The agricultural European Innovation Partnership (Eip-Agri) Viticulture Climate Exchange (VitiCE) project report

Viticulture Climate Exchange (VitiCE)

The VitiCE project delivers weather and climate related service provision to UK vineyards to facilitate a more sustainable UK viticulture sector. Through the project an app has been developed (Climate Vine) to offer UK grape growers a unique opportunity to monitor, manage, and record growing season weather impacts on UK grape yields.

The VitiCE project is part funded by the European Agricultural Fund for Rural Development

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Report by:
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- Dr Alistair Nesbitt, Weatherquest Head of Viticulture Services

Project period: June 2017 – February 2018
Project budget: £59,195.80

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Summary

Title
Developing and trialling a multi-platform app, ClimateVine, in 2017 to improve productivity and sustainability in the UK viticulture and wine production sector.

Project objective
The Viticulture Climate Exchange (VitiCE) project aimed to tackle two key problems faced by English vineyards, namely vulnerability to adverse weather events and poor inter-grower knowledge exchange. Both these challenges negatively affect productivity in the sector.

Through the development and delivery of a single innovative technological tool, the ClimateVine application (app), the VitiCE project provided vineyards with free viticulture-focused and co-designed weather forecast services, and collated, visualised and analysed real-time vineyard phenology in response to variable weather.

These two activities aimed to help the sector mitigate weather risk exposure. VitiCE is a new approach to climate risk management, identifying best practice, promoting sustainability and facilitating sector wide communication to boost productivity.

End user benefits of a successful project
Project success would provide end users (UK grape growers) with a weather-forecast and grower knowledge-exchange hub (via an Android and IOS app) in which operational weather forecast information is exchanged for grape-vine phenology, disease and harvest measurements. Having access to forecast information will help producers plan vineyard management activities such as spray-times or harvest dates more efficiently and prepare for potentially damaging events such as spring frosts. Vineyard data will be used to accumulate knowledge and enable further research.

Main results
Result 1. An app was developed and launched for Android and iOS products that was specifically designed and trialled for use in UK vineyards.

Result 2. Viticulture-related weather information was provided to 95 vineyards (approximately 15% of all vineyards) trialling the app comprising: 1) local weather forecasts, 2) cumulative weekly bioclimatic indicators presented through the growing season (April – October) in gridded (9x9 km) map format, covering rainfall amount, frost risk and temperatures (Growing Degree Days – GDD), 3) Monthly regional weather reports and summaries relevant to phenology stages; and, 4) the ability to send out alert (push) notifications for extreme weather.

Result 3. Information exchange. Collection, though the app, of phenology and harvest data from 21 growers.

Main outcome/recommendation
The main outcome of the VitiCE project was a valuable tool for growers which connects service providers, researchers and growers to support the growth and productivity of a developing sector. The key recommendation looking forward is that the app requires sector wide promotion, on-going content provision and live activity reporting to continually engage users and entice them to provide vineyard data in exchange for valuable industry reports. There are several desirable improvements to
the app which users have highlighted through feedback, with the subsequent aim of providing a semi-commercial product for the 2019 season.

**Main report**

**Title:** Developing and trialling a multi-platform app, ClimateVine, in 2017 to improve productivity and sustainability in the UK viticulture and wine production sector.

**Editors of the text:** Alistair Nesbitt & Steve Dorling

**Project proposal: Aim of the project, work undertaken and the industry challenge it is addressing.**

There are now around 650 vineyards in England and Wales, totalling over 2000 hectares, and over 130 wineries producing world-class internationally award-winning sparkling white and rose wines as well as red wines. In the last few years English sparkling wines have won no less than 15 International Trophies in global competitions and are receiving acclaimed international recognition for their quality. Sector investment and growth is significant, increasing over 150% in the last 10-years and with expansion ever increasing; over 1million vines were planted in 2017 and a further 1.5million are likely to be planted in 2018.

Climate change, upskilling, investment, opportunities for agro-economic diversification and increasing market awareness of the quality of wines from England and Wales are presenting significant opportunities for viticulture. Notwithstanding this exciting potential ahead, ongoing risks associated with weather and climate variability result in lower and more variable yields than one would find in warmer and more stable climates. These indicate the need for greater resilience and sharing of knowledge in the sector, to help ensure sustainability. These weather and climate related threats are documented in published research by this report’s authors (Nesbitt et al. 2016. *Impact of recent climate change and weather variability on the viability of UK viticulture – combining weather and climate records with producers' perspectives*. Australian Journal of Grape and Wine Research; DOI: 10.1111/ajgw.12215). Threats posed by weather variability were identified in this research through an industry survey of UK winegrape growers. When complemented by a statistical analysis and literature review of weather and yield interactions, key risks relating to specific weather phenomena at critical stages of the growing season were identified. To refine and scope these risks in order to develop a tool that would help growers manage them, the project operational group and project partners were selected and composed of a mix of researchers, consultants, English grape growers (producers) and Wine GB (formally the United Kingdom Vineyard Association) – the representative body for UK wine producers. Through further engagement with these ‘stakeholders’ by means of meetings and discussions, and through a careful assessment of existing industry reports documenting challenges relating to weather, yield and quality parameters, we were able to define operational requirements for the ClimateVine app to address a key sector constraint.

Through this preparatory work it also became apparent that there was little communication between wine-grape growers with regards to documenting, understanding and sharing of information regarding weather and viticulture interactions and impacts. Furthermore, that there was little sharing of best practice in managing these critical relationships. WineGB and members of the operational group supported this hypothesis and agreed that an app that encouraged information exchange would be a valuable tool in developing knowledge to help individual growers and the sector to increase their resilience.
Within this context, of threats and opportunities for a rapidly expanding viti-sector, the aim of the VitiCE project was to help producers and the sector collectively tackle two key problems, namely vulnerability to adverse weather events and poor inter-grower knowledge exchange. Both these challenges negatively affect productivity in the sector, and through a process of sector engagement and investigation into services that could usefully be provided through the app a product was designed and launched that specifically targeted the sector's requirements. Help for the English and Welsh viticulture and wine production sector in optimising the selection of potential vineyard sites and gathering and sharing operational information about the sector, is something that has been notably lacking up to now.

