



Ministry of Foreign Affairs

Precision Agriculture in Hungary

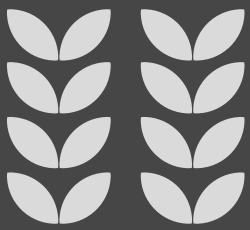
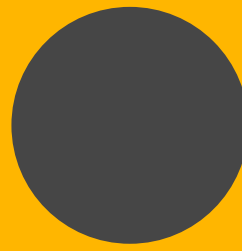
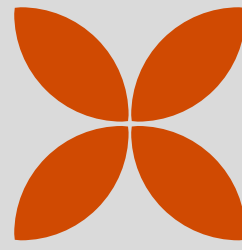
Commissioned by the Netherlands Enterprise Agency

*>> Sustainable. Agricultural. Innovative.
International.*



Precision Agriculture in Hungary

November 2022





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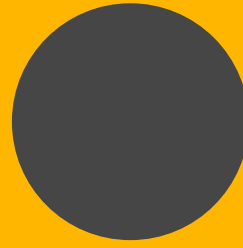
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1



Executive summary

Executive Summary



Precision agriculture (hereafter: PA) has been a highlighted topic in the agriculture sector in Hungary for several years, and as of 2022, investing in the modernisation of farms is still at strategic priority and highly subsidised.

The common goals set by the EU in regards to the development of agriculture are making the application of PA solutions a necessity.

Sustainability, efficiency and innovation are all cornerstones for new European initiatives which aim to keep the sector competitive. However, most farms in Hungary aren't developed enough to comply with expectations, so the EU and the Hungarian government are offering financial incentives to help modernising.

There are a lot of different subsidies available which support primary producers to invest in PA solutions.

With the agreement over the new CAP, the government will keep subsidising PA adoption in the following years. In order to ensure proper implementation, it is mandatory to use expert consultation services when making new investments.

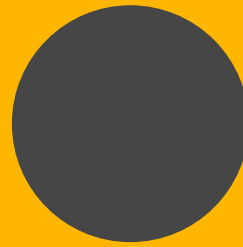
Integrator organisations are crucial to help raising the overall productivity of Hungarian agriculture by helping in digitalisation.

The sector's current productivity rates are significantly lower than their potential, which could be improved with PA solutions. Integrators are a key stakeholder group to help farmers better understanding and accepting new technologies, which is necessary for raising their willingness to invest, especially in a difficult economic environment.

Hungarian agriculture is vulnerable against negative externalities.

The difficulties of 2022, such as high input prices, uncertainty, inflation and drought showcase how vulnerable primary producers are. The resilience of the sector needs to be improved, which could be an incentive for adopting new solutions.

Executive Summary



The adoption level of PA solutions in 2022 is low.

Mostly larger, well-capitalized farms have started to adopt PA technologies and mainly more basic ones. The reasons for low adoption rates are more likely come from the demand side, since the supply of PA solutions on the market is adequate.

The willingness to invest has been relatively high in the last 5 years, with the first half of 2022 ending with record values of investments.

Subsidies have a huge influence on the willingness to invest, since smaller farms most likely couldn't and wouldn't develop their operations without them. Still, studies show that a huge number of farmers are still discouraged from applying PA because they either don't see the reason to, or don't have the knowledge to make use of them.

Although there are obstacles which slow down innovation, Hungary has great agricultural foundations to capitalize on current opportunities.

The vast amount of experience in cultivation and the continuous governmental support combined with outside expectations to push for modernisation provide a great opportunity to implement PA solutions to more farms. However, there are some critical factors which block innovation for most primary producers which need to be addressed by subsidies, technology suppliers, integrators and educational institutions.

Our analysis shows that there are several entry points which Dutch companies should consider.

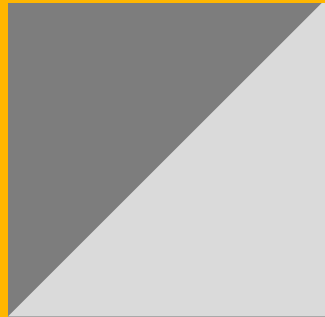
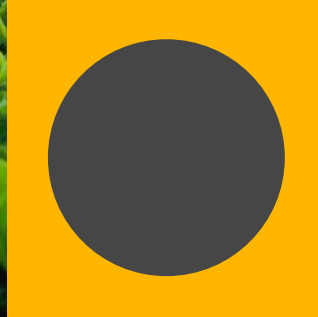
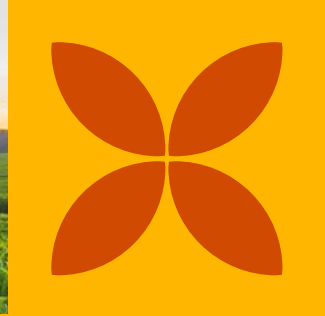
These entry points range from providing services, entering potential partnerships and educating Hungarian stakeholders. There are some key considerations which also have to be kept in mind when interacting with Hungarian players.

2



Strategies for the
modernisation of
agriculture

Chapter summary



The constant development and modernisation of the agricultural sector has been one of the top priorities of the EU for several decades, since the region is one of the leading producers and exporters of agricultural products. To ensure the sector's improvement, the EU sets different recommendations and mandatory actions which highly influence Hungary's agricultural policies.

PA is necessary for Hungary to meet the EU's expectations

Primary producers will not be able to make their farming operations more sustainable, efficient and data-driven without the application of PA solutions. Furthermore, to meet the EU's requirements of a common agricultural data space, Hungarian farmers have to be upskilled in digitalisation.

Data management will be the next challenge for the Hungarian agricultural sector

The Hungarian agricultural sector does not have a single data space, data is not yet connected either on plant or farm level. Both the EU and the Hungarian government will require all farms to provide data in exchange of funds and support.

Financial support tied to expert consultations

Currently all financial support for farmers have a mandatory consultation phase for its implementation. Expert consultants have the knowledge and experience in the application of PA technologies. With their collaboration there is a great possibility to start the change in the mindset and approach to farming.

EU strategies and initiatives



Being a member of the EU, Hungary's agriculture sectoral development programs need to follow the common goals and directions set by the EU. These strategies and initiatives have a significant influence on the member states' own policies. In accordance with the European Commission's goals set for 2030, the following EU policies are relevant for the Hungarian agriculture sector.

