

KTIF TUBERZONE – A Precision Approach to Predicting Potato Tuber Growth



**Final Report for
KTIF-022-2019**

March 2021

KTIF TUBERZONE FINAL REPORT

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1. KTIF TUBERZONE

Facilitated and jointly delivered by SAC Consulting (a division of SRUC) and Brechin based precision software company SoilEssentials for Montrose based Co-operative Grampian Growers.

2. EXECUTIVE SUMMARY

Project partners SAC Consulting, SoilEssentials and Grampian Growers joined forces to set up a Knowledge Transfer Innovation Fund Operational Group to assist 29 seed growers of the salad variety Gemson to predict tuber growth and haulm destruction dates to maximise crop value. The project had two principle aims a) to encourage the Gemson growers to use the Tuberzone software to help predict burn down dates and work out how useful this was b) to assess the level of support farmers need when adopting new technologies.

This one-year KTIF (Knowledge Transfer Innovation Fund) project ran from May 2019 to June 2020, spanning the 2019 potato production season and subsequent marketing of the crop. The project aimed to promote the uptake of a new technology with a high level of support to growers. It was overseen by an Operational Group who were in regular contact throughout.

Grampian Growers suggested we work with a distinct group of seed potato growers, based in the east and north of Scotland, all growing the salad potato variety Gemson. Tuberzone software was created by SoilEssentials to monitor potato crop growth, or more specifically tuber size remotely, using crop canopy data from satellite and UAV imagery, a field test dig of tuber numbers and size, and crop soil moisture and weather information, to provide growers with predictions of tuber size, yield and most importantly economic return. Reports were emailed to growers, allowing them to track the growth and potential value of their crops from early July and help them choose the optimum time to stop crop growth through haulm destruction.

Tuberzone predicted yields were compared to harvested or “box” yield initially, then saleable yield of potatoes after grading. Then the combination of Tuberzone predictions, agronomic information and tonnes sold was analysed to pick up any trends or information that could assist grower’s future agronomy decisions. The project team found a strong correlation between Tuberzone yield predictions and saleable yield, and successful prediction of the graded-out size of Gemson within 90% accuracy for the majority of growers involved. Grower feedback backed this up with 10 the growers finding it sufficiently useful to continue using the service for another year.

A programme of support activity and events was delivered including farmer training in the use of Tuberzone, two field-based meetings, one post-harvest store meeting and a final webinar in June 2020. A video was commissioned to document the project from start to finish, a highly effective way of disseminating information to the wider potato community and providing insight into the potential for technological adoption across the agricultural sector. [Full video](#)

A survey was undertaken in June 2020 to capture growers’ thoughts on the effectiveness of the project and their attitudes to adopting this new technology. The survey collected from 15 of the Gemson growers showed that potato growers are open to adopting new technology, with all respondents reading the reports. Some growers were sufficiently impressed by the results and over half of the farmers surveyed signed up to paying for Tuberzone monitoring of their crops in 2020. Others thought it had potential but preferred to adopt a wait and see attitude while Tuberzone was tested by the early adopters, and a few growers were happy with their current methods. This was expected and understandable and reflects a typical adoption curve. The achievement of this project was to move a higher than normal proportion into the early adopter category by providing a high level of support and information to growers.

Useful aspects of the Tuberzone reports reported by growers were; identifying variations in growth between different sampling points, regular growth reports allowing farmers monitor crops without having to repeatedly test dig the field, guidance on where test digs should be located, predictive yields, weekly change in size distribution and its impact on crop value. We also gathered several helpful suggestions as to how the service and grower support could be improved. The co-operative valued advance prediction of crop yields to help marketing and identification of best test dig sites, and potato consultants the opportunity to analyse a mass of production data to identify agronomic improvements for future years.

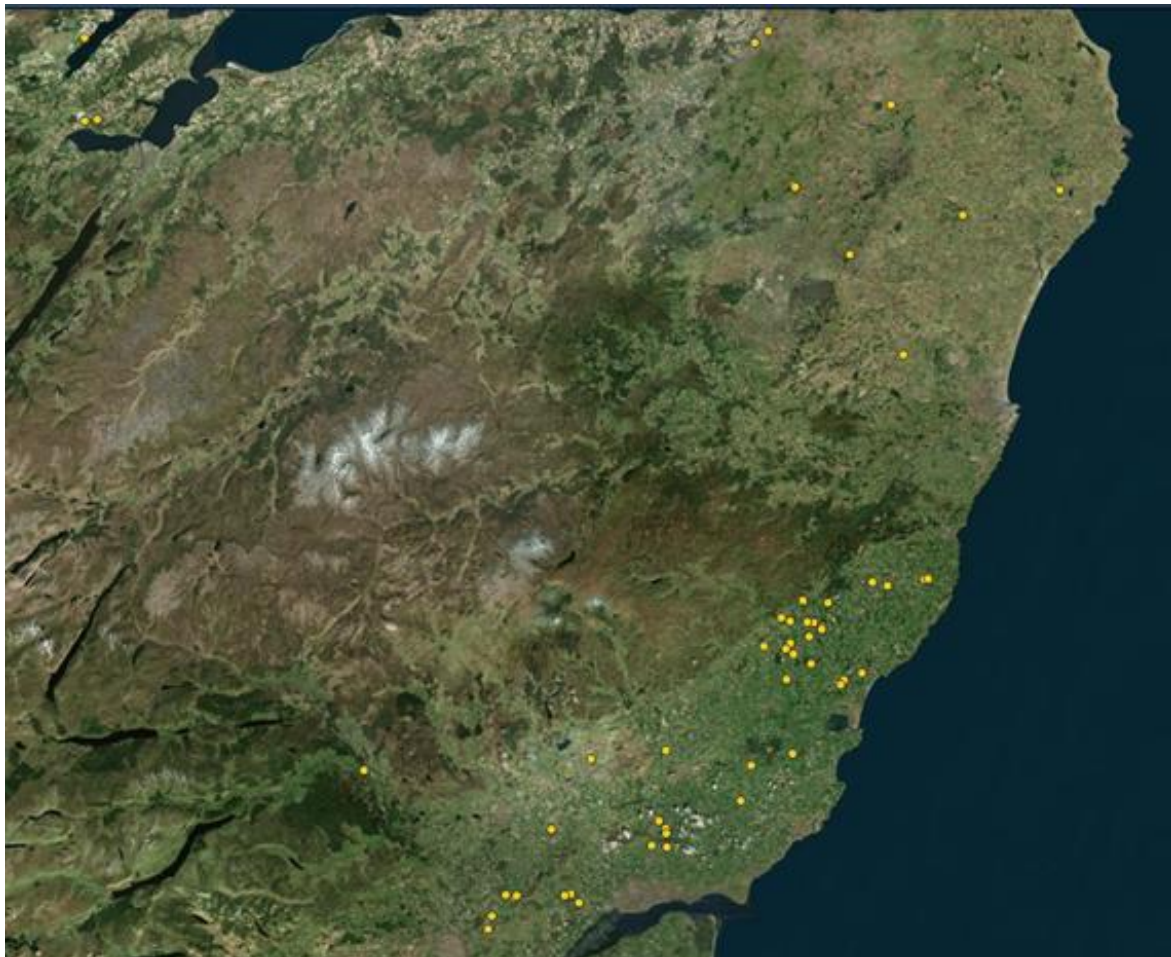
3. PROJECT DESCRIPTION

This one-year KTIF (Knowledge Transfer Innovation Fund) project ran from May 2019 to June 2020, spanning the 2019 potato production season and subsequent marketing of the crop. The project aimed to promote the uptake of a new technology and to provide a high level of training for growers.