The approach was to develop an app that delivered free viticulture-focused and co-designed weather forecast services for all vineyards in England and Wales, and collated, visualised and analysed vineyard phenology, disease and harvest data. In ‘exchange’ for free viticulture weather forecasts provided by Weatherquest Ltd., phenology, disease pressure and harvest data were sought from growers using the app. This was a novel and trial concept aimed at encouraging communication and starting to build a body of data / knowledge about weather and viticulture interactions in England and Wales. The concept was based on the premise that having access to forecast information would help producers plan vineyard management activities, such as spray-times or harvest dates, more efficiently and prepare for potentially damaging events such as spring frosts. The reciprocal within-vineyard data provided through the app will, over time, accumulate and start to provide the sector as a whole with a better understanding of spatially and temporally relevant weather risks, their impacts on phenology, disease and yields, and critically ‘best-practice’ risk mitigation activities to boost yields and sector sustainability.

One of the key enablers of the app functionality is the integration and presentation of viticulture-specific weather information. Weather data, information and forecasts used in the app are delivered by Weatherquest Ltd, a specialist weather services provider based in Norwich with a long experience since 2001 of weather and climate service provision to the agricultural sector. The data is drawn from both existing meteorological stations (and presented on the app – ‘observational data’), and from modelled simulations and forecasts generated by Weatherquest. One of the critical USP’s of the ClimateVine app is that the weather data is provided with viticulture specifically in mind. That is to say it differs from ‘general’ weather apps because it provides data and forecasts for conditions of critical importance to vine growing at a local resolution and delivers advice on the back of these such as whether it’s a suitable time to spray (generated by an algorithm that considers rain, temperature and wind), or whether it’s a suitable time to harvest. Additional information such as relative humidity and soil moisture are key viticulture variables provided via the app which most generic weather service apps don’t provide. The app also generates frost warnings/alerts (via push notifications) for growers, specific to the 8-week period during which vines are most at risk from air frosts. The cumulative Growing Degree days (GDD), rainfall and frost risks maps and data are generated specifically for the growing season (April – October or April – May in the case of air frosts) to be more informative and valuable than standard annual or seasonal data. In fact the GDD cumulative map that updates weekly is the only one of its kind in the UK (and possibly globally) that is driven by an algorithm specific to vine-growing.

The project market was all vineyards in England and Wales. In addition, the project aimed to be of benefit to those in the UK viticulture research community who have the ability to translate viticulture and weather data into outputs such as scientific research and recommendations regarding how viticulture, and in particular yield sustainability, can be improved, to drive a more resilient sector.
How the Operational Group was formed and how the group operates

To support the project development and delivery an Operational Group was formed in June 2017. The group was composed of:

<table>
<thead>
<tr>
<th>Name</th>
<th>Organisation</th>
<th>Position</th>
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<tbody>
<tr>
<td>Jo Cowderoy</td>
<td>United Kingdom Vineyard Association (WineGB as of 2018)</td>
<td>General Secretary</td>
</tr>
<tr>
<td>Steve Dorling (Lead Actor)</td>
<td>Weatherquest Ltd</td>
<td>Innovations Director</td>
</tr>
<tr>
<td>Alistair Nesbitt</td>
<td>Weatherquest Ltd</td>
<td>Head of Viticulture Services</td>
</tr>
<tr>
<td>Ilya Maclean</td>
<td>Exeter University</td>
<td>Lecturer in Natural Environment</td>
</tr>
<tr>
<td>Julien Lecourt</td>
<td>East Malling Research</td>
<td>Lead Viticulture Researcher</td>
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</table>

This group was supported / complemented by two vineyard managers who advised on specific requirements relating to app functionality and viticulture.

The group was formed by invitation to selected partners, based on their expertise and value to the project as leading contributors to the science and practice of viticulture in the UK, and their knowledge of the sector.

- Weatherquest Ltd is a private company, headquartered at the University of East Anglia (UEA) in Norwich, specializing in the weather and climate sector through forecasting, analysis and research. Since the company’s formation in 2001, Agriculture and Horticulture have consistently been amongst Weatherquest’s most important client sectors, alongside water, energy, media and transport. The company is owned by its directors and UEA. In addition to providing operational services to its clients, Weatherquest also participates in collaborative research and development projects, funded for example through the Innovate-UK Agri-Tech Catalyst. By leading the VitiCE project and being an enthusiastic founding member of SVINERGY, Weatherquest committed to providing its weather forecast services free of charge to all English vineyards during the 2017 growing season and, in return, seeks to learn much more about the needs of the viticulture sector through the 2-way knowledge exchange described in this project proposal. Weatherquest typically charges £500/year for our service to all growers and so our commitment to provide this service to up to 540 (at the start of the project) English vineyards represented matched funding of up to £270k. Steve Dorling, Innovations Director at Weatherquest Ltd and Associate Dean at the University of East Anglia, was the Lead Actor and managed the project. Steve was responsible for delivering the weather forecasts to producers through the app and, with Weatherquest’s Head of Viticulture Services Alistair Nesbitt, also managed the app development and delivery.

- Jo Cowderoy, as General Secretary of the United Kingdom Vineyards Association (UKVA) (now WineGB), represents the 540-member vineyards in England. Her role in the operational group, SVINERGY, was to represent and communicate directly with the UKVA’s members who have highlighted the problems this project addresses, and to facilitate engagement and dissemination with English wine producers, for example through the Grape Press publication.
Dr Alistair Nesbitt, Head of Viticulture services at Weatherquest, led on the app development through co-design with producers and also performed the regular monthly vineyard phenology and management data analysis.

To help develop the app and disseminate results Dr Ilya Maclean and Dr Julien Lecourt respectively were able to provide valuable expertise born out of their extensive research in UK viticulture and regional networks of producers who they engage with.