Common Agricultural Policy (post 2020)

The EU's Common Agricultural Policy (CAP) contains specific goals for the sector, which serve as the basis for the member states' own national CAP-s ("KAP" in Hungary). The current CAP contains 9 goals, which are primarily focused on digitisation, innovation and sustainability.

Farm to Fork Strategy

Part of the EU Green Deal, Farm to Fork Strategy targets sustainable food production by 2030 by significantly reducing the usage of cultivation inputs.

DIGITAL programme

A funding program that aims to improve digital technology usage across all industries. For agriculture, this means the creation of a common EU data space, AI testing facilities, digital innovation hubs and the development of digital skills.

European Strategy for Data

This strategy states that in order to ensure competitiveness, a single European market for data has to be established, enabling information sharing.

Horizon 2020

Although finished in 2020, Horizon 2020 contained several research and innovation activities that help to implement IoT, AI, robotics and similar modern technologies into agriculture.

Main expectations from European agriculture summarized



Lower usage of input materials

Increasing the sector's efficiency and sustainability is a top priority, thus the reduction of inputs such as fertilizers, pesticides and the land used are necessary.



Produce more quality food

Raising the rate of organic farming and protecting the quality of food produced will lead to help EU citizens to lead healthier lives.



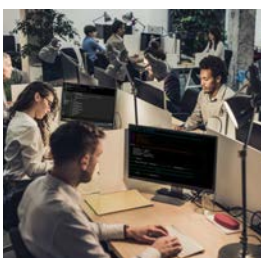
Achieve interoperability

By connecting farming operations to the internet and developing open platforms to share data, tools and analyses, a sustainable ecosystem could be built for an innovative, data-driven agriculture.



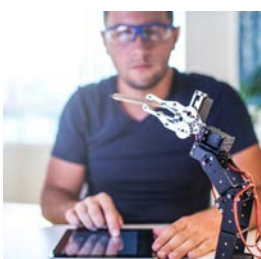
Establish a single EU wide market for data

Implement data collection methods and set the rules for sharing data. Connecting farming organizations, research institutions and policy makers will ensure the competitiveness of the sector.



Develop the digital skills of the sector

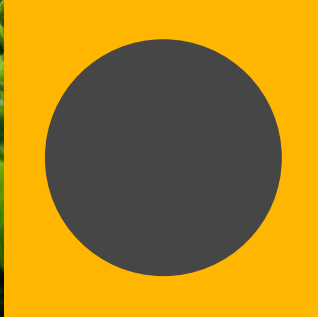
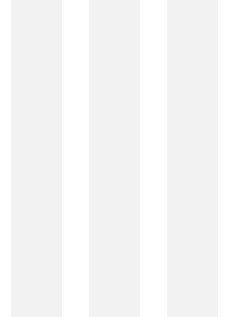
The agricultural sector typically has a traditional mindset, so in order to implement and properly use PA technologies, the digital skills of the farmers need to be improved.



Researching new technologies

The EU has to be in the front of new technological developments, therefore more research and testing facilities need to be integrated into the ecosystem.

Hungarian strategies and initiatives



The Hungarian government is aiming to offer a pragmatic approach to tackle the pressing challenges of agriculture is facing. There are several strategies and projects that will be able to provide the Hungarian Farmers with answers to how to stay competitive in a increasingly digital and automated agricultural market. The Hungarian Government offers strong financial and development incentives comparing to other EU countries.

Digital Agricultural Strategy (DAS)

The Digital Agricultural Strategy means an agriculture interspersed with Industry 4.0 solutions that, using data-based technology, provides a more advanced solution for those involved in precision farming. Data processing is supported by artificial intelligence, decisions are made by automated machines, and in the future it is expected to be robots. In order to achieve the goal of Hungary's Digital Agricultural Strategy, it is necessary for precision farming to be applied as widely as possible.

Artificial Intelligence Strategy

The Hungarian Artificial Intelligence Strategy sets goals for 2030 and creates the action plan of related activities that need to be carried out in order to achieve it.

Digital Producer Market (Digitális Termelői Piac)

The market's aim is the development and operation of related logistics and quality assurance services and educational programs. According to the cooperation, the Digital Producers' Market ensures the movement of goods between social cooperatives and consumers, consignment, and storage with logistics services, monitoring, and an infrastructure suitable for the delivery of food.

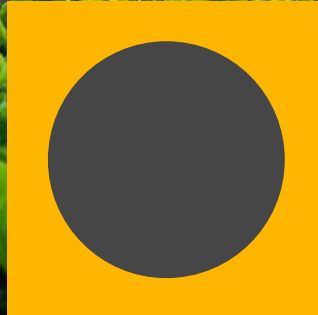
Digital Food Industry Strategy

The aim of the Digital Food Industry Strategy of Hungary is to provide support, regulation, and training assistance to further increase the efficiency and competitiveness of the domestic food industry.

Agricultural Data Framework (in progress)

It is a cloud-based data information platform that enables the coverage of the entire agricultural production solution, which is capable of recording data from several sources, storing it in a structured way on a plant basis and making the stored data.

Strategies & Initiatives And their relationships



There are both Hungarian **state support** and **EU funded supports** available for producers engaged in agricultural activities.

The **EU is harmonised** in the Agricultural Support system, states need to comply to the EU regulations and fund distribution.

The EU budget provides payments under two types of rights:

1. Market regulation
2. Rural development (co-financed by EU & state)

The **difference between the application system**, in The Netherlands there is a continuous application system, in Hungary a periodical (1 month) tender timeframe



Normative Support (EMGA) Supplementary national direct subsidies

(75% EU, 25% Hun
financed)

- Area-based (SAPS, /hct)
Cannot be called by Dutch owner
- Animal-based subsidies (number of animals owned)
Can be called by Dutch owner

Market regulation subsidies



Project Based support (EMVA)

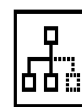
Project based support is based on **tenders**, clear ratings and ranking.

Categories:

1. Rural development
2. Next generation EU

Some projects:

- Biofarming
- Green/Sustainable goals
- Natura 2000
- Irrigation
- PA technology investments
- ESG



State support

Rural development co-financing: agricultural and improving the competitiveness of the forestry sector, developing the environment and the countryside, improvement the quality of life in rural areas

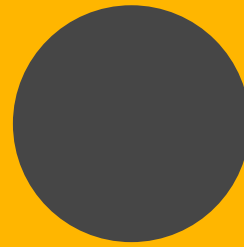
-Leader programs
-State support can be appealed for **special cases** and circumstances to enhance competitiveness on the market .