The project had two principle aims a) to encourage the Gemson growers to use the Tuberzone software to help predict burn down dates and work out how useful this was b) to assess the level of support farmers need when adopting new technologies.

A management or Operational Group, including representatives from the three participating organisations plus three grower representatives, oversaw project progress. Salad potato variety Gemson was chosen for the exercise because it involved a distinct group of seed potato growers based in the east and north of Scotland.

Below: Locations of Gemson growers farms



Tuberzone software is designed to monitor potato crop growth remotely using satellite and UAV imagery, thus minimising the need for growers to provide information, apart from providing initial cropping details and their normal test digs. The delivery team assisted with test digs to count tuber numbers at full canopy cover. Using this data alongside soil moisture and weather data, the tuber size and economic return was predicted. This information was conveyed to growers in individual reports, allowing them to track the growth and potential value of their crops in the latter part of the growing season from early July. As haulm destruction neared, the frequency of the reports increased, providing up to date recommendations as to when the crop reached maximum economic value.

Post-harvest, the crop yield and size predictions from the model were compared to the harvested number of potato boxes to provide initial insight to the model performance. The accuracy of this information was then improved using grade out (removal of unsuitable potatoes) data, to provide saleable tonnes per grower. Then the combination of Tuberzone predictions, agronomic information and tonnes sold was analysed to provide additional support to growers for future production.

Adopting a new technology has five phases of uptake: innovators, early adopters, early majority, late majority and laggards. This project aimed to promote the uptake of a potato growth predicting model, reducing the time taken for a beneficial technology to be used within the industry. Encouraging rapid uptake ensures that new developments can help growers to increase their economic security and reduce their workload. Although this model is specific to potato production, the uptake of a new technology can be applied to different sectors within the industry.

The project targeted 29 potato growers within an established production group supplying Grampian Growers. All of the farmers within this group grew Gemson potatoes for the salad and seed market, totalling 66 crops. Due to market specifications, the size of Gemson potatoes is particularly important. If the potatoes are too large (over 55mm), they are of little value, however if the potatoes are too small (under 25mm) the yield is lowered, reducing grower returns. This provides a difficult decision for potato growers surrounding when to harvest their crops. The Tuberzone model aims to help growers with this decision, while also taking into account variations within the field. The model was tested on two farms in 2018 with a high level of success, however, the transition to promote widespread uptake of a new technology within the agricultural sector is challenging and was addressed through this one-year project.

This crop modelling software utilises several environmental conditions, alongside crop growth patterns and field variation to predict when the crop will be most valuable. Developed by SoilEssentials, the model allows growers to use this information to increase their productivity by meeting market specifications. A major benefit to this software is its accessibility to growers. Most of the data can be collected remotely, with inputs only required from the farmer about field areas and initial early season test digs to count tuber numbers. Due to these factors, growers can concentrate on growing their crops, and when the individual reports are generated, they can be helped with important decisions.

Using a combination of in field and remote meetings, combined with regular training sessions and grower updates, the management team aimed to encourage interaction and learning within the group. Facilitated by SAC Consulting, initial scepticism from growers was overcome through a mix of presentations, discussions and updates. As the project progressed and growers became exposed to the range of benefits from this technology and enthusiasm increased. The grower meetings and interactions were scheduled around the growth and processing of the potato crops, ensuring the grower group were kept updated.

Following the model predictions and harvest of crops, growers were kept updated on the sale of the potatoes and how the model predictions compared to the number of tonnes sold per farm. This data was also used to explain the variation in yield and quality of potato crops, information that can be used in future years to promote efficient production.

4. PROJECT AIMS/OBJECTIVES

The two main aims of the project were:

1. To encourage the rapid uptake of Tuberzone potato technology by growers to improve seed potato production efficiency, product quality and supply chain information for all 29 growers of the variety Gemson working with the Grampian Growers co-operative.
2. To provide a high level of support to help growers adapt to this new technology and through a survey and a focus group at the end of the project learn what has worked and what we could have done better.

Specific objectives from the application form

- Pilot a methodology to increase the uptake of this new technology through support, facilitated meetings and an interactive online database.
- Increase grower awareness of the benefits of using remote sensing technology and software outputs as part of their crop decision making process.
- Gather data from each farm in the Gemson seed production chain and integrate the database to identify areas that can be worked on to improve performance.
- Learn how to use the programmes predictions to influence management decisions such as tailoring the sales schedule, using in season knowledge the likely yield and size distribution of the ultimate crop, both per field and across all fields for financial and individual benefit.
- Provide growers with the skills to make decisions on their own crops on the basis of Tuberzone data.
- Evaluate the effectiveness of the support provided to growers by the delivery team and note ways this could be improved.
- Provide guidance for the Scottish seed potato industry and Scottish agriculture on how new technology can be supported.

5. PROJECT OUTCOMES

Below is a summary of outcomes:

1. *To encourage the rapid uptake of Tuberzone potato technology by growers to improve seed potato production efficiency, product quality and supply chain information for all 29 growers of the variety Gemson working with the Grampian Growers co-operative.*

29 potato growers were provided with free access to the Tuberzone potato prediction model and given the opportunity to attend training events. One grower declined to be involved. 28 growers used Tuberzone during the 2019 production season, with 10 growers subsequently paying for this service in 2020. Most growers attended training events, aimed at increasing growers understanding of the model, ultimately leading to increased uptake. Improved burn down forecasting and regular updates provided by the model allowed farmers' monetary yield to be calculated based on tuber size. This, alongside model estimates which matched farmer findings increased the group's confidence in the new technology. The supply chain also benefitted from increased forecasting ability and reduced time commitment arising from GPS positioned test digs, increasing efficiency.