Much of the app development work was iterative in nature in order to give Operational Group members the opportunity to view, test and provide feedback on its various elements. To facilitate this process of refinement and improvement ad-hoc meetings were held with group members and supporting vineyard managers, but also three full project meetings (17th January 2017, 1st June 2017, 14th December 2017) with all members were held during the project to review progress and agree actions through to successful project completion. During the development process the app (in it’s development state) was made available as a ‘Test App’ to group members and the vineyard managers to trial the various components in real-time and then provide feedback to the group and developer regarding aspects that functioned well and areas for improvement / further development. This process of ‘trialling’ as the app was developed helped ensure we ended up with a user-friendly and ‘robust’ service. In addition, the sub-contracted app developers themselves (Hyperpixel) also undertook a rigorous process of app testing before launch to iron out any bugs, ensure data security, and sense check the usability of both iOS and Android versions.

**Project results and outcomes**

1. **The Climate Vine app: Delivery**
   
   At the outset of the project the aim was to have an operational app ready for launch in April 2017 and a development timeline was designed to achieve this. April was considered important as this month marks the ‘formal’ start of the grape growing season (April – October) in the Northern Hemisphere. However, due to circumstances out of the project’s control, there was a four-month delay in being awarded Eip-Agri project funding through the Rural Payments Agency. This considerable delay resulted in a new app developer having to be found, as the original quote submitted with the project application expired. Furthermore, critically, it significantly reduced app development time to a period too short to secure delivery by the start of the season (April 2017). Completion of development and app launch was subsequently delayed, partly because of this and partly because of unforeseen technical challenges integrating weather forecasting functionality into the app. In addition, to develop the app to be as useful to growers as possible, at no extra cost, we advanced the app functionality by incorporating the ability to automatically recognise user locations and provide location-specific weather forecasts, enabling date and location stamps on user photo uploads, interfacing the app with a content management system and adding in a real-time rainfall radar. This additional functionality provided assurance regarding the quality and authenticity of data being uploaded, and made the process simpler and quicker for the user.

   Both iOS and Android apps (See Figure 1 below for app screenshots) were launched at the end of June 2017. This delay meant that one of the critical viticulture-weather risk periods (early season frost risk) had passed by the time the app was launched. As such we were unable to roll out frost risk alerts to growers, as originally intended. However, this functionality was developed and used during the 2018 bud-burst period, and remains part of the app functionality, see Section 2 (app functionality) below.
2. **App functionality**

The app delivers the following functions:

- **Sign-up/Registration**
  - Growers locate their vineyards (up to 3) using an interactive map of the UK
  - Growers enter Variety, Clone and Rootstock combinations established in those vineyards
  - Growers can view and read the Terms of Use and Privacy Statement
• Current weather observations
  o Real-time data feeds from official weather stations around the UK provide current observations for (see Figure 3):
    ▪ Air Temperature
    ▪ Rainfall in the last 24 hours
    ▪ Soil temperature
    ▪ Solar radiation
    ▪ Sunshine duration
    ▪ Dew Point Temperature
    ▪ Wind speeds and direction
    ▪ Relative humidity
  o A rainfall radar display (mm/hour) including precipitation type

![Weather Observation](image)

*Figure 3. Rainfall radar and current observation example app pages (screenshots)*

• 24-hour forecast for 7 days
  o Hourly forecast in tabular or graphical form for (See Figure 4):
    ▪ Rainfall (mm)
    ▪ Air temperature (°C)
    ▪ Wind speed (mph)
    ▪ Cloud cover (%)
    ▪ Relative Humidity (%)
    ▪ Sunshine (symbol)
Figure 4. Hourly weather forecast data (tabular and graphical formats)

- As a day summary covering (See Figure 5):
  - Overview text
  - Rainfall
  - Spray index
  - Harvest index
  - Sunrise time
  - Sunset time
Extreme weather alerts for air frost, snow and lightning
European scale growing season maps of growing degree days, rainfall accumulation and air frost frequency (see Figure 6).

Figure 5. Forecast summary screenshot.

Figure 6. Screenshot of cumulative Growing Degree Days (GDD)
• A temperature, rainfall and air frost tracker for the user’s vineyard(s) showing their present season’s accumulation compared with a 10-year average (for temperature & frost) and previous years
• Insights into (See Figure 7):
  o Monthly regional weather conditions
  o An annual report

3. **Content management**
Weatherquest used its in-house IT expertise to create a bespoke Content Management System (CMS) for the app. Within this user details and uploads are securely stored, passwords can be reset and app content and push notifications can be managed. The latest weather information is streamed from Weatherquest to the app via a series of JSON feeds.

4. **Climate Vine website**
To support promotion of the app and the project we developed and hosted a webpage, see Figure 8. From this website interested users can link to download both iOS and Android app versions.
Figure 8. www.climatevine.com screenshot
5. **Promotional activity**

Throughout the project promotional activity has been undertaken:

- Three articles have been published in the Grape Press, a national publication for all UK grape growers / wine producers with a readership estimated to be 1000+, regarding app use and functionality.
- A presentation was given at Fruit Focus (an annual national fruit growing exhibition event) in Kent
- The app was promoted during a presentation to Viticulture students at Plumpton College, Sussex, many of whom already worked in vineyards or were training to be vineyard employees or managers.
- Via the south-east vineyard managers forum and the UK wine research and development group a presentation / talk about the app was provided.
- Growers were engaged directly via email and phone calls to encourage app uptake and discuss areas for app development.

The project output is the ClimateVine app, now available via the App Store and Google Play for iOS and android mobile devices respectively. The results, set out in this report, will be available via the app and website for users to see, once the report is approved. Ultimately the data captured and provided through the exchange process will accumulate over time into a useful data-set to inform the sector and researchers more fully about weather and viticulture interactions. The promotion of the outcome of the project continues via WineGB, the operational group and word of mouth, and the number of vineyards using the app is now close to 150 (as at August 2018) – it is worth noting that this represents 23% of all England & Wales vineyards, a remarkable achievement.

6. **Project engagement and development**

Following the app launch 90 growers registered and used the app (See regional breakdown in Table 1 below), during the 2017 season. They varied in scale and location, affording a good representation of growers across the UK wine production sector. These 90 growers registered an average of 2 vineyards each, 180 vineyards in total, close to 30% of all vineyards in the UK.