3



Overview of arable farming in Hungary

Chapter summary



The agriculture sector in Hungary is in a great position in several ways. The climate and soil are optimal, several subsidies and governmental support are available (with mandatory consulting services) and it has a long tradition of being one of the most important sectors in the country. Despite these, Hungary has fallen behind in terms of digitalisation and PA adoption, which prevents the realization of the sector's true potential.

Hungary has a lot to learn from Dutch agriculture

There are several similarities between the two countries' agriculture, but while Hungary has significantly more arable lands, the output and efficiency of Dutch primary producers are much higher.

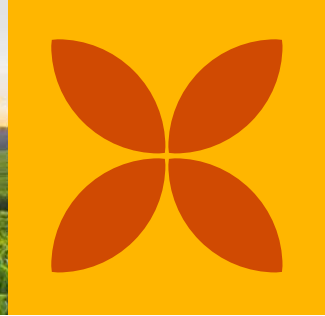
Stakeholders

The Hungarian agricultural sector is characterised by a strong governmental support including available local fundings, transmission of EU incentives and fundings, research institutes and academia. Integrators play an important role in the digitalisation of the processes and information flow to farmers.

Recent events and challenges

The sector is in a difficult situation due to the historically severe drought this summer and Russia's invasion of Ukraine. High fuel and energy prices and rising inflation rates make farmers highly dependent on state support, while mainly focusing on survival.

Comparing the two countries



Hungary		The Netherlands
9,3 million	Total surface area (ha)	4,2 million
1,9 million	Area excluded from cultivation (ha)	1,3 million
1,9 million	Forests (ha)	0,5 million
5,1 million	Farmlands (ha)	2,2 million

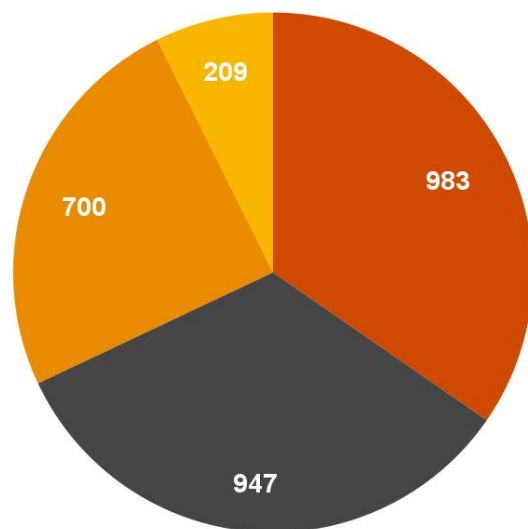
Agriculture is a standout sector in both countries, with a few million ha of lands dedicated to arable farming. Although similar in size, the distribution of primary producers working these lands differ from each other:

In Hungary, 20% of the holdings own more than 50 hectares, while the other 80% of farms own less than 2ha. The first category owns approximately 75% of the total lands, which means that the distribution between small and large farms is more extreme in Hungary.

The cultivated crops are also similar:

Main crops of Hungary (based on acreage) - thousand hectares

● maize ● autumn wheat ● sunflower ● rape



Comparing the two countries



When looking at the economy, Dutch agriculture performs better than the Hungarian. On less land, and with no direct subsidies from the government, Dutch farmers grow more crops every year, which indicates a less effective way of farming in Hungary.

	Hungary	The Netherlands
GDP (2021)	182 280 M USD	1 018 007 M USD
GDP/capita (2021)	18 772 USD	58 061 USD
Agriculture export characteristics	9,77 billion USD 8% of total export	2nd in the world 65 billion EUR 17,5% of total export
Main export products	Grains, meat, oilseeds, animal feeds	Cereal, feed crops, potato
GDP of agriculture	7,08 billion USD (3,9% of total GDP)	15,9 billion USD (1,7 of total GDP)
Government subsidy	Every year direct and national subsidies of almost HUF 500 billion are paid out to farmers in order to stabilise their income, mitigate their risks, and improve their financing positions.	No subsidised loan is provided, but has several guarantee schemes.

Productivity comparison



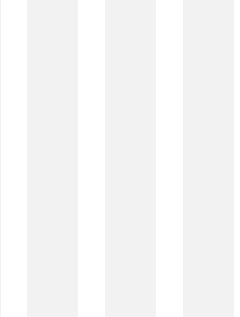
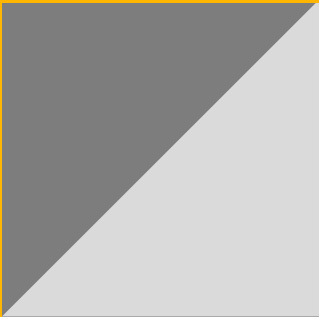
	Hungary	The Netherlands	HU compared to NL
Used inputs			
Land used (thousand ha)	4037,1	2236,3	180,5%
Fertilizer (kg/ha)	135	277,8	48,6%
Pesticide (kg/ha)	1,5	5,1	29,4%
Crop yields (kg/ha)			
Wheat	5500	8800	62,5%
Barley (Fall / Spring)	5800 / 4300	7600 / 6200	76,31% / 69,4%
Maize	8600	11600	74,1%

Hungarian farmers are unable to realise their true out potential

The table above compares input material usage and crop yields for Hungary and The Netherlands in 2020. The data shows that while Hungarian farmers use almost twice as much land for cultivation, fertiliser and pesticide utilization is significantly smaller. This is also the case for yields, as in the examined crop types the Dutch production is notably higher.

This shows that Dutch farmers operate with higher efficiency than Hungarians, with the latter unable to realise its true output potential. The application of different PA technologies in Hungary could help to optimise input usage, enable a more detailed yield planning and improve the output by 10-15%, which helps Hungarian agriculture in catching up with Western-Europe.

Generation change



The Hungarian Farming industry is traditional community that is reluctant to change. The average age of Hungarian Farmers is above 60. Generation change is at the door, however it is happening at a slower pace. New technologies, digitalisation and intelligent tools are feared by the older generation, while farming is not a trending career perspective for the younger generation.

The Hungarian farming community is constantly **aging**. The proportion of people of active age is constantly decreasing, while the proportion of people over 65 increased between 2010 and 2020. The proportion of farmers under the age of 40 also decreased, therefore who is taking over the farms will be a challenge in the future.

