AgroExact

Team A

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Executive summary.

In the world of agriculture, there is a wide diversity of types of crops, fruits, and grass a farmer can grow. While there are some differences to treat and grow all these things, the main goal is the same for every farmer: try to grow their assets as big as possible to gain the most profit. To do so, the farmer needs to take some big decisions regarding variety selection, general cultivation method, crop protection, and fertilization. Some of these decisions are not easy to make, such as when to irrigate the soil, and there is a lot of money at risk to potentially wasted if the farmer does not make the right decision.

Most of these decisions made by farmers are grounded on experience and instinct. They walk around the parcel and make and estimation what needs to be done. One downside to this is that the farmer can not see further than what he can see. They do not precisely know what the real condition of the crop is and how much it is growing. With the use of data the farmer can gain a better real-time overview of what the condition of his percel are and how to react to these circumstance.

The only time a farmer makes use of data is when they have soil- and leaf analyses. They take samples of the ground or take leafs and sent them to a lab. From the data, the farmer gains he can see in a clear overview of the condition of his parcel. The only problem with this is that taking those samples and sending them to a lab takes time and money. It cost them so much money and time that they usually do a ground analysis once every two years and a leaf analysis three times every year. What if the farmer has access to that data all the time when he desires?

AgroExact is a startup that is providing sensors for the crop farmers to place in their farms in order to gain such insights in data. At the moment, they provide two sensors whichare integrated with an application on your phone. The first one is called ‘AtmoExact’, a weather station which is predicting the weather conditions, and the other is called ‘SoilExact’, which measures the condition of the ground. These sensors are sending their data to the phone of the farmer and give them advice, such as when to irrigate for example.

These products are validated to fit the needs of farmers who are growing crops. In our project, we explored the possibilities if the products provided by AgroExact are sufficient enough for farmers who are growing fruits. To be more specific, fruit farmers who are growing their fruits outside.

In the research we have conducted, we found from qualitative data that there was indeed interested in these products, but there was still something missing. A factor that is different in comparison to crop advisors is that some of the fruits are growing on trees. While in both cases you can see the soil as a base all the assets are growing on, the tree is an extension that base. The condition of the extension is just as important as the soil the fruit is growing on. This is the reason why we introduce the ‘TreeExact’ to the AgroExact family. The TreeExact is also linked to the application on the phone and consists out of a dendrometer. A dendrometer is a tool to measure the circumference of a tree. When a tree is losing water, the circumference will become smaller, which can give a clear indication if a farmer needs to irrigate. It can also indicate stress from for example treats of pests or molds that are happening to the tree so it cannot grow to its full potential.

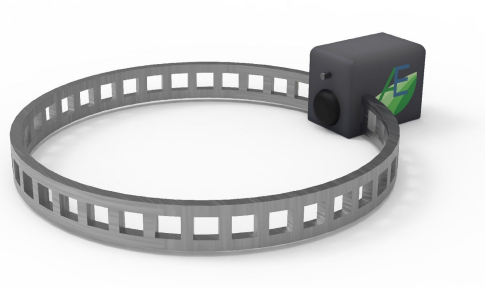
The application on the phone also got a redesign. Now, when opening the app, the farmer can immediately see the conditions of all his parcels. This is indicated with a stoplight system. Green indicates that the tree and the fruits are growing good, yellow indicates that the tree and fruits are not growing to its full potential and the farmer might need to act and red light indicated that something is wrong and the farmer needs to act. Which color a parcel gets is depending on the data from the sensors. When a parcel gets a color besides green, the application shows what might be the problem and gives advice on what to do. For example, the light on one of your elstar parcels is yellow. The

application indicates that the SoilExact measures dry ground which might cause this and advices the farmer to irrigate.

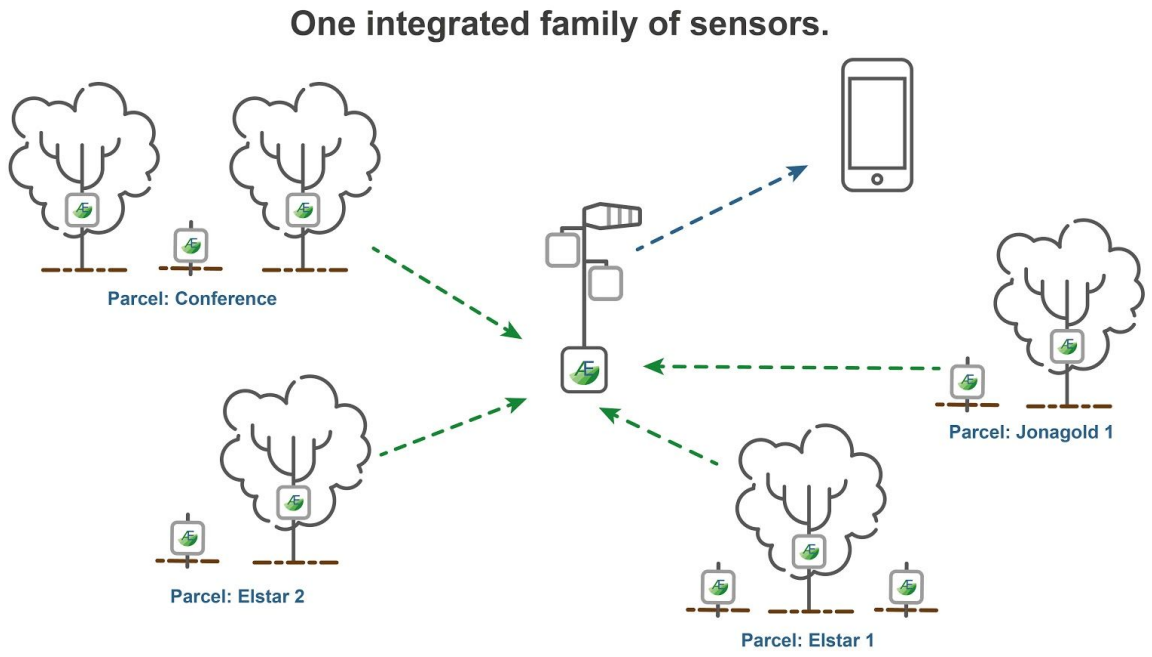
In the rest of this report, we are providing our findings which lead to these conclusions and design directions. Most of these findings and designs are visually supported as well in order to give a better understanding and clear vision of what we worked on.