<table>
<thead>
<tr>
<th>Location</th>
<th>Vineyards</th>
<th>Location</th>
<th>Vineyards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abergavenny</td>
<td>1</td>
<td>Loughborough</td>
<td>1</td>
</tr>
<tr>
<td>Bedfordshire</td>
<td>1</td>
<td>Northamptonshire</td>
<td>1</td>
</tr>
<tr>
<td>Berkshire</td>
<td>1</td>
<td>Nottinghamshire</td>
<td>1</td>
</tr>
<tr>
<td>Bradford-on-Avon</td>
<td>1</td>
<td>Oxfordshire</td>
<td>1</td>
</tr>
<tr>
<td>Cornwall</td>
<td>1</td>
<td>Pembrokeshire</td>
<td>1</td>
</tr>
<tr>
<td>Devon</td>
<td>3</td>
<td>Somerset</td>
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<tr>
<td>Dorset</td>
<td>3</td>
<td>Suffolk</td>
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<tr>
<td>Essex</td>
<td>3</td>
<td>Surrey</td>
<td>1</td>
</tr>
<tr>
<td>Gloucestershire</td>
<td>1</td>
<td>Sussex</td>
<td>22</td>
</tr>
</tbody>
</table>

*Table 1. App registration by region*
Effective knowledge exchange between the research and viticulture sector was at the very heart of the project proposal. The VitiCE project was developed in conjunction with the UKVA (now WineGB) to help meet the needs of the wine production sector in England. It realised an opportunity for them and their members to capitalise on industry focussed research knowledge by utilising a targeted technological innovation to help address recognised problems. The winemaking sector in England is characterised by a predominance of small enterprises, a low density of vineyards and high variation in relevant skills and experience. Individual vineyard managers and investors very rarely possess the skills to make use of scientific knowledge relating to risks. Conversely, the researchers at Weatherquest possess incomplete knowledge of the specific weather or climate events to which grapevines are sensitive. The project helped build bridges between the research community and industry by 1) initial consultation with vine growers to guide the VitiCE app development including specific desired platform(s) for delivery, e.g. Android, Apple; 2) demonstrating how data analytics can be used to monitor phenology and identify means of best-practice in response to adverse weather risks in English and Welsh vineyards.

The examples below show both the value of the app functionality so far and also the start of a long-term collection of data to improve knowledge sharing between growers and the research community:

1. Within the app a user can photograph stages of grape development and submit that information to the app ‘managers’. Where this has happened the app managers have been able to link the phenology stage (at a set location and time for a given variety) to the GDD stage in order to start to develop a model showing correlation between temperature, other weather variables and grape phenology. Such an outcome (once fully developed – requires several years of data) will ultimately help growers better estimate and plan for harvest dates and assess progress against other growers.

2. Where app users were prompted, via an app alert, to activate frost protection in the event of an up-coming air first event evidence from yield and temperature data can demonstrate how successful or not the frost protection was.

7. Monthly (April – October) regional weather data
At the end of each calendar month of the growing season regional mean temperature, maximum temperature, rainfall and rain day data was uploaded onto the app in graph form. These variables were presented for the month in question as comparisons with the previous 10-year (2007–2016) median values for the same region, accompanied with commentary, which enabled growers to easily view how the monthly variables compared with the recent decadal average. All regional monthly data was obtained from the Met Office. Figure 9 below provides four examples of uploaded graphs for August 2017.
Figure 9. August 2017 regional mean and maximum temperatures, rainfall and rain-days against 10-year (2007–2016) median averages (data from the Met Office)

In addition to these monthly comparative graphs, at the end of April and May, data relevant to the regional historic frost risk was presented with commentary to provide growers with an indication as to how many frost days occurred during these critical [frost risk] months compared to the 2007–2016 average, see Figure 10 below.
Despite the slightly lower than average April frequency of air frosts in 2017 it is worth noting here that just two events in 2018 (on the 18th and 26th) caused widespread damage to vineyard buds where adequate protection was not instigated.

8. Monthly reports
After every month of the growing season (April – October) reports were uploaded onto the app providing a regional summary of weather conditions relative to a 10-year (2007 – 2016) average. These were accompanied with commentary regarding the ‘impact’ of these conditions on vine phenology as reported by growers. Figures 11 and 12 below provide an example of graphs for South east & south central England and associated commentary provided in August 2017.
• August temperatures were very ‘average’.
• However, May, June and July were warmer than the last 10-year averages (median).
• June was the second hottest (16.9°C) on record since 1910, just below 1976 (17.5°C).
• Early June was unsettled but from the 2nd to 3rd week a consistent warm and dry spell resulted in rapid and relatively early flowering taking place in many south-eastern vineyards.

Figure 12. Example monthly rainfall and rain day anomalies for South east and south-central England

• July was particularly wet with ~90% more rain than average.
• Early June and the last week of June were unsettled bringing 58 mm of rainfall, 40% above the 10-year average and potentially disrupting grape vine flowering.
• However early season (April) was especially dry with only 10 mm of rain falling in just ~3-days. That’s nearly an 80% reduction compared with the 2007 - 2016 average.
• Rainfall following April was a welcome relief to growers, especially as most fell outside of the critical flowering period.

9. Weekly cumulative air frost risk maps
From the 1st April – end of May every week the app updated with a map showing the cumulative number of frost days at 9 x 9 km grid resolution, see example outputs in Figure 13. The data and maps for both the air frost days and Growing Degree Days (see below) were produced by Weatherquest Ltd using the Weather and Forecast Research (WRF) model and viticulturally relevant algorithms.
Complementing these maps, the app informed growers how many frost days they have experienced in the present April – May period compared with last year (2016) and a 10-year (2007–2016) average. Thus, growers could immediately and easily interpret the relative risk, spatially and temporally.

10. **Weekly cumulative Growing Degree days (GDD)**

As with frost risk, the app was updated weekly with gridded (9 x 9 km) maps showing the cumulative Growing Degree Day values, and with text informing the growers how their vineyard local temperatures compared with last year and the previous 10-year average. Figure 14 below, shows screenshots for April – October cumulative GDD output.
At the end of the season (31st October 2017) a UK and European map of GDDs was presented via the app, see Figure 15 below.

Figure 15. End of 2017 season European wide comparative GDD output.
11. Weekly cumulative rainfall maps
As with both air frost days and GDD, cumulative rainfall maps, driven from Weatherquest’s rainfall radar) was also presented on a weekly basis via the app.