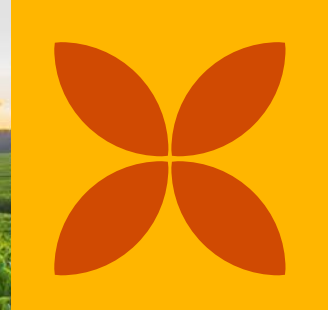
Among the managers of the farms, it can be seen that **younger farmers** have a higher proportion of **agricultural education** than older ones, who often do farming based on their experience. The managers of larger farms have a higher proportion of agricultural graduates.

Generation change will play a key role in the update of PA in Hungary. There is less and less equipment handling skill required on field, but rather The use of **computer and data analytics** is becoming more important. The majority of young farmers are familiar with and employ digital solutions and precision production tools. They understand the value and potential role of the data generated by the applications in management decision-making.

There are organizations and meetings of young farmers (e.g. MAGOSZ) where knowledge and experience is shared.



Education and upskilling



The education system in Hungary is fragmented and there is no common PA education curriculum developed nationally. Institutions follow subjective incorporation of PA teaching into their faculties. Collaboration between educational institutions and market players is low, and as innovation is changing rapidly, materials are often out of date and are not focusing on key skills such as data analytics and programming.



Organisation

The agricultural education in Hungary is disjointed and uncoordinated.



Materials

The university teaching materials are not synchronised with industry expectations and trends.



R&D

The amount spent on research and development is low and incentives are inadequate.



Career Vision

A number of negative career characteristics (eg. low wages and prestige) make the industry unattractive, which results in low applicant numbers in universities.



Consolidation

There is no predictable stable working environment due to the continuous changes and reorganisations in the industry.

The majority of agricultural university students have family members working in agriculture, only study at Bsc levels and report that the usage of digital tools in their education is really low. The application of PA technologies depend on the education acquired, the farmland size and management and also the generation gap and openness to digital technologies and applications.

Stakeholder Analysis



The Stakeholders of the Agriculture Sector in Hungary

Agriculture is an important sector of the Hungarian economy. The Government is responsible for the agricultural politics of the country including financing, subsidies and supervision. The government supervises the national scientific institutes that together with the academic deal with the current innovations and are the bridge between the research & development and the market. Integrators are disseminating the results of science and new technologies, by offering new products and services to the producers.

Government:

The Hungarian government is responsible for:

- Tenders
- Subsidy
- Funding
- Verifies outputs and funding usage



Research:

- Collaborates in education and knowledge sharing
- Food Industry quality improvement
- Increase the competitiveness of the Agrarium
- Development of proposals and methodology



Integrators

- Input materials for producers
- Machinery and services sales and development
- Specialist Advice/Knowledge sharing
- Purchasing crops
- Insurance



Academic

- Education
- Research & development
- Collaboration with Integrators



Community

- Promotion of digital tools
- Collaboration platform
- Education & Knowledge sharing



Stakeholder Analysis



Government

The Hungarian State is highly dependent on the EU funds for the Agricultural activities. The only EU fund that Hungary has secured in 2022 is the Agricultural Funds based on CAP. The state is setting the legal framework, dataplatform (AAK) and the monitoring of the application and implementation system in the country.



MINISTRY OF AGRICULTURE



Ministry of Agriculture

The ministry is responsible for land affairs. In order to facilitate the digital transition of farmers, the Ministry of Agriculture offers the support such as funds and programmes. In order to facilitate the digital transition of farmers, the Ministry of Agriculture announced a call to support the precision transition, for which 212 billion forints of support that can be requested by farmers.



NATIONAL CHAMBER OF AGRICULTURE

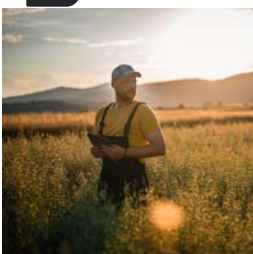


NAK

NAK's main task is to **represent the Hungarian agricultural** and food sector uniformly and efficiently. It has the role to ensure the development and implementation of **national property policy** and actively contributes to the establishment of orderly **market conditions**, and supporting the fair farming.

- **Digital Agricultural Academy:** trainings and education in the agricultural sector
- **Village Farmer network** (Falugazdász hálózat): Improve the **awareness and preparation**, and thus to increase their competitiveness of farmers. effective use of EU funds

D digitális jólét program



DJP

DJP prepared the **Digital Agricultural Strategy (DAS)**, Contribute to **increasing the profitability of agricultural production** by collecting and processing information, as well as by automating and robotizing technological operations in addition to the efficient use of available environmental resources

Stakeholder Analysis



Research

The agricultural research is progressing in both fields of basic and applied research with a focus on environmental factors and bio/organic farming. There is a strong collaboration with universities and international organisations such as OECD and researches like NATO Biotox. In order to bring innovations the quicker to the market, institutes participate in university education and postgraduate trainings.



NAIK

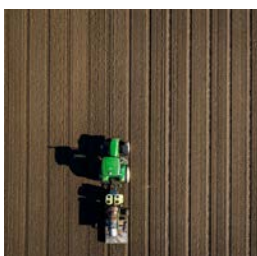
It was created by **merging** and coordinating the operations of twelve **research institutes related to the agricultural and food economy**, and four more research institutes joined it as a business association.

NAIK deals with the current **innovations** and is the bridge between the **research & development** and the market

AKK

AKK is part of the National Agricultural Research and Innovation Centre (NAIK)

It performs **basic and applied research** in the areas of chemical, microbiological and genetic safety of agricultural technologies.



AKI

AKI continues as a **research and knowledge centre** with agricultural economics databases and **policy expertise** in Hungary, performing both **public duties** and **state functions**.

- Develops **recommendations** for agricultural and rural policy **decision-makers** (based on research)
- Implementation and **execution of CAP**
- **Digitalisation**: development of EU and national agricultural information systems(FADN,MPIS,ASIS)

Stakeholder Analysis



Integrators

Integrators are spreading the results of **scientific research and the implementation of new technologies in the agricultural sector**. They are at the forefront of development in the field of agricultural application of digital technologies, making the entire system of tools, products, services, IT and business solutions necessary for precision farming uniquely available internationally and in the Hungarian market. Hungarian integrator organizations mainly deal with the **distribution of input materials**. More than **45% of producers** are currently **related to an integrator** in the country for the implementation of modern production tools and plant organization procedures. There are 3 leading integrators: Kite, Axiál and Agrotec, followed by a number of second Tier, smaller integrators (visit annex for list of Integrators).