2. *To provide a high level of support to help growers adapt to this new technology and through a survey and a focus group at the end of the project learn what has worked and what we could have done better.*

Comprehensive training was offered to group members at a one-to-one or one-to-few level throughout the growing season through workshops and individual grower consultations. This helped growers to familiarise themselves with the KORE platform (on which Tuberzone is sited), improving uptake. Due to Covid-19, we were unable to form a focus group, and instead conducted an online survey to provide feedback. The key findings of this survey are shown in section 6.2. Grower meetings have provided an excellent opportunity for the group to discuss any issues they have had and ask questions about how the technology should be used. The Tuberzone software is a tool that growers can use individually to manage their own crops. Greater benefit can be obtained through encouraging group discussion with potato specialists and fellow growers, where experiences can be shared and potato agronomy improvements identified.

6. 1) Specific outcomes from the application form

- *Pilot a methodology to increase the uptake of this new technology through support, facilitated meetings and an interactive online database.*

A program of support and delivery was developed with four parts. Firstly, each grower was given access to this technology to assess the model's accuracy and suitability on their own farm. Secondly, a series of face to face and online meetings was scheduled and delivered to provide regular updates and link the findings back to practical on farm solutions. Thirdly, several training events were scheduled and delivered, allowing growers to familiarise themselves with the software and the interactive grower platform. Finally, a follow up survey was distributed to review the program and delivery. Data from all 28 participating growers was collected and analysed and learnings from this data were shared at the final webinar to increase production efficiency in future years.

- *Increase grower awareness of the benefits of using remote sensing technology and software outputs as part of their crop decision making process.*

A video was produced to demonstrate the project findings and value of this technology for potato production. It featured interviews where growers stated the benefits of such technologies and why they

decided to get involved. A key theme of this project was to allow growers to use the technology and make their own minds up about its benefits. Some growers stated their scepticism at the start of the project, but after taking part they have seen the benefits from technology on their own farms. One is featured in the project video.

- *Gather data from each farm in the Gemson seed production chain and integrate the database to identify areas that can be worked on to improve performance.*

Production data for Gemson seed potatoes was gathered, comprising information on planting dates, seed rates, seed spacing, fertiliser applications, geographic location, soil type, weather data, total yield, tuber size fractions, harvest dates and season length. This data was analysed by potato specialists to pick up any trends that could be converted into practical advice. This unique data set, involving 28 farmers growing a single potato variety, was reviewed by SAC Consulting Potato Specialists who were able to draw a number of conclusions. The data showed that later planting and deeper planting had a negative effect on total yield (Refer to annex 11.5). However, a longer growing season, increased plant populations and more days between planting and haulm destruction all resulted in increased yields. This suggests that growers should concentrate their efforts on the early establishment of crops, where environmentally possible, and work to optimum seed rates per metre of drill. Information gathered has also allowed advisors to revise their recommended seed rates for Gemson.

- *Learn how to use the programmes predictions to influence management decisions such as tailoring the sales schedule, using in season knowledge the likely yield and size distribution of the ultimate crop, both per field and across all fields for financial and individual benefit.*

Several lessons were learnt about the model's predictions which can influence the way Gemson potatoes are managed at a grower and cooperative level. Accurate targeting of test dig locations using pre-determined GPS points, representative of each field, was seen to increase the accuracy of test dig results and economic value of the crop. This targeting also altered the way Grampian Growers managed Gemson crops across the cooperative, resulting in more efficient field sampling by field staff. Furthermore, fewer test digs were needed which reduced grower workload. Early in the program, it was decided to link yield predictions with financial reports associated with burn down dates. These reports gave growers the opportunity to see in financial terms when they should desiccate their crops.

- *Provide growers with the skills to make decisions on their own crops on the basis of Tuberzone data.*

Training tailored to the individual farmer increased the familiarisation with Tuberzone allowing growers to better make decisions. Additionally, meetings with a high level of interaction were delivered, highlighting the benefits of this new technology and demonstrating how it can add value to potato production. Each grower was able to compare their crop growth with others, generating much discussion on factors causing the variation. This is a conversation that would not have taken place without the Tuberzone predictions and has led to greater interest in factors affecting tuber growth. Over half of the growers surveyed saw potential in using Tuberzone in future seasons and cited several advantages of its use. See survey results on the following page.

6. 2) Summary of the grower survey

- *Evaluate the effectiveness of the support provided to growers by the delivery team and note ways this could be improved.*
- *Grower group surveyed to learn what was delivered well and what can be improved in the future.*
- *Provide guidance for the Scottish seed potato industry and Scottish agriculture on how new technology can be supported.*

A survey was undertaken at the end of the project in June 2020, by which time Grampian Growers and the individual growers had received feedback on their tonnage sold and 2019 crop value and had the opportunity to attend events and a final webinar reporting results from the project. 15 out of the 28 growers responded to the survey, just over 50% of those involved.

Our growers were generally in favour of using new technology, with an average score of 4.2, where 1 was “avoid” and 5 was “enthusiastic adopter”, so we were working with a willing group.

The median grower in our survey attended three of the five events available. Most of our respondents were growers from the Angus and south Aberdeenshire areas who found the meetings more accessible than those farms were further away.

73% of our respondents received training from SoilEssentials. All 15 respondents read the burndown prediction information sent out by Grampian Growers. The Tuberzone predictive information was rated at 3.87 for usefulness on a 1-5 scale. Some growers found it very helpful in aiding burndown decisions, others were less sure and commented that they would need to see more evidence over a longer period. Some commented that they still relied on their own test digs. It should be noted that the software is not designed to be a sole indicator of burn down time and should be used along with test digs.

Farmer quote - *“It was interesting to see the correlation between its predictions and the potential returns to growers from the different burn down dates. Given it was our first experience we didn't rely 100% on the programme and still dug ourselves when making final decision”*

Useful aspects of the reports noted by respondents were variations in growth between different sampling points, regular growth reports allowing farmers to monitor crops without being in the field, guidance on where test digs should be located, predictive yields, weekly change in size distribution and its impact on crop value.

There was a mixed response to the question - How can Tuberzone help your haulm destruction decisions going forward? Six respondents commented positively with 3 less sure. These were the positive comments - Better targeting the saleable tuber size bands, seeing a prediction of what would happen if the crop was left another week, precise timings to maximise profit, targeting seed fractions to specific markets, and targeting where test digs are done. Negative comments – continue with current practice, don't see how Tuberzone could help.

Twelve growers responded to the question about using Tuberzone in future, with six saying yes, three possibly but need more years' experience to be confident and three saying no.

How could the service be improved? Suggestions included use over more varieties, development of an app to input test dig info in the field, a text or email with updates and a more regular reporting process. These comments have been subsequently addressed by SoilEssentials.