12. Grower input – ‘exchange’
One of the main aims of the app was to encourage growers to provide phenology (vine growth), disease and harvest data via the app. Growers were invited to provide this data at key periods of the season via the insights section and via push notifications. The app was designed with a phone camera function so that a grower could take a picture of their vines or grapes and upload it onto the app along with free text. The app ‘system’ automatically recognised the location and date the photo was taken as a means for the administrators to verify the photograph’s authenticity and reduce the text inputs requested from the grower/user.

In response to the requests for data/information the following was received:

- No disease data was contributed by growers
- Phenology data was contributed by 20 growers
- Harvest data was contributed by 5 growers

The lack of disease data was disappointing. There are several reasons as to why no data was submitted:

- Growers may have been concerned that the data was too commercially sensitive and perceived that app security may not have been strong enough to store this information confidentially.
- Potentially growers were too busy to upload the data, with no real imperative to upload the data
- Growers may not have understood how this data would be used.

In all cases, greater clarity of purpose and communication with growers to explain in more detail why the data was valuable and how it was to be used would likely have resulted in some / more data being provided.

A summary and examples of the phenology and harvest data is presented in Table 2 below. For a first trial year 20-sets of phenology data was deemed a good return as it illustrated willingness to provide the data and the successful functionality of the app as a platform and conduit for data collection. As with disease data, improved communication could have resulted in a greater volume of harvest data being submitted, although this is especially commercially sensitive, which could remain a further barrier.
Table 2. Examples of grower submitted phenology and harvest data

<table>
<thead>
<tr>
<th>Location</th>
<th>Variety</th>
<th>Rootstock</th>
<th>Clone</th>
<th>Phenology (50%)</th>
<th>Date (2017)</th>
<th>Uploaded photo</th>
<th>Harvest start - end</th>
<th>Yield</th>
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<tr>
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<td>SO4</td>
<td>F105</td>
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<td>17.09 – 21.09</td>
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<td></td>
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</table>
13. What did and didn’t work

Feedback on the app was gathered through direct communication (email and phone calls) with users. Feedback was very positive from those using it. There are opportunities for development and challenges that need addressing but overall the app functionality worked, and growers found value in it. The SWOT analysis below highlights the principal areas of success and feedback, as well as areas that require further work.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Specific target engaged (UK vineyards)</td>
<td>• Requires a certain volume of input to produce results with higher value.</td>
</tr>
<tr>
<td>• Provision of valuable data to the sector and individual growers</td>
<td>• Problems logging on</td>
</tr>
<tr>
<td>• Seen as a ‘useful’ vineyard management tool</td>
<td>• Users forgetting passwords</td>
</tr>
<tr>
<td>• Ease of access to weather forecast and alerts</td>
<td>• It will take time to help yields to improve</td>
</tr>
<tr>
<td>• Targeted weather forecasts for vineyards</td>
<td>• Cumulative frost risk scale needs revising as can’t see the difference</td>
</tr>
<tr>
<td>• Information sharing within the sector</td>
<td>(separate UK map with dedicated scale)</td>
</tr>
<tr>
<td>• Great for record keeping</td>
<td></td>
</tr>
<tr>
<td>• Run by specialists (viticulture &amp; meteorology)</td>
<td></td>
</tr>
<tr>
<td>• ‘Doing something useful for the sector’</td>
<td></td>
</tr>
<tr>
<td>• Attractive design</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats/Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Quicker (perhaps automated) analysis of data</td>
<td>• Requires significant information volume, via the app, to retain user</td>
</tr>
<tr>
<td>• Could be used as a portal/platform to distribute a greater range of</td>
<td>interest.</td>
</tr>
<tr>
<td>services and to act as a repository</td>
<td>• Requires information/data submission from many users to offer the potential</td>
</tr>
<tr>
<td>• Opportunities to present more general ‘sector’ data/information</td>
<td>for meaningful analysis.</td>
</tr>
<tr>
<td>• Push notifications don’t fill up inboxes.</td>
<td>• Reluctance to submit information as not sure about level of data security</td>
</tr>
<tr>
<td>• Would like to see more phenology and harvest information</td>
<td>and what it will be used for.</td>
</tr>
<tr>
<td>• Disease pressure prediction would be good</td>
<td>• Users not having the time or reward for uploading information (phenology,</td>
</tr>
<tr>
<td>• Expansion to other countries</td>
<td>disease, harvest data etc)</td>
</tr>
<tr>
<td></td>
<td>• Requires a funded / part-funded cost model for sustainable development /</td>
</tr>
<tr>
<td></td>
<td>use, or additional components to attract subscriptions</td>
</tr>
</tbody>
</table>

User feedback = Red  
VitiCE team comments = Blue
Feedback indicates that app users found the product very useful, especially in terms of having access to vineyard specific weather data, alerts and cumulative tracking maps and data. The main novelty that was fed back was the ability for a user (vineyard manager) to track comparative temperatures, rainfall and frost events between vineyard locations, i.e. develop a spatial awareness of variability between sites, which is not provided/accessible through other apps. Whilst we have been unable to quantify the impact of the app on yields (due to the limited time-frame) we do know from feedback that many growers activated frost protection on nights they were alerted to frost events via the app. we are confident that doing so will have saved potential bud and shoot damage.

The project met the original objectives in so far as an app was produced through engagement with the UK wine production sector, that delivered the services and functionality that was envisaged and expected from the outset. In doing so weather and climate risks to grape growing in the UK have been reduced by virtue of a service providing tailored weather information and extreme weather alerts for growers. The cumulative data and maps have, for the first time, enabled growers to track both their own vineyard viticulture-specific weather conditions, and compare to those of others, and between seasons. Phenology data has been gathered but there has not been the quantity of data from growers yet, nor the time-frame in which to collect the data (several years’ worth are required) to provide meaningful conclusions via statistical analysis, regarding specific meteorological impacts on yield and quality parameters for specific varieties and clone combinations. As such for frost protection, growing conditions and best-practice activities recommendations more data is required to fully meet these project objectives.