First Tier Integrators offer typically 3 type of services in Hungary:

1. **Agronomic Trade:** seed, fertilizer, insecticide, crop, horticulture
2. **Technical trade:** environmental care, irrigation piece part, machine
3. **Services:** machine rental, service and special workshop, deferred payment, Broker, precision farming expert consulting, machine operation support, technical support

Second Tier Integrators' offer is limited and is focusing on input materials and seed distribution (please see the list of second tier integrators in the Appendix):

1. **Agronomic trade:** Fertilizers: plant protectant spray, Seeds
2. **Services:** Expert consulting



KITE
2011



KITE

The **largest hungarian integrator** it contributes to the technical, technological and market development. In addition to the product trade, they put emphasis on the distribution of innovative services: introducing and spreading systems-based, complex technological and commercial solutions, as well as by providing education, and by involving ever wider market segments and geographical areas (<https://www.kite.hu/>) .

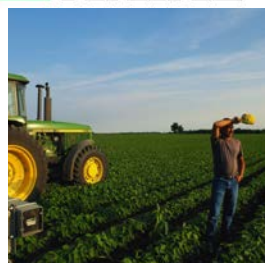
AGROTEC
Magyarország



AGROTEC

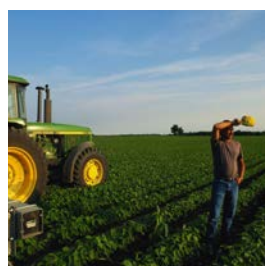
Agrotec's main profile is development of **IoT products** ,mainly oriented to high efficiency monitoring and remote control applications: designing and manufacturing precision farming tools, which yield great increases in the quality and productivity of crops. Furthermore, they offer specific tools for precision agriculture which they can monitor the soil and silos with (<https://www.agrotec.hu/>)

 **AXIÁL**



AXIÁL

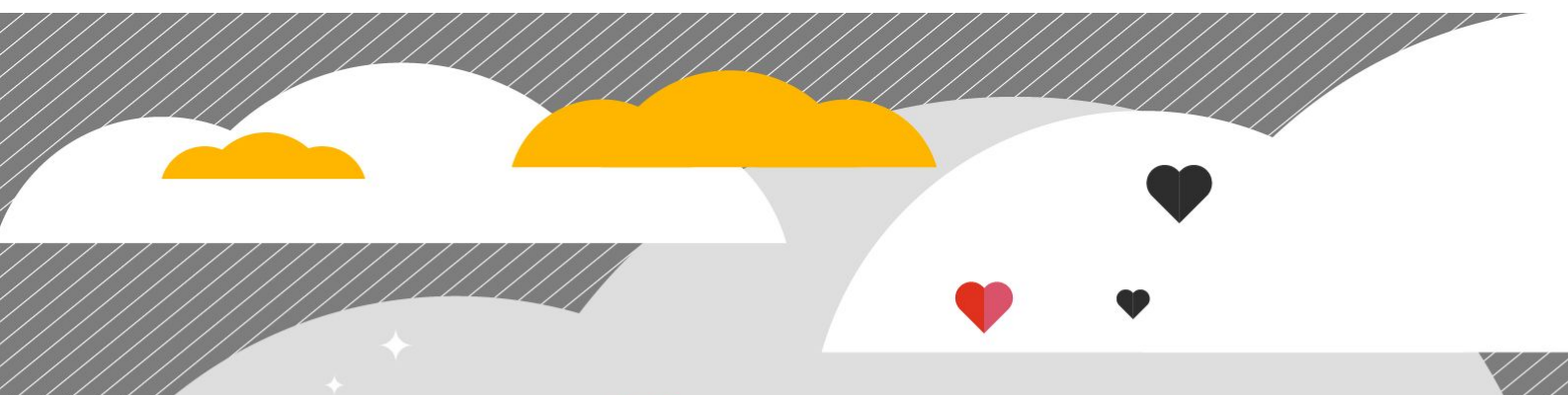
Axiál company has been on the market since 1991 with the of sales of **agricultural machines** and repair services. Along the years, the profile of the company expanded with the sales of mechanical parts of agricultural machines (<https://www.axial.hu/>)



IKR

IKR provides expert advice in all areas of plant cultivation. The company offers tools, products, services, IT and business solutions necessary for **precision farming**. Main competency is the **precision soil sampling** and personalized expert advice.

Besides services the company sells fertilizers, seeds, pesticides and crop trade (<https://ikragrar.hu/>)



Universities and PA technologies:

Universities have 2 types of approach regarding to the incorporation of Precision Agriculture into the curriculum. One point of view is to **incorporate it into existing faculties** and all majors (MATE) or to **start a brand new faculty** like in Debrecen where a whole BsC is based on only PA technologies. PA education is very subjective with **no common core curriculum** and is in **delay in adopting new innovations** into teaching. Education is facing the following challenges:



Organisation

The agricultural education in Hungary is disjointed and uncoordinated



Materials

The university teaching materials are not synchronised with industry expectations and trends



R&D

The amount spent on research and development is low and incentives are inadequate



Career vision

A number of negative career characteristics (eg. low wages and prestige) make the industry unattractive, which results in low applicant numbers in universities



Consolidation

There is no predictable stable working environment due to the continuous changes and reorganisations in the industry



University of Debrecen

The Faculty has launched in 2019 February a **precision agricultural engineering course**. The two-semester continuing education guarantees complex, up-to-date knowledge in the agricultural or technical field. An additional crop protecting **drone training** is also available at the university. Consultants and development engineers of **KITE Zrt.** also participate and give showcases in the training.



Széchenyi University (Győr)

Faculty of Agricultural and Food Sciences: There is a wide range of **research and development** work at the Faculty . University of Győr has strong roots in engineering and informational technology, thus it is managing a project with precision farming in its focus.



MATE (Budapest)

Department of Precision Farming and Agricultural Digitization. The Department, founded in 2022, is the **first in the country to deal with precision farming** and agricultural digitization. MATE also takes part in **dissemination activities** by communicating the project at scientific conferences and symposia.

Information flow



Information flow between Stakeholders

Farmers are connected to all stakeholders. They receive funding and support both from the EU and State in exchange of meeting requirements/KPIs and providing data. Farmers are supported in their activities by integrators who are integrating in their product offering and expert consulting the newest technologies and developments from research and university. Farmer's communities are strongly collaborating by sharing best practices, tendering strategies and educating themselves.