AtmoExact

SoilExact

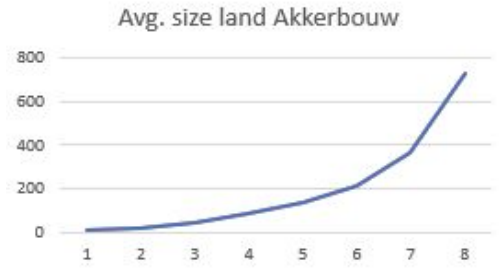


TreeExact



Design challenge and process

Week 1 and week 2



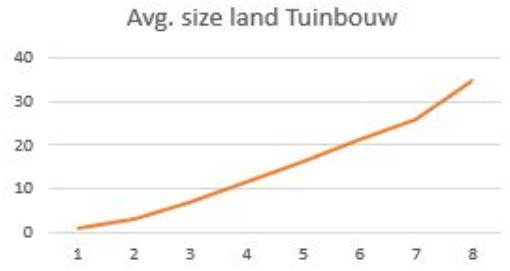
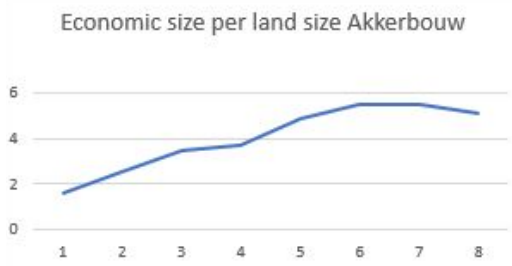


Fig 1. average size land Akkerbouw

Fig 2. average size land Tuinbouw

	yield per year
1	3.000-25.000
2	25.000-100.000
3	100.000-250.000
4	250.000-500.000
5	500.00-1.000.000
6	1.000.000-1.500.000
7	1.500.000-3.000.000
8	more then 3.000.000



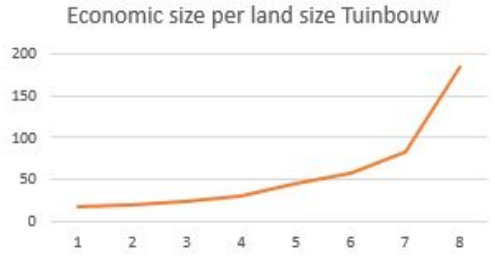


Fig 3. Economic size per land Akkerbouw

Fig 4. Economic size per land Tuinbouw

When looking at the agriculture market and the potentials it can offer, we compared the land size and the economic size of the farms specific for akkerbouw and horticulture in the Netherlands. When looking at size, the amount of acres used by akkerbouw farmers is many times higher in comparison to horticulture farmers. However, when looking at the economic size per acre, the economic size of the horticulture farmers is on average 13 times bigger compared to akkerbouw farmers. When looking at this data, you can conclude that per acre a fruit farmer is risking more. This means that every decision a fruit farmer makes regarding the treatment of his parcels has a bigger economical impact for them. For a company as AgroExact, this can create opportunities to introduce themselves in the horticulture and help fruit farmers to make the right decisions. For analysing the market we have been making a Petal diagram and a flow model too, these can be found in appendix E.

Week 2 and Week 3

To gain some insights in what crop advisors and fruit farmers do, we called crop advisors and visited and interviewed some farmers. From these results, we see that farmers are already used to make decisions depending on data they receive from soil and leaf samples they send to the lab. Compared to the data AgroExact can offer the data they receive from the the lab is more sophisticated and provides more information. When further investigating on the data they use, we concluded that most farmers already have some robust ways to measure the data which AgroExact is measuring, like having a weather station or a water meter. The pain of these farmers is that they do hardly use it due to the fact that they need to interpret what they need to do with the data. Secondly, sending their samples to the lab is very expensive. Finally, unlike the weather station or water meter they own, the farmers do not have any tools for measuring the condition of their trees. We will further elaborate on the results in section ‘Validation’.

Week 4 and week 5

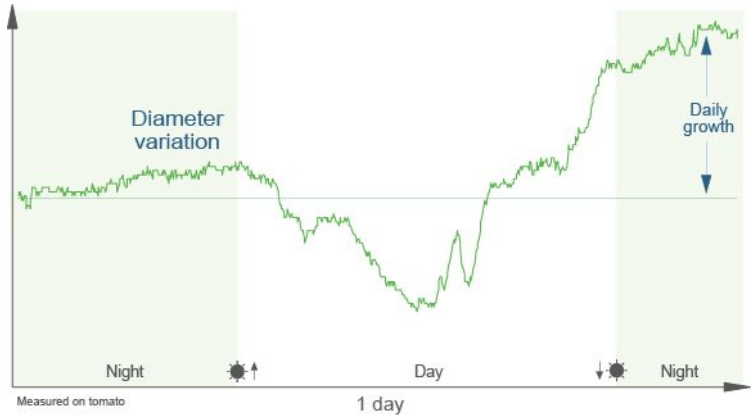
When evaluating the data we received, we concluded that there is enough potential to add some value to the farmer. This lead us to the creation of the ‘TreeExact’. This product consists out of a dendrometer, a meter which can measure the thickness of the tree very accurate. We will further elaborate on this in section ‘Value propositions’.