14. Additional benefits

There have been several unexpected benefits from the project:

- Through contact from growers using the app we have been able to answer questions regarding 1) how bioclimatic indices (in this case GDD) are calculated and used, 2) what weather sensors or stations are of use in vineyards, 3) how the weather forecast is generated, and 4) whether the data could be used to drive disease models. These questions facilitate engagement between growers and researchers and have value to both parties.
- Several growers have approached us to say they have in-site weather stations that we could access the data from. Although this hasn’t been capitalized on yet, the data from these will help improve vineyard specific weather forecasting accuracy.
- Encouraging growers to submit phenology and harvest data via the app is an on-going process. However, through the challenge of doing so we have also been encouraged to look at opportunities for remote sensing and data capture of vineyard variables that could assist in this process in the future.
- We have become more aware of vineyard activities and of vineyards. Several app subscribers were unknown to us so we have been able to build up a more complete picture of vineyard numbers and varieties being grown in the UK.

Conclusions

You should explain the conclusions which have been derived from the results and outcomes of the project. The conclusion should also include how the project could be taken forward in the future including any future projects which could be developed on the back of the results. This should
include whether there are any further (scientific) questions from the project results, which need to be considered in the future.

The SVINERGY Operational Group was formed in order to oversee the VITICE project and with the expectation that the Group would submit follow-on collaborative project bids, led by different group members, for potential funding through the European Agricultural Fund for Rural Development. So, it was quite a shock and a great disappointment to the Group that no further calls are anticipated for UK projects under this programme.

Nevertheless, we have demonstrated through the VITICE project that the ClimateVine app is already an excellent platform for two-way sharing of climate and viticulture information. Furthermore, given the number of Vineyard Managers who were keen to evaluate the app, there is clearly an appetite for such a tool and activity. With the feedback that we have received we have identified ways in which the app can be improved, to further enhance its appeal.

While we were able to sustain the information-exchange associated with all aspects of the ClimateVine app functionality (including air frost alert push notifications) throughout the 2018 growing season, even though our VITICE project funding ceased in February 2018, we are now necessarily investigating several alternative business models to place the platform on a successful long-term footing for the 2019 growing season and beyond. These include the following options, both individually and in combination:

(1) Further regional, national or international funding support through suitably aligned project funding programmes;

(2) Sponsorship of the app through a partnership agreement;

(3) the addition of new app functionality/features to further enhance its commercial appeal.

It is important to recall that the ClimateVine app platform offers great potential in the collection of data which is valuable for research – the value of which must be included in the business model going forward.
Appendices

A. Partners:

Project coordinator according to the cooperation agreement:
Steve Dorling
Innovations Director
Weatherquest Ltd.
Enterprise Centre
Norwich Research Park
Norwich, NORFOLK,
NR4 7TJ

Email: S.Dorling@uea.ac.uk
Tel: 01603 592533

Project partners:

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alistair Nesbitt</td>
<td>Weatherquest (as above)</td>
</tr>
<tr>
<td>Jo Cowderoy</td>
<td>United Kingdom Vineyards Association Knoll House, Union Wharf, Market Harborough, LE16 7UW</td>
</tr>
<tr>
<td>Ilya MacLean</td>
<td>Environment and Sustainability Institute, University of Exeter, Penryn Campus, Penryn, TR10 9FE, UK</td>
</tr>
<tr>
<td>Julien Lecourt</td>
<td>NIAB EMR, New Road, East Malling, Kent, ME19 6BJ</td>
</tr>
</tbody>
</table>

As well as the above ‘official’ partners the app was developed in close co-operation with numerous UK wine producers and vineyard managers including Nyetimber vineyard in Sussex and Flint Vineyard in Suffolk.

B. Terms of reference of the operational group

Terms of Reference

1. Introduction

The SVINERGY operational group has been established to manage and deliver the VitiCE project. VitiCE will develop an application (app) to tackle two of the key problems faced by English vineyards, namely vulnerability to adverse weather events and poor inter-grower knowledge exchange. Both these challenges negatively affect productivity in the sector. Over the project lifetime (December 2016 –
March 2018) and through the app, VitiCE will 1) provide vineyards with free viticulture-focused and co-designed weather forecast services, and 2) collate, analyse and visualise real-time vineyard phenology and management activity in response to variable weather. These two activities will help the sector (700+ vineyards), as a whole, to mitigate risk exposure and to identify vineyard practices which enhance efficiency and resilience. VitiCE is a new approach to climate risk management, identifying best practice, promoting sustainability, and facilitating sector wide communication to boost productivity from 2017 onwards.

The project is funded by DEFRA and the European Union through the Rural Development Programme for England (RDPE) European Innovation Partnership (EIP-Agri).

The operational group (SVINERGY) is made up of a private business (Weatherquest Ltd.), research institutions (East Malling Research (EMR) and Exeter University) and a representative body of UK vineyards (The United Kingdom Vineyards Association (UKVA)). The group has the backing of UK vineyards to develop and deliver the VitiCE project in line with the UKVA sector development strategy and RDPE objectives.

SVINERGY is a dynamic group which responds to the UK viticulture sectors’ needs through expertise, research, and innovation. It is not a formally constituted group and as such it operates under these Terms of Reference (TOR), but as a body it has no legal responsibility or liability. The accountable body, Weatherquest Ltd., is responsible for the delivery of the VitiCE project on behalf of DEFRA.

2. Membership
SVINERGY is currently composed of:

1. Steve Darling. SVINERGY Chair and Director of the accountable body (Weatherquest), responsible for project delivery and accountability to DEFRA and the RPA.
2. Alistair Nesbitt. VitiCE project manager and Head of Viticulture Services at Weatherquest, responsible for project management and operational implementation.
3. Joanne Cowderoy. UKVA General Secretary responsible for stakeholder engagement and VitiCE project dissemination.
4. Ilya Maclean. Exeter University Senior Lecturer in Natural Environment with a SVINERGY role of supporting the VitiCE project with English climate and viticulture expertise. Also responsible for facilitating a project engagement meeting in the south-west.
5. Julian Lecourt. EMR lead viticulture researcher with a SVINERGY role of supporting the VitiCE project with viticulture research expertise. Also responsible for facilitating a project engagement meeting in the south-east and communicating project outputs with the EMR viticulture research consortium.

As well as these five members, at the start of the VitiCE project, the SVINERGY group will co-opt two UK vineyard managers to trial the app. in their vineyards, as ‘early adopters’ and provide feedback into the development process.