Farmers' communities

- Best practices
- Experiences and constant knowledge sharing and result analysis

Conferences

- Thematic seminars
- Networking opportunities
- How to exploit the support opportunities won in the precision tender

Farm to Fork

- Sustainable food production technologies and support for its implementation

Policy/State

- New tenders and incentives
- KPIs and Data driven funding

University

- Technology: application of precision agricultural technologies;
- Data: collection and analysis of data
- Management: knowledge and management of hardware and software required for engineering work

Agrarian Community

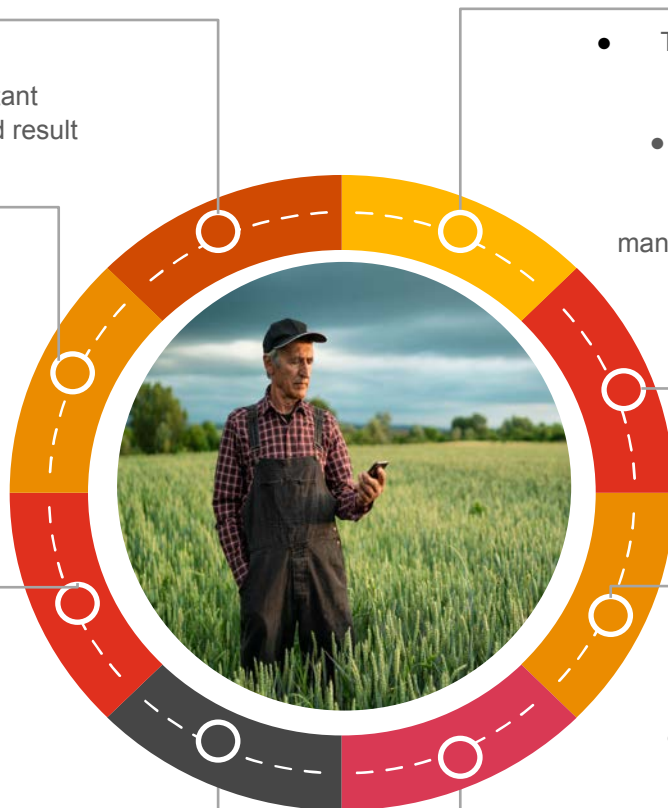
- Spreading the application of the PA
- Communities where farmers, experts, researchers can collaborate.

Integrators

- Information about the new technological solutions in the agriculture
- Distribution of input materials, tools and services necessary for production, the purchase and resale of agricultural crops.

Expert Consultants

- Support from Mechanical and agronomic experts, soil sampling assistants and IT specialists dealing with geospatial information
- Support in applying for state and European Union subsidies (admin, tender writing, planning etc)



Recent events and challenges

The Hungarian agriculture sector faced many difficulties in 2022 and these issues are likely to repeat in the following years.

The Ukraine-Russian war caused an energy crisis and raised fuel prices all over Europe, which had an impact on the sector. In addition, the 2022 summer brought less rainwater to the fields of Alföld (where half of the country's agricultural output comes from) than expected, causing difficulties for farmers to produce agricultural goods and creating a need for improved irrigation systems.

Currently, Hungary is facing a serious inflation rate, including a huge increase in food prices.

The agriculture sector is in a rush to find long-term solutions for the price and supply problems in order to avoid further shortage problems.



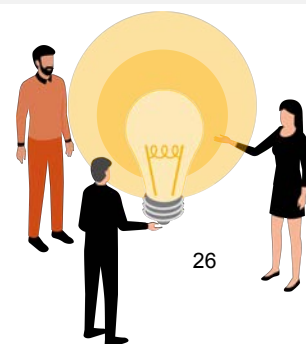
2022 has brought difficulties for the Hungarian agriculture sector:

- Rising inflation rates
- Drought
- Increase in energy and fuel prices



Rising inflation rates

Because of the current economic situation, the average prices of agricultural production have increased while the availability of some inputs became unpredictable. This eventually caused high inflation in Hungary, especially in the food industry, which may encourage consumers to buy cheaper products, or lower their consumption. Current outlooks predict that high inflation rates will stay next year, which could set back the willingness to invest among primary producers.



Recent events and challenges

Drought in the Summer of 2022

2022 was a drought year in Hungary. It is expected that the long term effects of climate change will raise temperatures in the country which means a change in rainfall as well. While Hungary has a good plant gene bank, and breeding of drought-tolerant species is already underway, irrigation systems need to improve in order to make cultivation more sustainable.

As of today, only 2% of lands (100.000ha) under cultivation is irrigated, with some reports expecting this rate to be two - or three times higher in the future. Hungary has to develop its water storage facilities, repair the channel system and develop the current infrastructure. In the long term Hungary will have to start using purified wastewater.

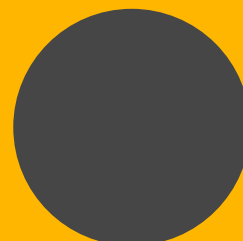


Increase in fuel and energy prices

Agricultural machines are extremely fuel demanding, especially during the harvest season. Hungary introduced a fuel cap with a standard price of HUF 480 to combat high prices, but at some gas stations there is also a limit of 100 litres / refuelling, which isn't enough for some agricultural operations. Thus, while the fuel cap is helping the sector in general, it also causes problems for those farmers who get their fuel at gas stations.

High energy prices also increase production costs, which can even cause a temporary shutdown of production for some farmers. Most primary producers can't measure their operations' energy consumption and do not have sustainable energy sources.

In summary, recent events have caused most farmers to think about survival rather than growth, but also showed that technological solutions are necessary to build more resilient operations.



4



Adoption of PA in Hungary

Chapter summary



The current rate of PA adoption in Hungary can only be determined by different research reports from the last 4 years, since there are no exact data available. For several years now, the Hungarian subsidy systems have supported farmers who invested in PA, but mostly larger organizations were able to benefit from them.

The current PA adoption is level low

Only a small percentage of farmers use digital technologies and an even lower number of them use PA. Most of the adopters' profile matches that of international standards.