Comment on these results. It is encouraging to see that nearly half of the respondents were keen to use Tuberzone for another season and the actual number using it in 2020 was 10 growers. These include farmers, possibly those most enthusiastic on using technology who saw sufficient benefit in 2019 season to be convinced that the Tuberzone service would work for them and some who were not involved in the project group but heard about the results. It is not surprising that a group of farmers would want to see how Tuberzone worked in subsequent seasons before committing – some are more cautious than others and need more evidence. There will always be others who can't see a role for a new technology because they are happy with their current practice and see no reason to change.

Survey comment on general project delivery was positive.

Question - How would you rate the following aspects of the KTIF Tuberzone project on a scale of 1 to 5 with 1 being the poorest rating and 5 being the best?

Average Rating: 14 Responses

Organisation	4.3
Communication	4.4
Meeting Delivery	4.0

Key messages arising from this project include many growers recommend that it is worthwhile taking part with innovative projects as highlighted in the video. Another key message to the agricultural industry is that a collaborative supply chain effort will have the greatest impact on uptake as farmers will all learn in different ways. Furthermore, collaboration between organisations is beneficial as each organisation has its specialities, resulting in a project which has maximum impact. In this project Grampian Growers supported their contract growers by promoting the project meetings and results and undertaking test digs in July. SoilEssentials provided the Tuberzone software, training for growers, processed data and provided regular reports on crop growth and value. SAC Consulting facilitated the project, undertook a proportion of the July test digs, analysed the growers data and provided specialist advice to the group.

6. 3) Milestones

- Operational group – formed May 2019
- Project initiation meeting – 7th June 2019
- Grower group meeting – 7th August 2019
- Gathering data – field data gathered throughout 2019 growing season, marketing data gathered throughout 2020.
- Tuberzone set up on each farm – June 2019
- Fields registered (weather data capture and Synthetic Aperture Radar) – June 2020
- Grower training – June, July and August 2019
- Tuber count test digs – July 2019
- Assist growers with burning down decisions – reports provided August, September and October 2019
- Grower store meeting held – 4th December 2019
- Results analysed – May 2020
- Final meeting held as a webinar – June 2020
- Growers Surveyed – June and July 2020
- Reports and outcomes made public – July 2020

7. LESSONS LEARNED

7.1 Issues/Challenges

- The growth pattern of crops in 2019 meant that early season test digs had to be postponed as the crops had not finished tuber set, therefore, test dig timing needs to be more flexible to fit in with environmental conditions.
- Accurate field size data is very important, especially smaller fields or areas of crop. Correctly mapping each field area can be difficult for farmers, and mapping from satellite imagery can create mistakes if the crop canopy is developed. This can be overcome by improved farmer/modeller correspondence regarding small crop areas.
- Difficulty engaging growers from such a wide geographic spread. In any project of this type growers closest to meeting locations are most likely to attend. The high numbers of growers and others attending our Covid enforced webinar, 82, greatly exceeded numbers we might have anticipated for a hotel-based event. We are all getting more used to online meetings and events and this format suits itself well to engaging with a wide-spread group and this will be borne in mind for future initiatives.
- More a fact than a lesson, but the Gemson sales pattern spanning from harvest until May the following year created a long delay in obtaining data that verified the usefulness of the Tuberzone tool and provided pointers for next season's crop. Next season's crop was already in the ground by the time results were available in May, but this is no real way round this when results depend on saleable yield of the entire crop.
- There was a range of feedback from growers. Those who enjoy adopting new technology have been keen to use it. Others have commented that although initially sceptical they can now see how it could help them in practice. Others prefer to adopt a wait and see attitude until the technology is well proven. This is human nature and the challenge for technology project leaders is to gather as much compelling evidence and testimonials as possible to influence adoption rates.
- Grower feedback has highlighted that running this project over multiple years would help to build confidence in this technology. The KTIF project could not be extended therefore the challenge is for SoilEssentials and Grampian Growers to continue to provide detailed analysis of growers results over several years.
- A one year time frame was tight for a project of this nature which spanned a growing season from April to September and crop storage up to late April 2020 before final results were available by early June. We then added a survey period in summer, once farmers had their results and were through their busy planting period before analysis and factoring answers into the final report. But our funding was for one year duration and we were very pleased to have it.

7.2 Impacts

There is a degree of overlap between comments in this section and those in the Key Findings and Recommendations section 9.

- This novel technology requires minimal grower input, reducing workload, however the principles behind the predictions are complex. For this reason, a series of training sessions were run to encourage growers to familiarise themselves with the software, promote learning and build confidence in the new technology. This has resulted in the uptake of this technology by 10 growers beyond the end of the project.
- The accurate targeting of test digs, based on satellite data of each field or parcel of land, increased the accuracy and reduced the workload associated with model predictions. This has led to the development of a test dig location app, providing further benefits for the industry.
- The final meeting was delivered as a Webinar, the attendance of this was 82 people. This included a wide geographic spread and helped to disseminate the project results very effectively.
- Growers obtained valuable information to help them determine when Gemson crops should be burnt down to obtain the highest crop value. They also benefitted from the involvement of SAC Consulting potato specialists providing recommendations to improve crop agronomy through attending meetings and the webinar.
- Grampian Growers were pleased that we developed a new system of identifying GPS points for test digs for field staff to survey and found the yield and size prediction information very helpful when planning sales and marketing.
- SoilEssentials gained valuable feedback on their Tuberzone methodology, on farmer requirement for training and on dissemination and content of results emailed to growers that allowed improvements to be made.
- SAC Consulting provided an independent evaluation of the technology thanks to KTIF funding and were able to analyse a unique set of potato production data to identify trends and provide advice to growers through the face to face meetings.

8. COMMUNICATION & ENGAGEMENT

8.1 Grower Group Engagement

- Grower meeting one (7th June 2019)
Project and technology outline provided alongside specialist support detailing the importance of haulm destruction. The meeting was held on farm and included demo drone flights assessing crop canopy cover and an indoor demonstration of how Tuberzone works in practice at local venue, 30 attendees.
- Grower meeting two (7th August 2019)
Each grower was provided with their results in advance of the meeting, which offered them an opportunity to compare their crop growth with others generating much discussion on factors causing the variation. This was the turning point in the project when the value of Tuberzone really hit home to the group. These conversations would not have taken place without the Tuberzone predictions and has led to greater interest in factors affecting tuber growth, 24 attendees.
- Grower meeting three (4th December 2019)
Held in store at Grampian Growers, the model results to date were discussed. Ways to improve the model and usefulness for growers was also debated, alongside additional information on storage and seed rates which was gleaned from the model data set, 24 attendees.
- Three meeting reports have been prepared and sent to the operation and grower groups (2019).
- Regular feedback was provided to Gemson growers through Grampian Growers email list.
- A WhatsApp group was established for exchanging information between project partners and growers that was well used by our group and provided a forum for chat discussion and posting pictures.

