trajectory algorithms, fertilizer application can be simulated and robustness to GPS noise can be investigated.

Several examples demonstrating the comparison of seeding, fertilising and spraying operations between experimental and simulation were shown. There was no error in comparison of the area of worked soil, operational time was simulated to better than 4% error and product distribution error was no more than 2.5%.

Fuel consumption and emissions

IPG Automotive and SI are currently working on several applications for the simulation tools – including a collaborative project with Horiba-MIRA who provide the off-highway powertrain model in order to evaluate fuel consumption and emissions. A paper based on this project is expected to be presented at the SAE's Energy & Propulsion conference in November 2024.

A further on-going application of the simulation process is the development of an autonomous driving control system for vineyard inspection.

While the application of the IPG Automotive simulation tools is widespread in the passenger car and commercial vehicle sectors, its application to the agricultural vehicle sector is an emerging and developing process. We are very grateful to our speakers for giving us an insight into this emerging application of the technology.

Wrekin Branch

Meeting report

Methane mitigation, enabling products and systems

Chris Mann, Bennamann.

CNH methane powered T6 and T7 tractors

Ian Bennett, CNH

Report by Bill Basford

Hot on the heels of the Landwards Summer 2024 coverage of the subject, Chris Mann and Ian Bennett spoke to the first session of the Wrekin Branch programme. Chris took the meeting passionately through the impact of Methane levels in the atmosphere and his company's approach to capture and use of the gas.

Considerable supporting data was presented, some headlines were: an open topped slurry lagoon boiled off methane routinely, dependant on temperature. Possibly worth £3.00 per day, or more. 1 kg of Fugitive Methane (losses and leaks to the atmosphere) is equivalent to some 86 kg CO2. He noted that most of the audience would be aware that CO2 was normally the key reference of energy audits. The significance was not lost on the audience whilst videos showed free roaming cows in the Cornish landscape. A single cow was suggested as producing 171.5 kg methane per year equivalent to filling up the average car 6 times.

Thus, he outlined his company's activities in working with local farmers in Cornwall, Waitrose in Hampshire and other HGV users in creating projects to harvest the methane, process it and use it for prime mover power on farm or highway. Of course, such few words here shoot through considerable detail of such plans – the audience was not slow at seeking answers to many questions, one of which confirmed that slurry towers could not be capped currently – pressure vessel significance ruled that out. Purpose designed inflatable bags sited in new excavations were highlighted as the way forward. Packaged plant already is developed for gas processing.

Ian Bennett described where the CNH methane powered tractor project had got to. Working with Bennamann in several areas he indicated much of the practical challenges and benefits to the use of methane as an energy source. Particular challenges have been high exhaust temperatures needing ceramic coatings on key surfaces of turbo and exhaust pipes. He stressed that engine management systems had to cope with far more cyclical changes in power / torque levels referencing larger balers as particular issues where ram loadings varied quickly.

He illustrated fuel storage demands well showing visually for several fuels the increased volume occupied by tanks/pressurised cylinders, eg, CNG / Methane, Hydrogen and LNG / Liquid Methane compared to good old diesel. The challenges of adding range to the basic tractor initially satisfied by front mounting tanks, with side mounts and increased pressurisation looking at new materials – carbon fibre were discussed. Range over various jobs including extenders was suggested as 4.5 -14.7 hours before fill up, dependant on task.

Question time revealed that some 200 methane powered CNH tractors were 'out there' with current costs being some 30% higher than diesel models.


METHANE

Membership Changes

1/08/24 to 31/10/24

Admissions

Member

Mr Matthew Mutter (Wrekin)
Mr Christopher Faulkner (Southern)
Nr Greg Wright (Wrekin)
Mr Ryosuke Sasaki (Japan)
Mr Gruffydd James (Western)
Mr James Croxford (Wrekin)
Mr Patrick Nix (East Midlands)
Mr Ewache Umama (West Midlands)

Associate Member

Mr Sam Howden (East Midlands)

Technician

Mr Mark Wheeler (South East Midlands)

Student

Harper Adams University
Eimear Dunne
Harry Luck

Royal Agricultural University
Onyedikachi Emereole
Timo Cooper

Glasgow Caledonian University
Jordan Welton

Hartpury College
Emma Home

CAFRE
Tommie Phair
Fionn Devlin-Kelly
Alex Somerville
Clarke McCabe
Reece Thompson
Samuel Dalzell
Harry McMillan
Jacob Willis
Thomas Richardson
Adam McMullan
Matthew Nelson
Rhyan Doole
Jack McKirgan
Gavin Dewart
Rory McShane
Darren Moorhead
Thomas McAlinden
Aaron McCready
Ryan Murphy
James Hoy
Rhys Coburn
Jack Dorrian
Dylan Reid
Freddie McCall
Sam Killen
Grace Nevin
Adam Booth
Danny O'Kane
Lewis Armstrong

Deaths

We have recently learned of the death of the following members and we send our condolences to their family and friends:

Mr John H Neville HonFIAgrE

Mr Neville joined the Institution as a student member in April 1956 and then went on to up grade his membership to Associate Member in March 1961. In January 1969 he upgraded to Member grade and in April 1981 he gained Chartered Engineer Registration and in the same year, he also gained Fellow of the Institution. In May 1995, the Institution awarded him Honorary Fellow. Mr Neville was a long-standing valued member of the Institution with over 65 years of membership.