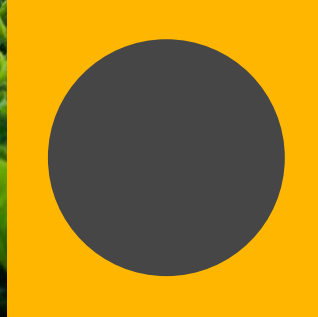
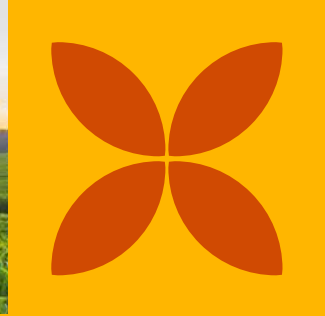
The willingness to invest has been high in the last 5 years

Current subsidies play a huge part in the high values of investments in the sector. However, primary producers with smaller lands and low digital skills are still very far from accepting PA technologies.

The available technology supply is adequate, but the implementation processes need to improve

It is widely accepted that every relevant technology is available from Hungarian suppliers, however in most cases the validation and calibration of these solutions are inadequate, which often makes farmers disappointed.

PA technology categories



Many different technology solutions can fit precision agriculture principles, so it is worthwhile to apply a flexible categorization for them. For the present study, the categorization will be based on the the different maturity levels a farming operation can reach with PA technology application.

These maturity levels can be illustrated by a short description of the process a farming organization takes up PA technologies. The following process is only a schematic representation, in reality the implementation often has a modular approach, which means that the investment only goes for a selected number of interconnected technologies which are initially used for smaller parts of the farms.

1. Assessment of the farmable land

The proper assessment of the farmable land, its borders and any obstacles on it serves as the basis for most PA technologies.

2. Vehicle navigation

Guided or automatically steered vehicles are working on the farmable land. This technology is the easiest to implement, and it also serves as basis for some others.

3. Zone creation

The next level is reached when there are different zones created and analysed within the farmable land. The analyses are focused on the heterogeneity of the whole land and aim to find solutions for increasing yields in each zones.

4. Application of differentiated operations

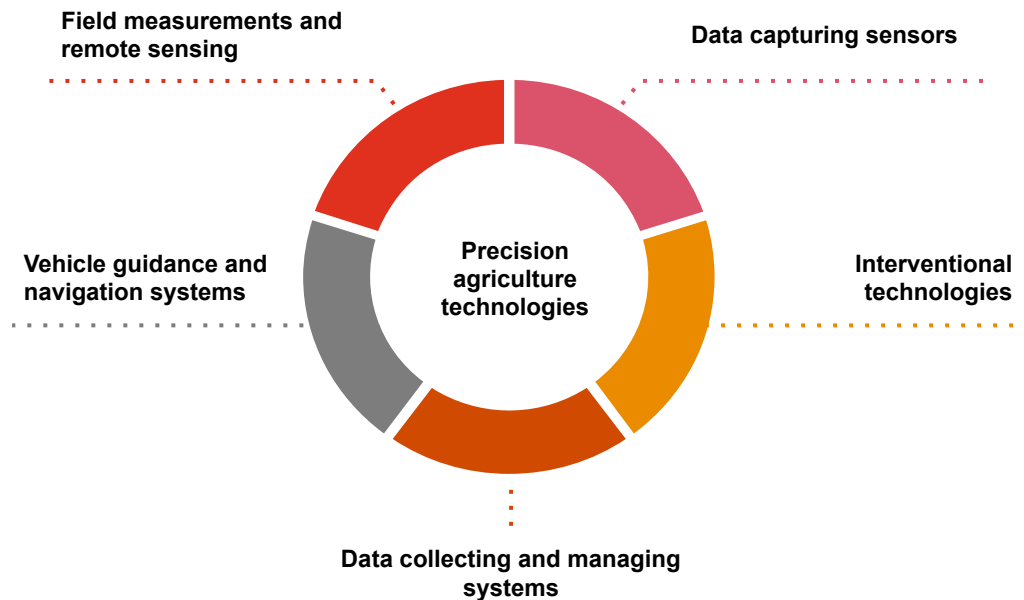
The previously created zones enable the implementation of a wide variety of automated equipment, which optimize the different operations of the cultivation.

5. Collecting and analysing data

The implemented technologies create a lot of data about the used inputs, yield and the equipment itself. Collecting and analysing this data helps decision makers improve their farming operations.

PA technology categories

Based on the previous maturity levels, we sort PA technologies in 5 categories:



- **Field measurements and remote sensing:** Technologies helping in mapping and sensing the parameters of farmable lands, such as GPS / GNSS network services, RTK correction or UAV-s.
- **Data capturing sensors:** Measuring the different parts or steps of the cultivation process, this category includes sensors and scanners collecting relevant data for later utilisation.
- **Interventional technologies:** This category includes a wide variety of dispenser systems, which can be automated.
- **Data collecting and managing systems:** The necessary IT infrastructure (hardware and software) which enables data-driven decision making.
- **Vehicle guidance and navigation systems:** Vehicles and devices needed for guided or fully automated driving



Current adoption of PA in Hungary

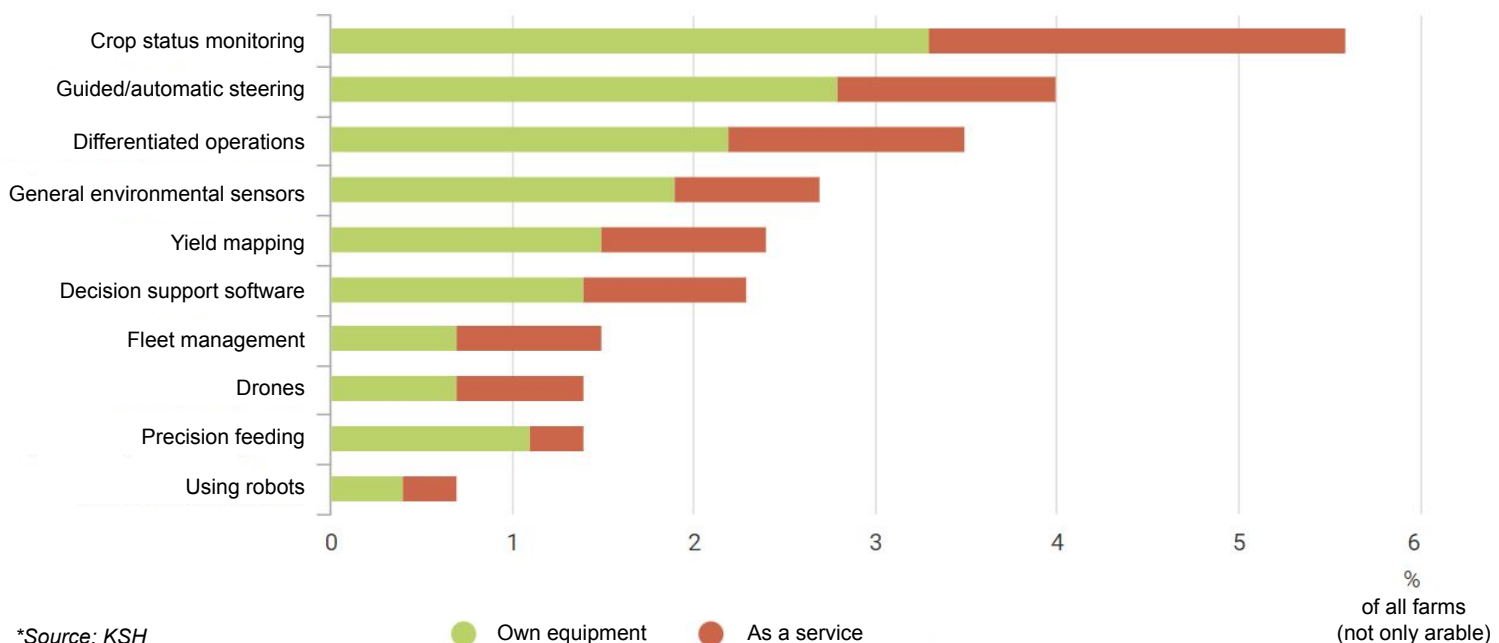
As of 2022, mainly larger, well-capitalised farms have started to invest in digitalisation, but the smaller ones can't do so without significant financial help. The main adopters are primarily younger than 40 years old, have higher education and lands over 300 hectares.