8.2 Wider Community Engagement

- A taster video was produced and released in January, to encourage engagement of other growers and highlight to the industry the benefits of adopting new technology: [Teaser video](#)
- A longer, more detailed video was released in June 2020 demonstrating the project success and providing grower to grower recommendations: [Full video](#)
- The final meeting was run as a webinar, open to all. With 82 attendees, a recording was then shared on social media and is available to view online, the online recording received another 73 viewings:
<https://vimeo.com/427009725>

- A website was developed to promote the project and share the projects findings, it can be found here: https://www.sruc.ac.uk/homepage/1317/the_tuberzone_project

8.3 Press Coverage

Several articles have been written both in the national and international press about the project and are available at the following links:

- <https://www.potatonewstoday.com/2020/07/15/sac-consulting-and-soilessentials-supporting-british-growers-with-tuberzone-potato-technology/>
- <https://www.pressandjournal.co.uk/fp/business/farming/2340458/precision-technology-is-hailed-in-potato-project/>
- https://www.farminguk.com/news/farm-trial-uses-precision-tools-to-predict-tuber-size_56107.html
- <http://www.fareasternagriculture.com/crops/agriculture/sac-consulting-and-soilessentials-supporting-growers-with-tuberzone-potato-technology>
- <http://ct.moreover.com/?a=42601735251&p=3bo&v=1&x=Cn3s-80rcuRKR1tTmS-5JQ>
- <http://ct.moreover.com/?a=42603179740&p=3bo&v=1&x=gCBIRFDFul7iucCR8yul8Q>
- https://www.sruc.ac.uk/news/article/2682/collaboration_is_key_to_adoption_of_agri-tech

8.4 FAS Engagement

- The project video and final report were sited in a website and made available through the Scottish Farm Advisory Service. The project has recently been completed and more use can be made of learnings in adoption of new technology in future.
- FAS has also increased engagement through social media, using Twitter and Facebook to share the projects results.

8.5 EIP-AGRI Engagement

An executive summary report has been completed for EIP-Agri. We will also make the video available through this European forum.

9. KEY FINDINGS & RECOMMENDATIONS

Each of the project partners was interviewed to identify key findings and recommendations from their perspective.

9.1 Grampian Growers

- The accurate targeting of test digs using GPS improved the efficiency of Grampian Growers crop management and enhanced their ability to monitor crops throughout the season.
- Grampian Growers also commented that the additional information about how planting dates and weather affect crop variation is useful when predicting yield and harvest dates.
- Grampian Growers found it very useful to have yield predictions to aid marketing and sale of pooled Gemson potatoes.

9.2 SoilEssentials

- Accurate forecasting of the yield and size distribution of all Gemson crops to an acceptable level (90%) is achievable.
- Collaboration between SoilEssentials, Grampian Growers and SAC Consulting made this project a success.
- Expanding grower's knowledge, who were involved in the project, about burning down decisions and crop growth patterns has been a positive experience for SoilEssentials.
- Showing the wide range of crop yields and values across Grampian Growers' grower base and prompting discussion between growers and advisors about the reasons for the relative performance of their crops, has helped knowledge transfer within the industry.
- SoilEssentials added that seeing crop development from satellite imagery helped improve growers understanding of which crops are bulking fastest and need to be inspected most regularly

9.3 Grower Group (from grower survey)

Comments have been extracted from the grower survey from three types of respondent.

The convinced:

- "I don't like change! I thought it was a load of nonsense for a start however looking back at the results I'm happy to admit I was wrong."
- "The variations across the field was the most interesting part"
- "We were very pleased to be involved with the project and really think Tuberzone could work for our business"

The wait and see:

- “Useful, but confidence would develop with use over a few years.”
- “Time and experience in using the service over multiple years to give the grower confidence in the accuracy of the service.”
- “Looking forward to seeing how it develops, it would be good if Grampian Growers/SoilEssentials could get funding for another two years of trials to give 3 years of data”

9.4 SAC Consulting

- The collaboration between the three organisations has been hugely beneficial to this project as each organisation has provided a unique skill set.
- The discussion between growers and the organisations involved has been extremely valuable gaining feedback and encouraging growers to take this technology on board, this could not have happened without face to face meetings.
- The use of a webinar as a final meeting allowed farmers from a wide geographic spread to participate, this method of delivery would be beneficial when considering other projects with similar challenges.
- The collation of a dataset to validate Tuberzone and as a by-product has helped to investigate agronomy of Gemson, and provide unforeseen advice for the production of this variety. Particularly, through the identification of areas of agronomy that require further improvement.
- This project has also helped to provide independent evaluation of a new technology, by advisors and growers alike, this evaluation has built grower confidence.

10. CONCLUSION

To summarise, this project successfully introduced 28 seed and salad potato growers to a new technology through a KTIF project involving farm meetings, training sessions and individual reports. Initial scepticism towards the project gave way to optimism about the potential of this technology, with a major turning point observed during the discussion session in meeting two.

Although some growers remain reserved about the potential of this technology, others have chosen to continue using it beyond the project, with 10 growers now using this model as a commercial service. This level of uptake combined with the positive feedback from the survey has highlighted that a combination of meetings and virtual delivery has been successful in promoting this technology. Nevertheless, the geographic location of growers has been a challenge to uptake, and grower feedback highlights that a multi-year project would be beneficial to increase grower confidence.

11. ANNEXES

11.1 Project Pictures



11.2 Meeting one hand out

Grampian Grower Tuberzone KTIF project

Timing of haulm destruction

Timing of haulm destruction is when maximum income can be generated for both the grower and Grampian Growers. For Gemson, this means when the majority of harvested tubers are in the 25 to 55mm marketable fraction. Tubers in the 55+mm fraction have much less value.

A typical guideline for haulm destruction to start is when the first tubers reach the top riddle size of 55mm. To identify the best timing for haulm destruction, test digging on a regular is the usual approach. However, by monitoring crop ground cover and using an initial tuber size distribution in July, the Tuberzone programme from SoilEssentials can predict tuber development.

Figure 1. Shows a typical output graph from Tuberzone from a crop of Gemson in 2018. The canopy cover is determined from drone or satellite images and tuber fresh weight predicted over time is based on estimated capture of solar radiation. In this crop, emergence started around 13 June and reached almost 100% ground cover by mid-July. Haulm destruction occurred around 10 September. Total tuber Fresh weight increased steadily until haulm destruction.