Mr Robert Lockhart MIAgrE

Mr Lockhart joined the Institution as a student member in March 1976. He went on to upgrade to Affiliate in May 1984 and then transferred to Member grade in May 1997. He was a long-standing valued member of the Institution with nearly 50 years of membership.

Mr Anthony A W Chestney MIAgrE

Mr Chestney joined the Institution as an Associate Member in January 1966. He went on to upgrade his membership to Member grade in January 1969. He was a long standing valued member of the Institution with nearly 60 years of membership.

Transfers

Member

Mr Andrew Garnett (Wrekin

Associate Member

Mr Mike Allan (Scotland)
Mr Samuel Withers-Lewis (West Midlands)
Mr Harry Rigby (Wrekin)

Technician

Mr Hywel Jones (Western)

Registrations

ENGINEERING COUNCIL

CEng

Dr Teo Chee Loong (Malaysia)

SOCIETY FOR THE ENVIRONMENT

REnvP

Mr Ryosuke Sasaki (Japan)

Long service certificates

2024

	Name	Grade	Date of Anniversary
50 years	Richard Christopher Gower Danby	FIAgrE	21 October 2024
	Reginald Vincent Ward	MIAgrE	21 October 2024
	Robert Leslie Pilcher	MIAgrE	7 November 2024
	Christopher George Nendick	MIAgrE	1 December 2024
	John Dumelow	MIAgrE	16 December 2024
	David Corfield Black	MIAgrE	16 December 2024
35 years	Anthony Neville Haywood Smith	MIAgrE	31 October 2024
	Paul Martin	AMIAgrE	1 November 2024
	Anthony Pain	AMIAgrE	1 November 2024
	Hipolito Ortiz-Laurel	AMIAgrE	17 November 2024
	David Francis Perry	AMIAgrE	27 November 2024
	Geoffrey Alan Walker	MIAgrE	27 November 2024
	David John Perry	MIAgrE	18 December 2024
	Michael Whiting	MIAgrE	19 December 2024
25 years	Richard Smalley	FIAgrE	25 October 2024
	Robert Neill Clemas	MIAgrE	5 November 2024
	Andrew John Ruff	MIAgrE	15 November 2024

Technical

It is b
efficiency

Alternative powertrains for tractors

Energy efficiency and reducing CO^2 emissions are essential to promote sustainable agriculture. This edited paper from CNH originally published on the VDI Wissensforum gives some food for thought.

The main research areas are automation of tractors and implements, as well as the development and use of new technologies and alternative fuels such as methane, biofuels and synthetic fuels, hydrogen, and battery electric vehicles (BEV). It is becoming clear that advances in energy efficiency and propulsion technology are critical to meeting energy needs while minimising environmental impact. For CNH, as a large international manufacturer of agricultural machinery, it is crucial to examine all available drive technologies to find more efficient and environmentally friendly solutions.

Today's agricultural machinery is mainly driven by diesel-engines. The advantages are obvious. Diesel offers high energy density and low specific weight. The oxygen needed for combustion is available from the ambient air. Despite a diesel engine efficiency of well below 50 %, the weight and space requirements for the liquid fuel remain acceptable.

One key strategy on the reduction of greenhouse gas emissions (GHG) and polluting emission is the transition to alternative fuels, such as biofuels, synthetic fuels, hydrogen propulsion,

becoming clear that advances in energy y and propulsion technology are critical

and electrification including hybrid systems. This as part of an ecosystem approach that combines machine and "fuel" production infrastructure to maximize the impact on GHG specifically. Biofuels are produced from biomass, i.e., livestock, plant or waste that has biological origin. Renewable fuels are produced using wind or solar energy. Drop-in fuels act just like conventional fuels, working in existing vehicles and infrastructure without modifications. Synthetic fuels are liquid fuels made via chemical conversion processes, from various carbon sources like coal, captured carbon dioxide, natural gas or even biogas or biomass.

Criteria in implementing alternative drives

Several criteria must be considered for the introduction of alternative propulsion systems:

- **Power and performance, run time, and operating range:** One of the primary challenges for off-highway vehicles like tractors is to ensure that they can provide the required power and performance. The demand is different for the various agricultural tasks. The operating time should be comparable to that of today's Diesel-driven tractors.

- **Cost and affordability:** The initial costs of vehicles with alternative drives will be significantly higher than for traditional powertrain systems. This will be a challenge for wide adoption. Operating costs need to be lower, resulting in a lower total cost of ownership (TCO) in the long term.

- **Infrastructure and dealer support:** Refuelling/recharging needs to be possible in the environment where agricultural activities take place. A robust infrastructure network will be crucial to support alternative propulsion systems. Additionally, the local dealers need to provide workforce with evolving technologies and customer needs.