Week 5 and Week 6
With the dendrometer we explored the possibilities how to incorporate all the data in the application and how to present it to the farmer. In these weeks we discussed about the design of the application and what the algorithm should be able to process the data, conclude what the condition is of the parcel and what advice it should provide to the farmer. The design and algorithm will be further discussed in section ‘Value propositions’.

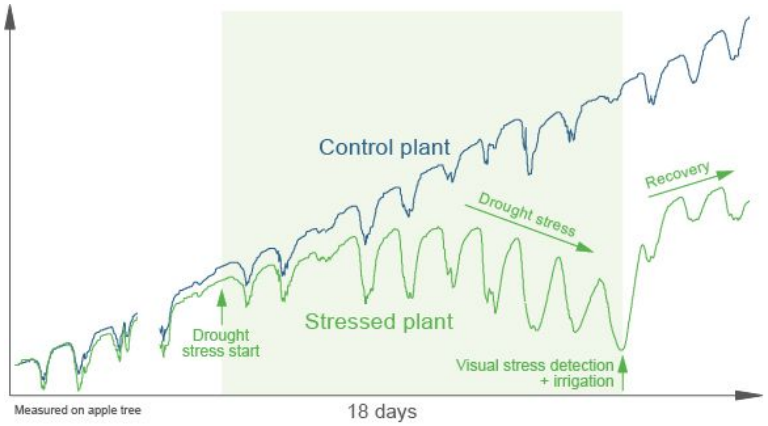
Week 6 and Week 7
With the application and a render of the TreeExact finished, we wanted to validate our hypotheses if farmers are interested in the products, the services and the price. For the price we created a new fair pricing model which includes all the products and the services AgroExact has to offer. These hypotheses were tested and confirmed, which makes us conclude introducting the TreeExact in the AgroExact company can be a valuable asset. The validation of the hypotheses concerning the final designs are further discussed in section ‘Validation’.

Value propositions

The AgroExact family will be extended with a new sensor, the TreeExact. This sensor measures stam diameter variations in µmm, which represents the trees daily growth (see figure below as an example (Phyto-IT, n.d.)).

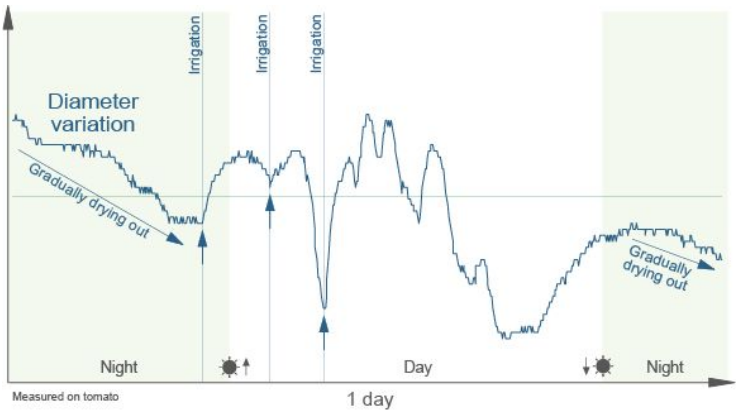


The trees transpiration increases in the morning. At that time, the roots cannot supply enough water and the tree uses its internal water reserves from the stem to meet it's transpirational demands. As a result, the stem diameter will shrink. At the end of the day, transpiration decreases, and the tree is able to refill its internal reserves. This causes the stem diameter to increases again. During the night, the tree can grow through a positive pressure in the stem cells. Over a longer period of time, the diameter variation will describe the growth during the season. A visualisation of this data representation can be seen the figure below (Phyto-IT, n.d.).

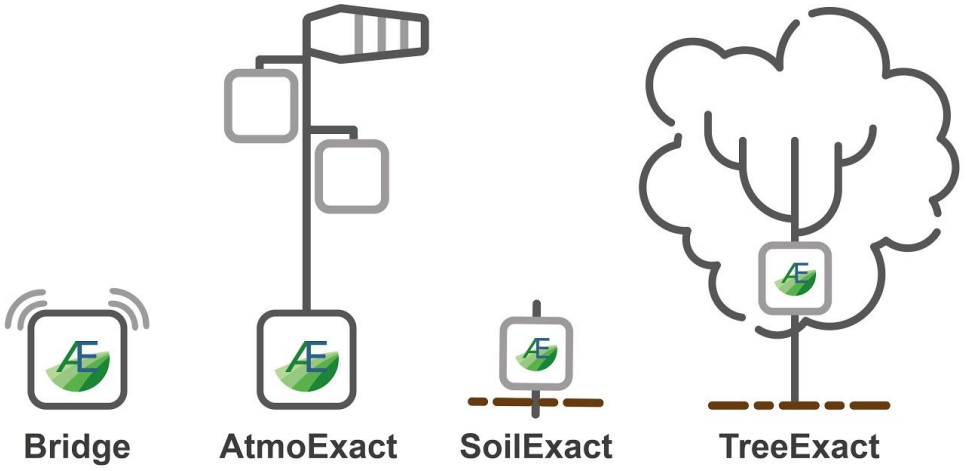


If this diameter variation data can be compared with the weather data from the *AtmoExact* and the data received from the *SoilExact*, advise on how to treat your trees will be more accurate.With this data, a fruit farmer receives insights which he can't see with the naked eye. Which means that he can anticipate on different factors in an earlier stage than he is used to.
Knowing the (daily) growth has the following gain creators for a farmer:

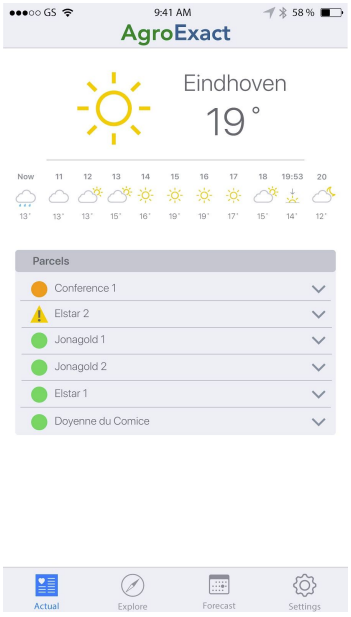
- Identifying stress of your trees in an early stage.
- Knowing when it is really necessary to irrigate, which can be seen in the figure below (Phyto-IT, n.d.). Especially this is something which is hard the see with the naked eye. When a farmer is in doubt about if to irrigate, he mostly does irrigate because he won't take the risk.



Another sensor we will add to the product range of *AgroExact* is the *Bridge*. This device makes it possible to connect every sensor with LoRa technology. When a farmer wants to add a new sensor to his netwerk he will connect the sensor to this device, which send the data to the database. Also the *AtmoExact* will be extended with this bridge module. This means that a farmer needs to buy the Bridge or the *AtmoExact*, to connect all the sensors to his netwerk. When he has one of them, he is free to add as many sensors he needs.
This means that *AgroExact* will have the following product range:

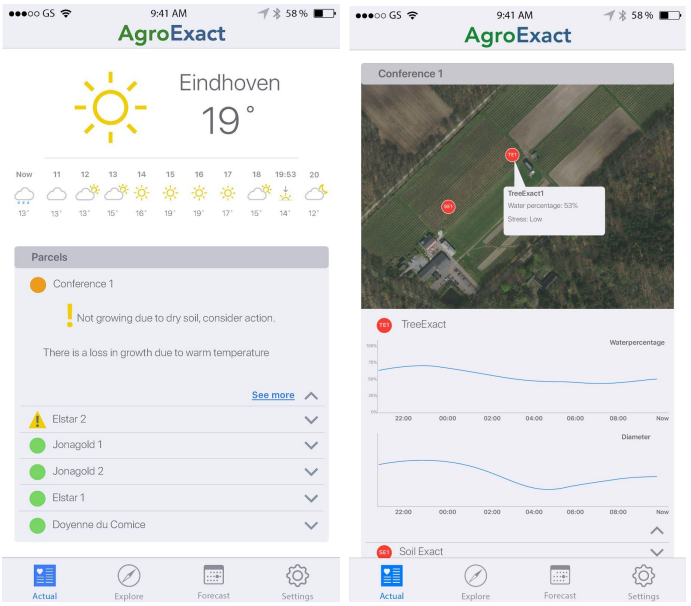


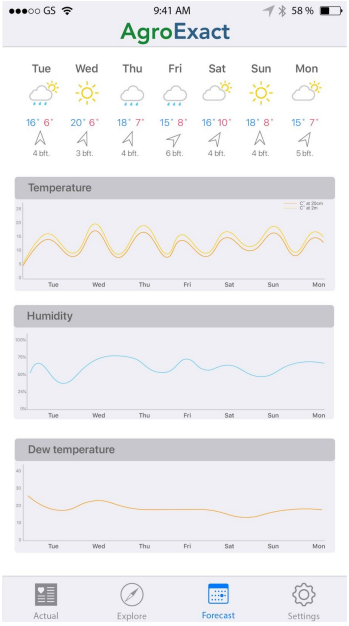
The true value for the fruit farmer is how the data from all the sensors will be translated by the smart algorithme to a tailor made advice which is visualised in the AgroExact app. By making different parcels and assigning the right sensor to the belonging parcel, the farmer can easily see what's happening on every parcel. An video can be found in appendix C.



The homescreen of the app will look as follows. First you see a weather forecast for the upcoming days. This gives the the farmer a global overview of the upcoming weather, he can see a more detailed forecast under the "*Forecast*" tab.
Second he has an overview of his parcels. Every parcel has a color code which represents the status, the codes have the following meaning:
Green: Everything's alright on this parcel.
Orange: Some irregular values are measured, but nothing to be care about at this time.
Yellow: Something irregular is measured! The following actions are suggested.
Red: Extraordinary values are measured for a longer period of time.

Under the tab "*Forecast*" the farmer will find a more detailed weather forecast for the upcoming week. At the top, the overview is presented, underneath every received data from the *AtmoExact* is presented individually. The user can change the ranking of those different variables. Every variable is presented in a graph, because this makes the numbers easier to read at makes a better comparison between the different days.
In the settings menu, a farmer is able to create new parcels and assign or delete sensors to them. This makes it possible to change their setup at every moment.