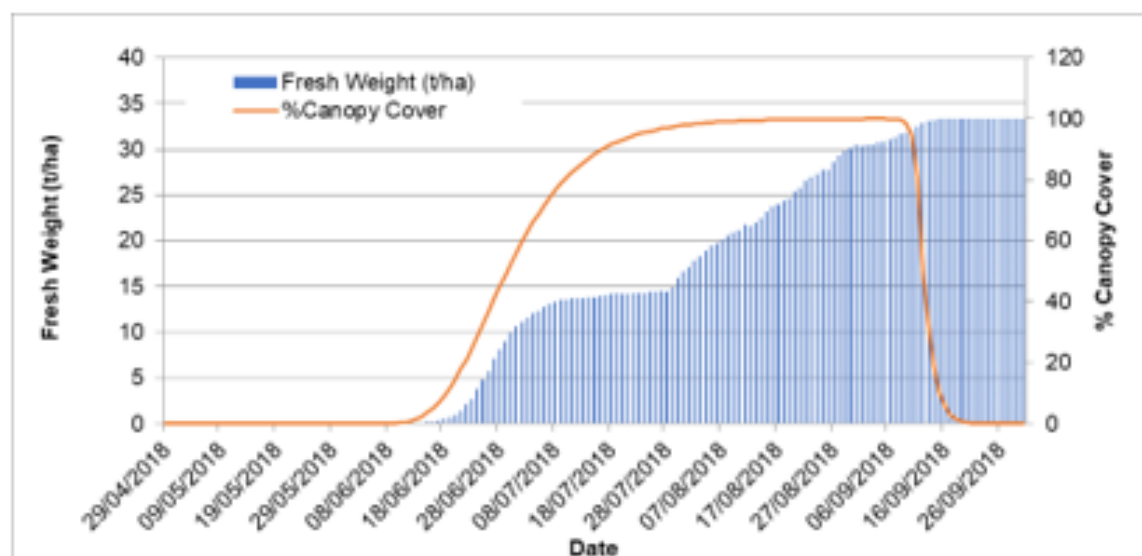
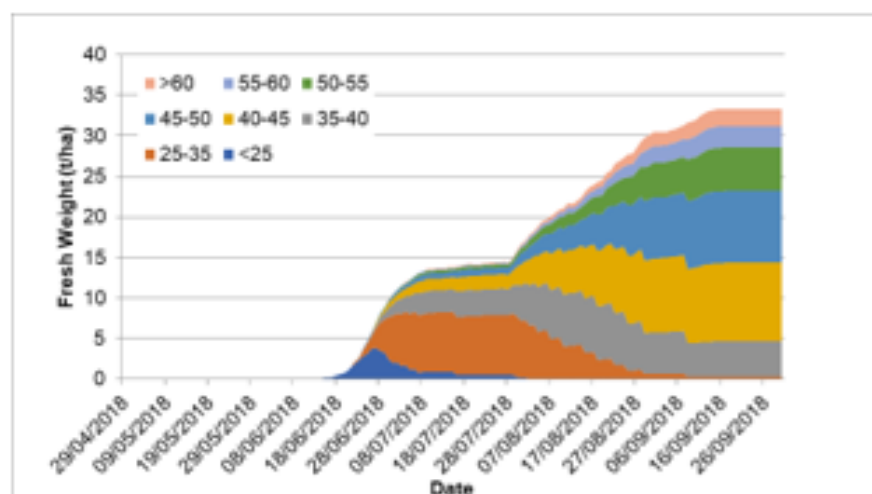


Figure 1. Haulm development as % Canopy Cover and Tuber Fresh Weight predictions for a crop of Gemson in 2018



The Tuberzone programme can go further, providing an estimated tuber size distribution over time (Fig. 2).

Figure 2. Estimation of tuber size distribution in 5 or 10mm size bands over time for a crop of Gemson in 2018

From the data that created this graph it is possible to estimate the income over time. This will also help predict the optimum time for haulm destruction. Based on 2018/9 pool prices the income from this Gemson crop changed over time as shown in Table 1.

Date	Estimated tuber yield (t/ha)		Estimated income £/ha		
	25-55mm	>55mm	25-55mm	>55mm	Total
28/08/2018	26.2	3.1	£6,026	£400	£6,426
04/09/2018	26.9	3.8	£6,193	£492	£6,685
11/09/2018	27.8	4.7	£6,393	£609	£7,002
18/09/2018	28.5	4.8	£6,565	£626	£7,191
25/09/2018	28.5	4.8	£6,565	£626	£7,191

Table 1. Estimated yield and income over time for a crop of Gemson using 2018/9 pool prices

Income continued to increase until the yield stabilised after haulm destruction. Later haulm destruction would result in a higher yield but substantially more in the less valuable >55mm size band and thus a lower overall income.

How much do tubers increase in size after haulm destruction starts

There is no simple answer to this question as it depends on how rapidly tubers are growing, the soil conditions and the speed of haulm destruction. Normally, when it is time for haulm destruction, Gemson crops are still growing vigorously.

Experience suggests that if soil conditions are dry and uptake of nutrients and water limited, tubers may increase only 1mm (or at maximum 2mm) in size from their pre-haulm destruction size, irrespective of haulm destruction method.

If the soil is damp or wet, the increase in size depends on how rapidly haulm destruction is achieved. Experience suggests pulverising the haulm tends to restrict subsequent tuber growth better than chemical desiccation as reserves from the haulm are more rapidly stopped from moving to the tubers.

As a rough guide, when pulverisation starts the haulm destruction process, increase in tuber size is generally 1-2mm but with diquat desiccation it could be 2-3mm. Swelling could be even greater with slower haulm desiccants such as Gozai and Spotlight. Even a 1mm swelling of all tubers can mean a substantial increase in total tuber weight.