SVINERGY membership is flexible, ensuring representation of all regional wine production sectors, through the UKVA. An emphasis is placed on the private sector rather than representation from public bodies, with no one sector making up more than 40% of the membership. This model puts the responsibility for delivery with Weatherquest, acting in partnership with other organisations and the UK viticulture sector. It also helps to ensure that a balanced mix of specialist knowledge (viticulture
and climate related) and other relevant expertise (vineyard management) is brought together to deliver the projects objectives.

A maximum operational group (SVINERGY) membership of seven ensures that the group can effectively represent the broad range of interests across the UK vineyard sector, whilst allowing all members to fully participate in meetings either in-person or via a web-ex platform. Non-members can be invited to observe meetings.

There is a minimum fixed length of term for SVINERGY members: 18 months, but members are encouraged to remain engaged post VitiCE project delivery. However, if members do step down, replacement representatives will be sought from the appropriate sector. New members will also be welcomed to join SVINERGY throughout the project’s delivery, especially if they bring a particular skill, background, interest, or knowledge to the group that will support the VitiCE project.

SVINERGY will regularly reflect on the group’s membership and meeting attendance to ensure that it actively represents the UK wine production community and their needs.

The UKVA and EMR viticulture research consortium act as fora to engage with other stakeholders from across the UK wine production sector. The UKVA is recognised in legislation as the representative body of the UK wine production sector. It has circa 600 members, most of whom are UK wine producers. The UKVA has an active role in promoting UK wine and in providing strategic and day-to-day support for development of the sector. The EMR research consortium is formed of over 20 UK vineyards who work with EMR on R&D projects relevant to their viticulture and wine production activities. These two networks, which SVINERGY will be actively engaged with, represent communities from which new potential SVINERGY members can come forward.

3. **Chairing**
SVINERGY is chaired by Dr Steve Dorling. The appointment or election of a chairperson occurs annually. The chair declares that they act on behalf of and in the interests of the SVINERGY group.

4. **Meeting frequency**
SVINERGY meets at least four times a year, in person or via a web-ex platform. A calendar of more regular meetings has been agreed for the duration of the VitiCE project (18 months), and will subsequently be agreed each year for the following twelve months. A meeting can be cancelled or postponed at the discretion of the chairperson. A quorate meeting will be attended by at least three members including the chairperson. If a meeting is not quorate it can proceed on the basis that it will not make decisions. Meeting minutes will be taken and available to all group members.

5. **Delegated decisions**
If a decision needs to be made with some urgency and a quorate meeting cannot be convened (or the nature of the decision does not merit the convening of a meeting) SVINERGY members will be notified by email of the matter that needs to be decided and requested to comment within five working days. The chairperson will then make a decision based on any comments submitted.

6. **Decision making process**
The decision-making process within SVINERGY is transparent and democratic with strategic decisions being made at four annual meetings. Operational decisions, as part of the project management
process, are the responsibility of the project manager, but will be undertaken in accordance with strategic direction and project objectives set by the SVINERGY group.

7. Governance
SVINERGY is authorised by the DEFRA to undertake the VitiCE project. SVINERGY will be accountable to the Chair and to DEFRA for the delivery of the VitiCE project. A report of the project will be submitted to DEFRA upon project completion. SVINERGY will retain responsibility for all aspects of internal control, satisfying itself that appropriate processes are in place to provide the required assurance.

SVINERGY has decision making powers with regard to the VitiCE project. It is established to provide recommendations to the project manager and oversee risk management, governance and successful project completion.

SVINERGY is authorised to create sub-groups or working groups, as are necessary to fulfil its responsibilities within these terms of reference.

8. Accountability of SVINERGY, and members' conduct

- SVINERGY members commit to attend meetings.
- SVINERGY members will ensure that the sector that they represent has an effective voice at meetings. However, SVINERGY members commit to act in the interest of the project, and not just their own organisations or personal interests.
- SVINERGY members will take joint responsibility for decisions made by the group.
- SVINERGY must be able and willing to justify decisions to others if needs be.
- SVINERGY members will work effectively with the DEFRA and follow the DEFRA Code of Conduct for working well together.

9. SVINERGY role and responsibilities

- Encourage UK vineyards to come forward with data and input that will help to deliver the VitiCE project.
- Oversee engagement activity with the UK wine production sector relevant to the project.
- Oversee the direction, delivery, and impact assessment of the VitiCE project, including:
  - financial budget
  - outputs and outcomes delivered
  - monitoring and evaluation
- Oversee the programme communications strategy, within this:
  - Publicise and communicate the project and engagement opportunities
  - Utilise own networks to raise awareness of the programme and generate involvement
- Work with DEFRA to ensure compliance with RDPE and Rural Payments Agency (RPA) rules and regulations.
- Work with Weatherquest Ltd and the RPA to maintain accurate and timely financial management.
- Support and guide the project manager’s work.
- Support project delivery by offering insight and expertise, for example:
  - Offer technical advice or expertise during the App development and delivery
  - Provide knowledge of viticulture, climate and phenology to the group
• Build strategic links with appropriate partners and encourage joint projects that build collaboration with similar and complementary interests.

10. Role and responsibilities of the Lead Actor (Weatherquest)

• Ensure compliance with RDPE and RPA operating procedures including:
  o Processing grant payments against approved claims.
  o Maintaining project records to provide an audit trail
  o Regularly monitoring the progress of the projects
  o Evidencing decision making process e.g. minutes of meetings, attendance lists etc.

• Weatherquest will provide:
  o Project management skills
  o Financial management skills
  o Ability to employ staff
  o Ability to procure

11. SVINERGY and VitiCE project organisational structure

SVINERGY and its accountable body (Weatherquest) are responsible for delivery of the VitiCE project in accordance with their EIP-Agri project proposal, DEFRA guidance, and RPA processes. As set out in Figure 1 the VitiCE project manager falls within the accountability of the SVINERGY group and is responsible for operational delivery. This involves managing relationships and project timelines with the App. developers and stakeholders (vineyards), the latter primarily through the UKVA.