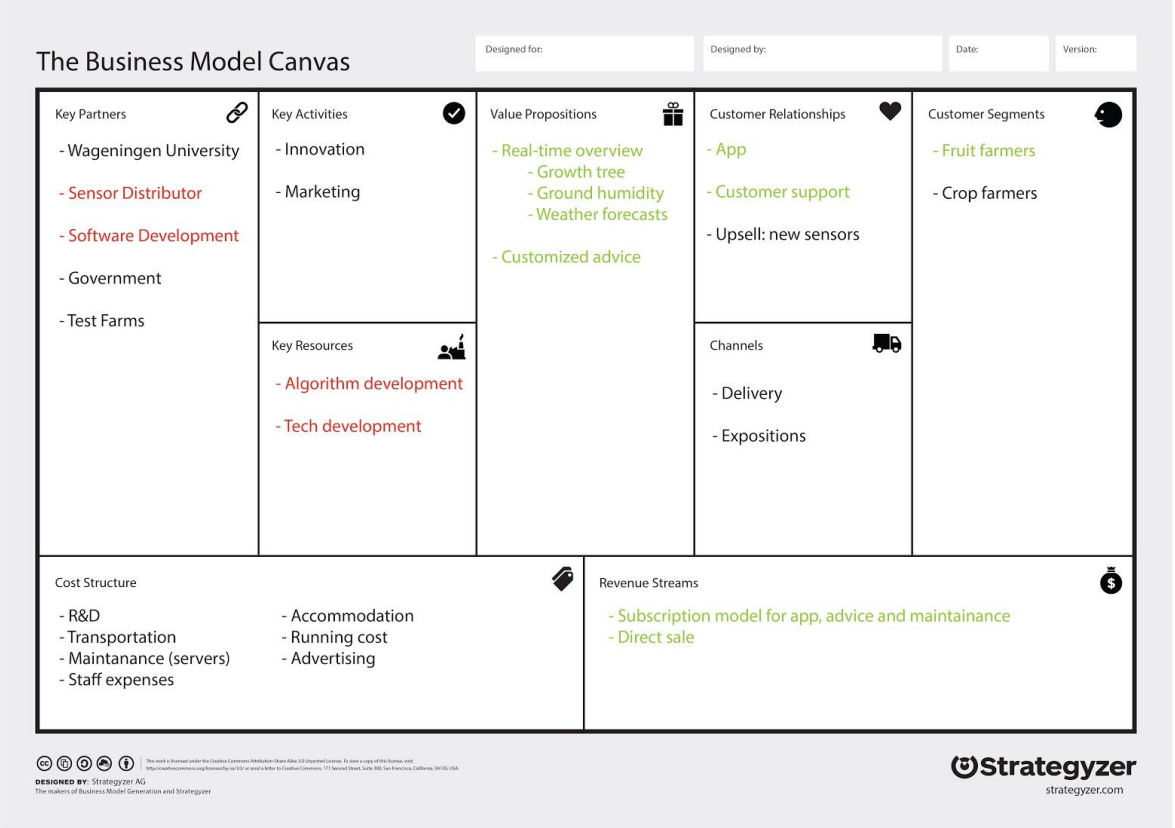




By opening the dropdown menu of the parcel, a more detailed description of the status and some advice emerges. If you push the "See more" button, you can see the insights from every sensor. These insights are visualised as can seen above. Every assigned sensor can be seen on de map and the measured that is visualized in very easy graphics.

AgroExact will provide a farmer one system which measures the daily growth of their crops. With this, they receive personalised advice and have a real time insight in the data from their crops. The visualisation of the data and providing the farmer usefull personalised advice, is the main value where AgroExact distinguishes from their main competitors, like Metos.

Business model and strategy



Customer Segment

The focus of this research was mostly based on the right side of the business model canvas. After market research, a decision was made to make a pivot towards the fruit farmer.The netherlands counts 6.745 fruit farmers which all have difficulty seeing the conditions of the ground and tree's. These conditions are essential to the farmers in order to have maximum output of the land and thus maximum profit.

Get, keep, grow strategy

Get

To raise awareness by fruit farmers we will advertise in the magazines like Fruitteelt and on agf.nl, further we will participate at some expo's. With both activities we give farmers the opportunity to make an appointment with one of our account managers. They will come by and discuss which package of sensors suits the farmer the most. Our customer intimacy will be relative very high.

Keep

Different processes are implemented to keep customers. The app makes use of a subscription model. These subscriptions are based on fair pricing. The more sensors you buy the higher the the subscription will be, costs increase with an inverse exponential function. This makes large users pay for the cost that they make while small users still have the opportunity to make use of the ecosystem. With a subscription the farmer also receives technical support at any time. For that reason, user experience should be optimal.

Grow

To grow, unbundling is part of the business model. A bridge is introduced next to the weather station to connect the sensors. This creates the option to still use the SoilExact and the TreeExact even if an AtmoExact is not requested. Users also can decide the amount of sensors they need. The more

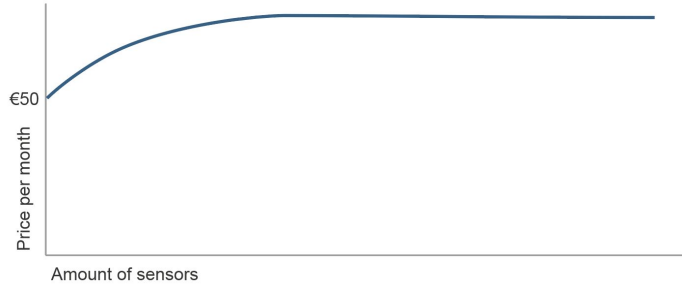
sensors they buy the more precise the advice in the app will be. This way cross-selling is implemented. When new sensors are developed, farmers can easily extend their setup with these new sensors too.

Revenue Stream

Farmers will buy the sensors as an one time investment. We will sell the sensors for the following prices:

Bridge	€200
AtmoExact	€1000
SoilExact	€150
TreeExact	€300

Farmers will also subscribe to our service. This includes personalised advice on their received data and technical support at any time. We made this model in such a way that it's fair priced for the amount of sensors you have. The model starts at €50 a month for the basic subscription, from that the costs increase with an inverse exponential function. Which means that you that you pay gradually less for each sensor you add to your setup. This can be seen in the figure below.