Stuart Wale
07 June 2019

tuberzone

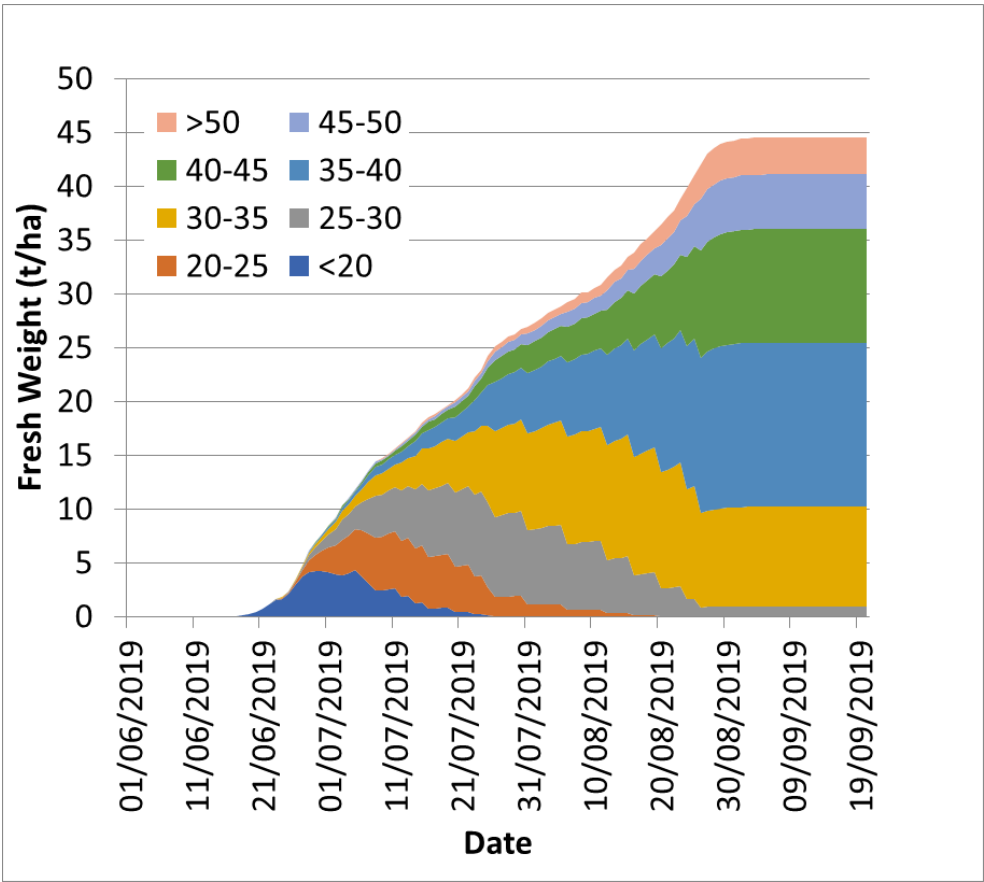
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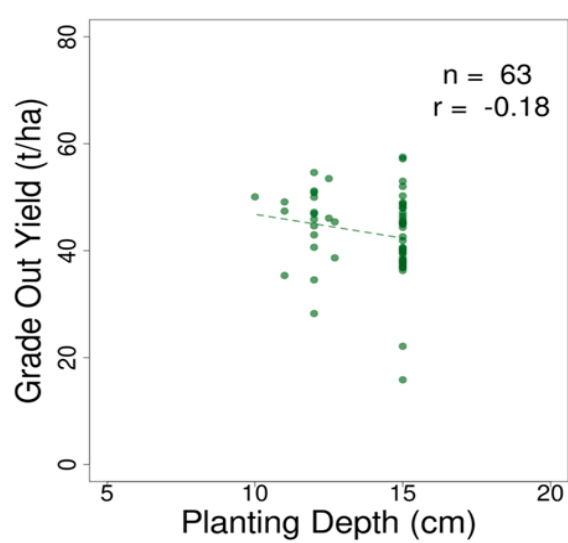
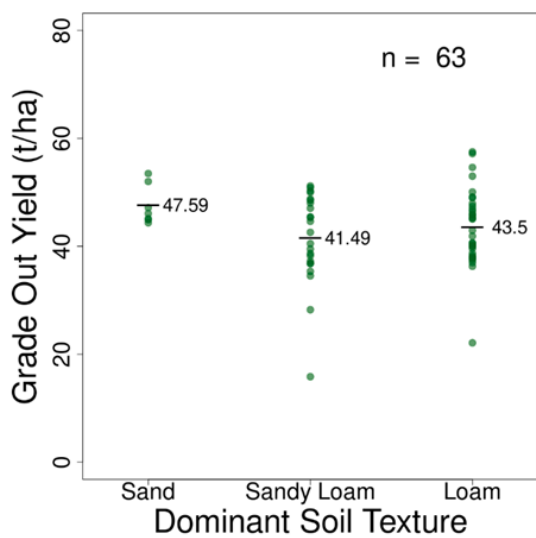
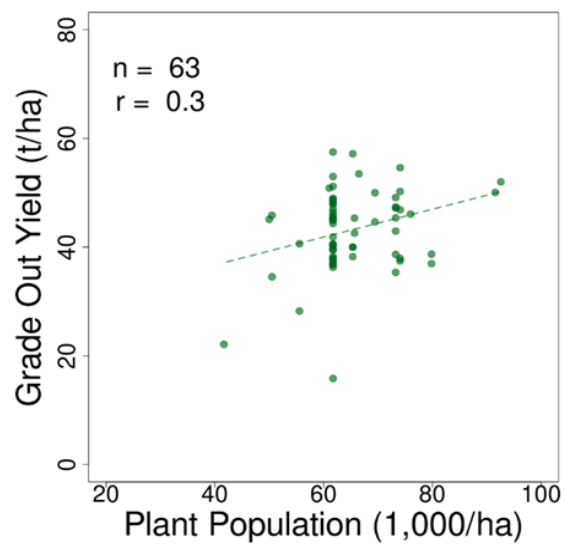
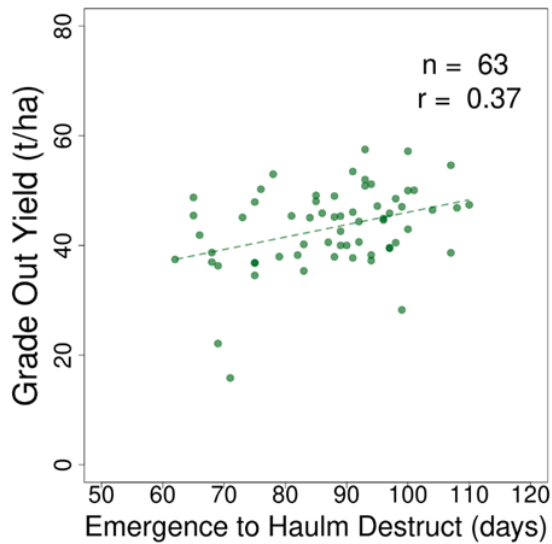
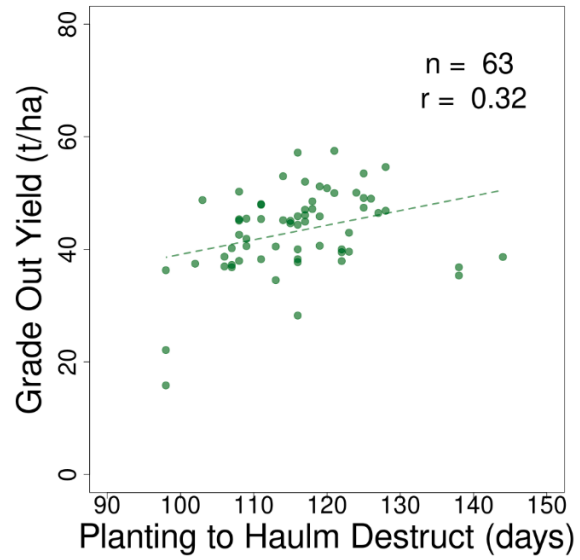
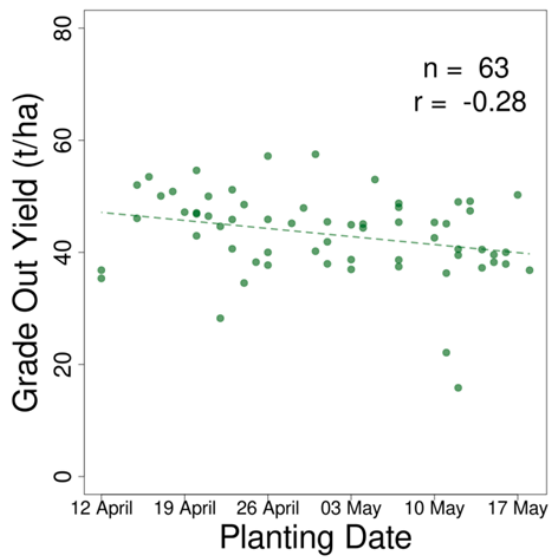
SRDP Scottish Rural
Development
Programme