12. VitiCE project management staff

The VitiCE project has the equivalent of two part-time members of staff; Steve Dorling the Lead Actor and Chair, and; Alistair Nesbitt Head of Viticulture Services, who is responsible for managing project
delivery. They are employed and managed by the accountable body (Weatherquest), in accordance with Weatherquest’s terms and conditions of employment.

They are responsible for the day to day activities of the project including overseeing the App. development, claims administration, communicating with stakeholders and keeping SVINERGY, Weatherquest and DEFRA briefed on all project deliverables and activities.

13. Declaration of interest
SVINERGY group members will prioritise the needs of the end-users of the VitiCE project over any other interests in the project.

14. Finance
The VitiCE project costs total: £326,733.64. Of this £56,733.64 is to be provided through the EIP-Agris scheme by way of a grant. £270,000.00 is being provided by Weatherquest Ltd. in the form of matched funding. Additionally Weatherquest Ltd. will be ‘bankrolling’ the project prior to grant claims payment by the RPA, for the following:

- Stationary: £206.31 (January 2017)
- Promotional costs: £1,750 (January 2017 (£500), March – October 2017 (£1,250))
- App development: £11,900 (January – May 2017)
- Staff salaries: £40,268.07 (January 2017 – March 2018)

Irrecoverable VAT, payable by Weatherquest totals £2,609.26.

15. Ownership
Results from the project will be attributed to the SVINERGY group but will not be ‘owned’ by any single party. Group members can use the results to further advance their own work or in the case of the UKVA to support its membership and the sectors development strategy. Should opportunities for publication of the project and/or associated data arise SVINERGY members should notify other members of intention to publish using information generated through SVINERGY activity at least 6 months before submission and offer other members co-authorship. The App. will remain the property of Weatherquest.

All results and outputs can be shared with non-group members.

16. Confidentiality
Any financial and personal data/information relating to SVINERGY members will be treated as strictly confidential. Information of and from vineyards participating in the VitiCE project will be treated as strictly confidential. Data gathered from vineyards through this project will be subject to data encryption, i.e. plaintext will be encrypted using an encryption algorithm and an encryption key to generate ciphertext and vis versa. Data will be anonymised unless growers are willing to waive their anonymity. Proceedings and records of the SVINERGY group are subject to the Data Protection Act 1998.

17. Variations to the terms of reference
The Terms of Reference for SVINERGY will be reviewed annually by the group, and they may vary or add to these Terms of Reference if necessary.
C. Explanation or presentation of how the results were communicated or disseminated this should include a list of all the dissemination activities undertaken not just those agreed in the Grant Funding Agreement. Applicants should include copies of material published and web links to presentation given.

Dissemination activities:

- Grape Press Article Feb 2017: TITLE: New viticulture weather app for UK vineyards
Grape Press Article July 2017: Climate Vine: The essential viticulture weather app for UK vineyards
Grape Press Article Feb 2018: Climate Vine: The essential viticulture weather app for UK vineyards
Over 90 UK vineyards used and benefited from the new Climate Vine app during the 2017 season.

This unique and valuable tool has been developed by a team of scientists exclusively for UK vineyards and is available at climatevine.com. Both Android and iOS versions of the app will be available from mid-March for the 2018 season.

The app provides essential:
- Vineyard weather forecasts and extreme weather alerts
- Vineyard, regional & national weather information, through the seasons
- Phenology progress updates
- Industry insights to keep you abreast of UK weather & vine news

The app also acts as a portal for sharing anonymised UK vineyard data, analysed for the benefit of the whole sector. In exchange for weather forecasts, seasonal weather tracking and extreme weather alerts, growers are encouraged to upload phenology, disease and harvest information with just a few clicks on their phone. This confidential information will be collated, anonymised and analysed to produce reports for all users on progress through the growing season, and to support further research by project partners to help improve UK grape yields.

The app was initially developed through the Viticulture Climate Exchange (VCCE) project, a partnership between Weatherquest Ltd, the UKYA, NIAB-EMA and Exeter University, which was funded by Weatherquest and an EIP-Agrifood grant. A report on this project will soon be available via climatevine.com. The app development also benefited from valuable co-design by UK vineyard managers and, with their continued help • and yours • the app will continue to expand its services and functionality. The aim of further enhancing this information exchange tool is to help users and the sector improve yields and build resilience.

For more information, go to www.climatevine.com or email info@climatevine.com

- Results sent out monthly via the app. See the ClimateVine app.
- Presentations to Plumpton viticulture students, Fruit Focus, South East Vineyard Managers Association and English Wine Development and Research Group. See below:
Summary

A free (2017) iOS and Android app. for UK viticulture

1. Delivering viticulture specific weather forecasts.
2. Presenting weekly national, regional, and local weather metrics, tracked comparatively with previous seasons.
3. Enabling recording and analysis of phenology, disease, harvest, and yield variables.
4. Providing news and reports on weather and viticulture relationships, across the UK.
Background

A project run by Svinergy.

- Svinergy is a partnership between Weatherquest, the UKVA, NIAB EMR, and Exeter University, established in 2016 to work with wine producers in delivering weather & climate services.
- Svinergy’s VitiCE app project is being funded by Weatherquest (£270k) and an EIP-Agri grant (£50k).
- The VitiCE project is being supported by several UK wine producers, and managed by Dr Alistair Nesbitt.

App design

www.climatevine.com
App design

App functionality

The app will deliver local:

- Weather observations and up to 10-day weather forecasts.
- Weather alerts for frost, snow, and lightning.
- Spray and harvest risk warnings.
- A temperature, rainfall, air frost, and solar radiation tracker, updated weekly, showing accumulation compared with previous seasons.
- Maps of temperature, rainfall, frost, and solar radiation accumulation, for the UK.
D. Website address of the operational group where results and publications along with presentations will stay available for at least five years after the project has ended.

www.climatevine.com

15. Recommendations
The Eip-Agri funding was crucial in enabling the groundwork, development, launch, and promotion of the Climate Vine app. This technology ready app has received very positive feedback from the UK wine production sector and recognition of its existing and future value. The recommended activity now, from the VitiCE group and the wider wine production sector, is to continue the app development, data
provision and analysis for a full season (April – October 2018). Funding models are being looked at including a part or full subscription service, and opportunities for additional funding that would widen and enhance the app functionality.