Because of climate change and to keep water quality at the maximum different water authority municipality around the netherlands have set aside money for farmers that invest in initiatives to save water and improve the quality. For example the waterschap rivierenland invests 40% of the total costs in systems that provided insights in climate, land and plants. That makes it more interesting for (fruit) farmers to invest in the system that we provide.(Subsidie waterbesparende maatregelen agrariërs., 2019)

Validation

Every week a few hypotheses are set and validated with corresponding users and stakeholder. In the first weeks the following hypotheses are validated. The interview questions and can be found in Appendix B.

The first hypothesis validation

- *In its current state, the functions which AgroExact are providing are sufficient for the crop advisors to make use of it.*
- *Crop advisors are willing to advise technologies such as AgroExact to their clients.*

Figure 5: visit of "De Genneperhoeve".

To validate these hypotheses, we visited "De Genneperhoeve" a small farm located in Eindhoven. Here we conducted a open-ended interview with a farmer. Next to that, we contacted a total of 29 crop advisors and conducted an open-ended interview. A total of 13 different crop advisors responded and provided us with the following insights. the interview questions can be found in Appendix A.
In its current state, the functions which AgroExact are providing are sufficient for the farmers to make use of it, but for the crop advisors the information is not sufficient enough.
We suggest a pivot to further development in the SoilExact in such a way it can be used to give advice concerning variety selection and the development of a product, which measures the water, nutrients and CO2 in the crop/plant.There are mixed responses whether crop advisors are willing to advise technologies such as AgroExact to their clients.
This time of year they are to busy to instal the AgroExact system or provide help to AgroExact.

The second hypothesis validation

- *Fruit farmers use systems to collect data about their parcels*
- *Fruit farmers are interested in products that AgroExact is offering*

Figure 6: visit to the philips fruittuin

To validate these hypotheses a appointment was made with Carlos a Fruit farmer of the "Philips fruittuinen" located in Eindhoven. An in-depth interview was conducted and the different parcels were shown.This interview can be found in appendix B.
The visit showed that fruit farmers own different sensors to measure the climate of the land. This farmer had his own (cheap) weather stations to get a better picture of the the weather of his parcel. for that reason a stand alone weather station by AgroExact was not requested.
Fruit farmers do not use systems to collect data about the their parcel but conduct a ground and leaf analyses a few times a year to see how he can let his tree's and fruit grow in the most optimal conditions. The ground alone was not enough to understand the steps that need to taken. The tree

functions as an extension of the ground for the fruit, it functions as a sort of base. Knowing what the ground provides helps in maintaining the base but to help fruit grow the base also needs to be measured.

The third hypothesis validation

- At least 50% is interested in the AtmoExact even when a second option is presented, the bridge.
- At least 50% values growth data of their trees.
- At least 50% wants to buy the sensors and pay a subscription fee for the platform, for the described price.

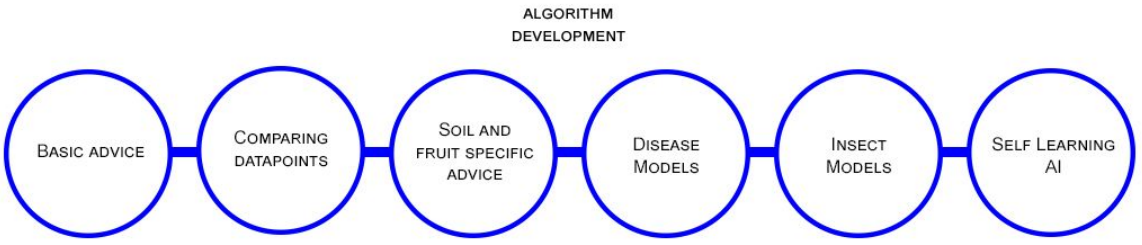
Figure 7: Visit to the (second time) "Genneperhoeve" and "Appelboer Jurrius".

To validate these hypotheses, 3 fruit farmers have been visited. With each of them a semi-structured interview was conducted, which can be found in Appendix C. With the representations of the app and future product range, we tried to validate our hypotheses. Be speaking with each of them we could conclude the following things:

- Fruit farmers are more interested in the AtmoExact than in the Bridge, when we sell them sensors who extend the product range too. Fruit farmers say that if they invest in a system which collects data from their crops, an AtmoExact will be much more valuable than a Bridge.
- Fruit farmers are interested in data which they can't see with the naked eye. They are interested in comparing the data with their own feelings and receive the very accurate data.
- Fruit farmers are interested to pay a monthly fee to receive personalised data for their crops, based on the data of our sensors.

Future development plan

We suggest to further investigate the partners needed to realise this product. For this development a partner who is able to make the algorithme is needed. We have devide this development in a few steps.



The first two steps are the most important ones. From there on, the algorithm can be extended with the following steps. The first two are needed as minimal viable product for the farmers. The following steps can be added with updates.

For the hardware a partner who is able to deliver and make the TreeExact is needed. There is no partner yet, but there are a few possible suppliers for the dendrometers. An partner who can design the casing for this device is needed. Therefore a design engineering partner need to be found.

A research and development (R&D) team is set up to make improvements on current sensors and to find new sensors that can improve the advice. Improvements on current sensors can be sold as new versions and new sensors can be sold separately. This creates opportunities to create more up-selling and cross-selling of products.

For the app we suggest to implement a logbook. This makes it possible for the farmer to make notes on different received data, so he can always look back at when he received which data and how he anticipated on the data. With this logbook a farmer can learn from the system too.