GRAMPIAN
Growers Limited

11.3 Example Tuberzone Grower Graph



11.4 Data Analysis



11.5 Survey Questions

KTIF Tuberzone

Thank you for taking time to respond to this survey – it should only take 10 minutes.

Your feedback is very important to us and will provide valuable information on your experience with Tuberzone. We hope to gather information on how it could be improved, and also how other farm technology solutions could be introduced in future. We particularly value comments so please fill in the open text boxes if you can.

1. What is your name?

2. What is your Business name?

3. What is your location or farm name?

4. On a scale of 1 (avoid) to 5 (enthusiastic adopter), what is your attitude to using new technology?



5. Meeting attendance - please indicate if you attended any of the following meetings:

- ☐ First growers meeting in field at Fettercairn on 7th June 2019
- ☐ Second growers meeting in shed at Coldstream on 7th August 2019
- ☐ Third meeting in store at Grampian Growers on 4th December 2019
- ☐ Grampian Growers AGM on 13th February 2020
- ☐ KTIF Tuberzone Webinar on 4th June 2020

6. Other methods of finding out about the Tuberzone Project

	Yes	No
Have you read about the project in the press?	<input type="radio"/>	<input type="radio"/>
Have you seen the project video?	<input type="radio"/>	<input type="radio"/>

7. Your use of Tuberzone

	Yes	No
Did you receive training from Soil Essentials in the use of Tuberzone?	<input type="radio"/>	<input type="radio"/>
Did you read the information provided by Soil Essentials regarding your potato crops growth?	<input type="radio"/>	<input type="radio"/>
Did you use the information sent out to assist your burning down decisions	<input type="radio"/>	<input type="radio"/>

8. How useful did you find the Tuberzone predictive information?

1 = no use, 5 = very useful



9. Do you have any comments to explain your rating?

10. What else did you find useful in the Tuberzone reports

11. How good is your understanding of how Tuberzone can help your burning down decision making?

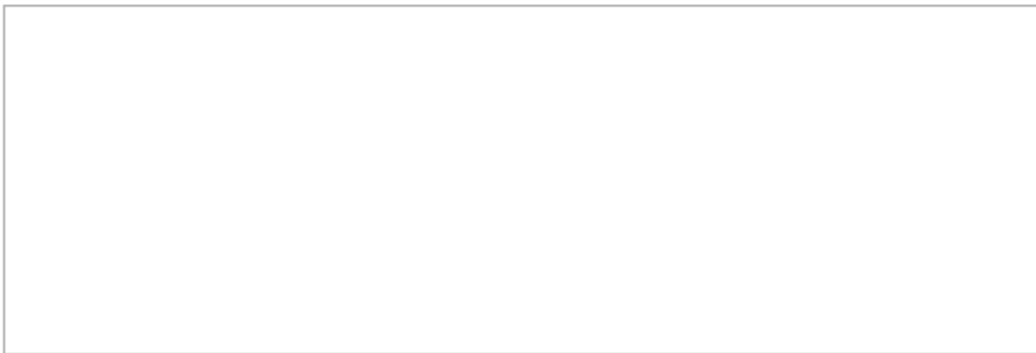
1 = poor understanding, 5 = complete understanding



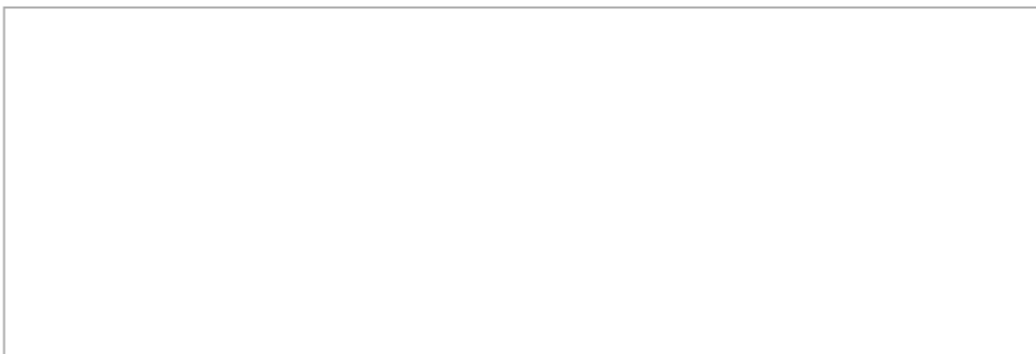
12. How can Tuberzone help your haulm destruction decisions going forward?



13. How could the Tuberzone service be improved?



14. Would you like to use Tuberzone to assist your burning down decisions in the future?



15. What barriers are there to you using Tuberzone?

- ☐ Meetings were too distant from my farm
- ☐ Don't use email that often
- ☐ Not enough information on how to use it
- ☐ Did not receive any training
- ☐ Not enough explanation in the data sent out
- ☐ Too busy to use it
- ☐ Too complicated
- ☐ Prefer to make my decisions in the field

☐

Other

Question on the KTIF Tuberzone project

16. If we were to run a project of this type again what could we have done differently?

17. How would you rate the following aspects of the KTIF Tuberzone project on a scale of 1 to 5 with 1 being the poorest rating and 5 being the best?

	1	2	3	4	5
Organisation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Communication	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Meeting delivery	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

18. Do you have any other comments on the project?