- **Vehicle architecture:** Shifting to alternative fuels necessitates significant changes to vehicle architecture. Different energy sources and propulsion systems often require substantial modifications to the vehicle layout. These changes address technical considerations (packaging, new thermal management systems), alongside aiming to enhance performance, efficiency, and sustainability.

- **Durability and reliability:** Off-highway vehicles, particularly agricultural tractors, operate in demanding environments and endure heavy loads. Maintaining the durability and reliability of alternative drive systems in such conditions poses a significant challenge for manufacturers. Essential components like batteries or fuel cells must endure usage and deliver consistent performance over prolonged durations. Hybrid/electric solutions play a crucial role in the development of new business and maintenance models.

- **Regulatory compliance:** Manufacturers of off-highway vehicles face a tough challenge: complying with stricter emission rules while keeping vehicle performance up to par. This balancing act requires constant development and adjustments to adapt to evolving regulations. It's important to note that only full battery and fuel cell electric tractors achieve "zero emission" status (considering emissions throughout the entire process, from fuel source to vehicle operation).

Comparing space requirements and weight

In a simple evaluation the volumetric and gravimetric demand of a tractor with an average power-requirement of 54 kW (according to the DLG-Powermix cycles) assuming a runtime of 9 hour and 14 hours without refuelling, were calculated (figure 1).

Diesel stands out as the most compact solution. Hybrid systems with diesel engines and compressed natural gas (CNG) and liquified natural gas (LNG) combustion systems have similar space requirements. Battery electric systems, due to their high mass, are less suitable for applications demanding high power and long durations. Gaseous fuels like CNG require storage at high pressures to achieve a reasonable onboard capacity.

Examples of tractors with alternative drives

Several manufacturers are developing small electric tractors powered by batteries or fuel cells. These tractors offer significant benefits: zero-emission operation, reduced noise levels, and potentially lower operating costs compared to traditional diesel models over time. The Case IH Farmall 75C Electric Tractor, for example, delivers 65 hp (48 kW) of power at the PTO and features an electric motor that provides maximum continuous torque instantly, offering immediate response to workloads and reducing the need for frequent gear changes. Its 95 kWh battery pack allows to

Case IH Farmall

power external tools through electric outlets.

Some agricultural tractors can now run on biofuels like biodiesel, ethanol, and hydrotreated vegetable oil (HVO), offering a renewable and more environmentally friendly alternative with a potential for a circular economy due to its feedstock. These biofuels typically work with existing engines without major modifications, making them a good option for retrofitting existing machinery in the field. New Holland's T6.180 and T7.270 Methane Power tractors are prime examples, running on biomethane produced from organic waste and achieving a carbon-negative footprint in terms of life cycle analysis (LCA).

Hybrid tractors offer a potential solution, combining a range of features and functions aimed at improving efficiency, reducing emissions, and enhancing performance. A recent development is the STEYR Hybrid CVT prototype, featuring a front axle with independent wheel suspension and a CVT transmission. This model utilizes electric motors on the front module for additional power and functionality. Supercapacitors do manage the energy flow. The tractor's 700 V connector allows electrically driven implements to be powered directly.

Hydrogen fuel cell technology is also being explored for use in agricultural tractors. Hydrogen-powered tractors offer zero-emission at the point of use and quick refuelling times, making them a potentially viable option for sustainable farming practices. In the Austrian funded project "FCTRAC" a standard tractor has been retrofitted to demonstrate the fuel-cell technology in this domain.

Conclusion

When comparing performance and size requirements, different power sources are suitable for different classes of agricultural machinery. Each technology offers advantages and disadvantages. Battery electric vehicles, with their clean operation, are a promising solution for lower-power tasks. Hybrid systems can improve efficiency and introduce new functionalities on tractors. Biological natural gas production offers a path to carbon neutrality in agriculture, although limited by raw material availability. Hydrogen propulsion systems are still in research state.
The scarcity of currently available alternative-driven tractors makes it difficult to fully assess their cost implications.

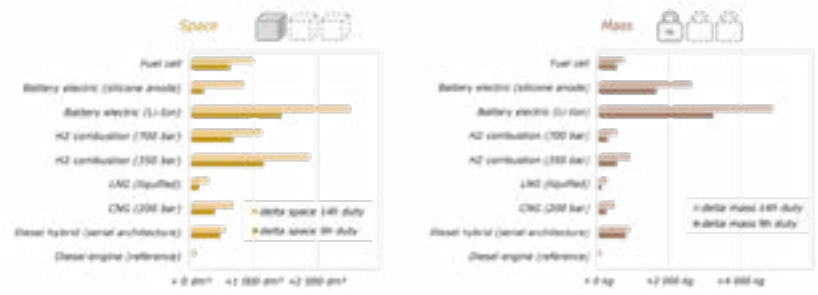


Figure 1: Volume and mass demand at 9- and 14-hours operation compared to Diesel (9 hours as reference)

Commercial Members

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AMAZONE
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BAGMA British Agricultural and Garden Machinery Association
CASE IH AGRICULTURE
City & Guilds
The DOUGLAS BOMFORD Trust
JOHN DEERE
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Magna
M&C Marks&Clerk
MASTENBROEK
NICK YOUNG TRACTOR PARTS
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