Individual contributions and group reflection

Contribution in this project was equal and correctly divided. All students contributed to the end result with their own goals and expertise. In time, every contribution was equal. From the case study we could implement some useful findings in the main project. For example, a method to work with a fair pricing model. It was very useful for us to explore the steps who were taken in this case study and compare them with our own steps.

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Appendix A: data from phone calls with crop advisors (Dutch)

Set-up of interview:

- Introduce yourself:
    - you are a Master student of the TU/e
    - Explain what you are doing: researching a device which can measure the ground, climate and plant in a way it can benefit the farmer but also the advice of the advisor
- job specific questions:
    - What is their routine when they are on the farms of the clients?
    - How do they get their information?
    - How many times do they visit their clients?
    - What kind of advise are they providing?
- Present the core value AgroExact is offering
    - Firstly ask What does the device needs to measure?
    - If it depends on the surface/crop, give apples as an example
    - Present own idea
    - Would you make use of this product or advise this product to your clients(farmers)? why?
- MORE IS BETTER! Go in depth with the answers provided
-

Advisor 1: Jelle

- 80% van de tijd in het veld, 20% kantoor. In de winter meer op kantoor
- Adviseert op een paar gebieden: **gewasbescherming, bemesting, algemene teeltwijze, rassenkeuze**.
- HBO Niveau werknemers → hebben dus al basiskennis, krijgen nog een interne opleiding
- Technische info krijgen ze van fabrikanten. Bayer, ESF, Certis
- **Voor bemesten gebruiken ze analyses van blad, grond en water.**
- Voedingselementen in de planten kan je meten door om de 2 weken monsters te nemen.
- Meestal zijn de boeren bij wie ze langs gaan al een hele tijd bezig, gaat ook over generaties heen. Enkele zijn nieuw begonnen.
- Tegenwoordig moeten de boeren bellen voor afspraak omdat de adviseurs het druk hebben. Om de 1-2 weken langskomen is vrij intensief, 3-4 weken is ongeveer gemiddeld.

Advisor 2: Jan

- Gaat meestal op afspraak naar de boek, maar gaat vaker op eigen initiatief ook naar de boer.
- **Gebruikt geen meetaperatuur, maar eigen ogen om te oordelen welk schimmel of welke plagen er zijn.**
- De boeren moeten bestrijdingsmiddel en mest zelf aanschaffen
- Teelbegeleiding → wat er het beste past bij welke grond tot de oogst, wanneer het het beste geoogst kan worden.

- **Stand van gewas -> licht sensor, reflectie, slap of stug**
- Meerjarengewas heeft meer aandacht nodig
- Grond geeft al verschillende dingen aan op 10 meter verschil
- regenval en zonneschijn → windfinder
- Vond het idee goed, maar meer als ondersteunend gezien er veel te beoordelen is.

Advisor 3: Siebers

- 6 teeltadviseurs, begeleiden telers van graszaad.
- Door het jaar door advies, bemesting,
- augustus tot juli
- Half februari tot juli, voornamelijk de oogst
- Veldkeuring doen ze voor. Nog 2 maanden tot oogsting
- 600-1000ha tot beschikking, 70 telers, 8 tot 10x per jaar
- 90% in het veld
- Gemiddeld 1x in de 2 weken als het druk is, in de winter 1x per maand
- Gebruiken geen apparatuur om te meten (los van grondmonsters)
- Concept uitgelegd
- Boeren kijken zelf naar het weer en besluiten of het rendabel is om te bewateren
- Bodem meting, kwaliteit is goed om naar te kijken,
- Bodemkwaliteit, bodemmonsters worden dan genomen, dat duurt lang voor ze binnen zijn. Meerjarige impact is belangrijk is belangrijk voor de adviseurs, dus als AgroExact dat kan meten dan zou het potentie hebben om te gebruiken.

Advisor 4: Hein

- Hoe veel boeren ga je af op een dag?
- wisselvallend
- Week-, maand- en jaarplanning
- Duur 1.5 - 2 uur per persoon
- max 3-4 personen waar je langs kan
- 1.5 administratief werk
- advies onder glas
- Half uur alleen rondlopen
- Uur met de klant
- Staat van het gewas -

Appendix B: Interview with fruit farmer (Dutch)

Vanuit 25ha beplant in 2000 naar nu 8ha beplant. Vroeger ging er 80% naar de veiling en was er 20% voor eigen verkoop. Tegenwoordig is alles voor eigen verkoop. Vanwege dit nieuwe verdienmodel is er dus verkleint.

A.d.h.v suiker gehalte wordt bepaald hoe ver het product gerijpt is, wanneer het geplukt kan worden voor de juiste bewaartijd.

Beslissingen worden genomen a.d.h.v. analyses: blad, grond etc.
Dit wordt altijd geanalyseerd in het lab
Visueel waarnemen is erg belangrijk, ter bevestiging
5/6 bladmonsters per product/ras per jaar
Vochtspanning in de grond

Weerstation is er aanwezig. Deze meet oa. Relatieve luchtvochtigheid, blad nat periode en gewoon het weer. Het is gekoppeld aan

"*meestal ben ik het voor"* – Carlos heeft door zijn ervaring al vaak wel door wat het weerstation hem die dag zal doorgeven.

Maak je gebruik van een teeltadviseur? -> Tuurlijk!
Deze komt een paar keer per jaar langs. Vroeger zelfs 2x in de maand.

"*Er kijkt iemand mee. Het is heel prettig om een second opinion te hebben*"
Dit jaar 3 extra bodemanalyses moeten doen omdat vorig jaar het zo'n droog jaar was.

Maar 2 soorten ondernemers overleven het in deze killende branche. Aan de ene kant heb je diegene die voor de massa produceren, aan de andere kant heb je de mensen die het kleinschaliger doen en een ander business model hebben.

Elk blokperceel wordt apart gemeten. Één monster (een blokperceel) kost €150. Kost €1050 voor alle perseels
Grondanalyses worden doorgaands een keer per 2 jaar genomen

Bladanalyses worden voor €90 per blokperceel uitgevoerd. 5/6 bladmonsters per product/ras per jaar. Iedere de 5/6 jaar wordt er een chroma analyse gedaan. Dit kost 8 à 10K

"*Telen is topsport*" "Je speelt de Champions League plus" Je moet het beste uit je grond halen en je grond dus ook als een topsporter behandelen

Appendix C: Interview setup final design

Voorstellen - tue

1. Gebruikt u al iets wat data verzameld van het klimaat van uw land, planten of grond?
2. Wat doet u nu om het klimaat te beoordelen?

Soil en groei meter uitleggen en value uitleggen: data krijgen die je niet (goed) kan zien. En de app laten zien en waarde uitleggen

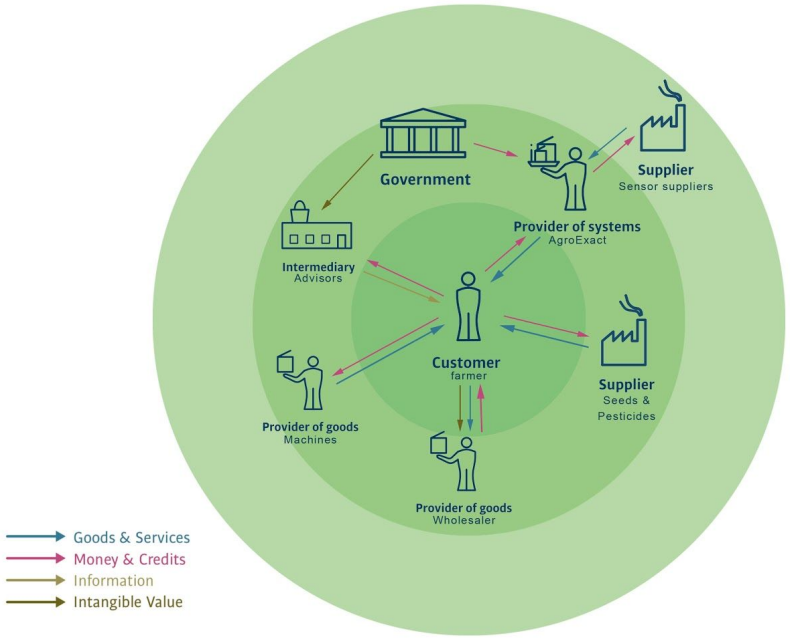
3. Wat vind u hier van? nuttig? waarom? mist u nog iets dat u graag zou willen zien?
4. Hoe gebruiken
    a. Hoe veel datapunten zou u willen?
    b. Welke momenten zou u de data gebruiken?
    c. Zou je niet meer over het land lopen als de data zegt dat het goed is
5. Overige vragen
    a. wat is belangrijker, de conditie van de boom of de conditie van de oogst?
    b. (Zou u deze data delen met andere zodat uw data accurater wordt?)
6. Financiën
    a. Welke zou u kiezen?
        i. Uitleggen sensor prijzen
        ii. hoeveel en welke?
7. Bent u geinteresered?
8. Nog andere op- of aanmerkingen?

Appendix D: Video

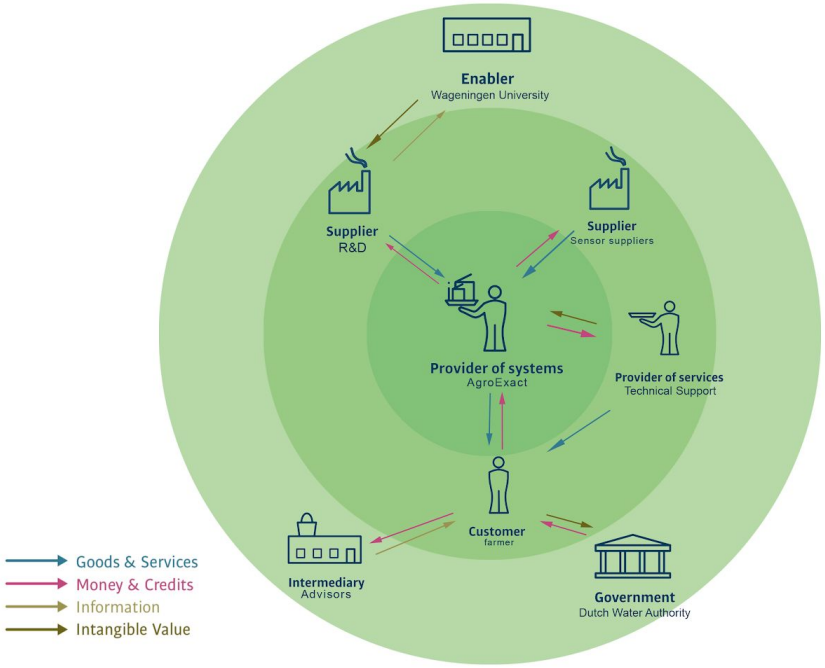
The video can be found via: https://vimeo.com/342719513
The password to watch this video is: AgroExact

Appendix E: Market Analysis

First iteration - current situation



Second iteration - envisioned situation



Petal diagram