According to the most recent research results, 38% of all farms use any kind of digital equipment and only 12% apply PA solutions. Farmers with higher education are more likely to use PA technologies, but less likely to actually own the equipment.

Of all farming categories, arable farming has the highest percentage of PA adoption. Although the chart below shows data for the entire agriculture sector, the most popular five solutions are the same for arable farming:

- 8-8% uses crop status monitoring and guided / automatic steering
- 6% uses differentiated farming operations
- 4-4% uses general environmental sensors and yield mapping

Most commonly used PA solutions in the Hungarian agriculture sector (2020)*



Attitude towards PA in Hungary

PA technology adoption has been growing slowly, but steadily in the last 5 years and the willingness to invest is still high in 2022 H1.

According to AKI's 2022 H1 report, there's been a dynamic growth in the sales of agricultural vehicles in the last few years, which shows that **there's a technological modernisation happening in the sector.**

+80%
Sales of new vehicles and equipment compared to 2021 H1

+22%
Sales of vehicle parts compared to 2021 H1

Over 300 billion HUF
was spent on agricultural vehicles and parts in 2021, which is a record number

Primary producers are greatly encouraged to implement PA solutions by the currently available Hungarian subsidies. Farmers that make these investments state that their main goals are the following:

- **Remaining competitive.**
- **Being able to handle environmental and climate challenges.**
- **Adapting to more strict requirements for food safety and security.**

On the other hand, there are several discouraging factors which affect the majority of primary producers. In 2020, a study was conducted among farmers who aren't willing to invest in PA technologies and they gave the following reasoning:

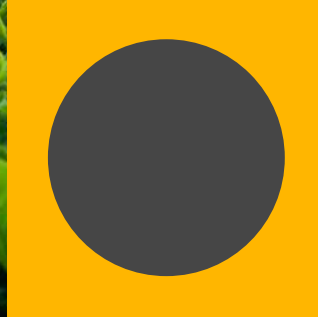
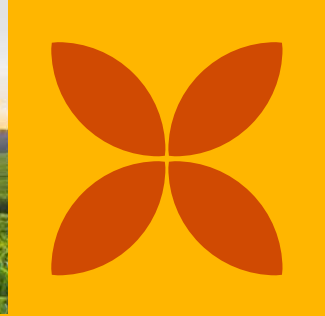
- **There's no need for PA in my operations (~85%)**
- **I don't have the necessary knowledge (~15%)**
- **Digital solutions are expensive (~5%)**
- **My other equipment is not compatible with PA technologies (~5%)**
- **There's limited supply for trainings and consultation (~2%)**

In addition to these reasons, 2022 brought some outside effects which makes investing even less attractive according to primary producers:

- **The availability of vehicles and vehicle parts are uncertain.**
- **The prices are rising rapidly.**
- **There's an uncertainty regarding delivery times.**

In order to further advance the Hungarian agriculture sector, appropriate actions, policies and subsidies need to be present to help transforming attitude towards digitalization and PA.

Technology suppliers



The availability of different PA technologies and expert consulting services on the market are adequate.

There are several technology suppliers in Hungary, who have a wide selection of PA solutions available. Expert consulting services regarding implementation or data analytics are often provided by the same company, since these services are mandatory to use when the investment was supported by subsidies (4% of the total value of the subsidy has to be spent on agricultural expert consulting services).

Field measurement and remote sensing solutions are widely available in every region of the country in different subscription models. These technologies are supported by Hungary's strong telecommunications network coverage.

In the other technology categories - farming machinery, vehicles, sensors and interventional technologies - the supply is also extensive. Almost every major international brand has distributors and there are also some Hungarian manufacturers (eg. Farmgép Kft., Omikron Kft., Digitroll Xeed System).

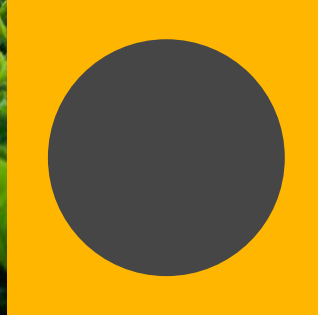
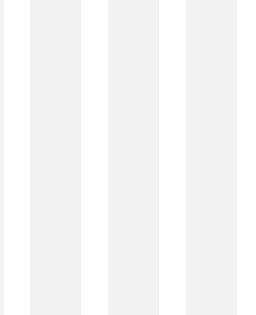
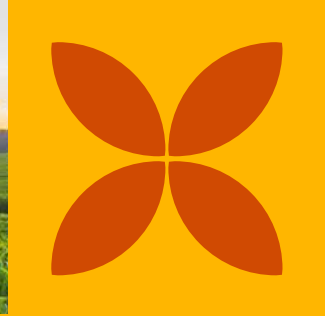
CASE STUDY - Drone application in Hungary

Market leading drone manufacturers (eg. DJI, HSE, TTA) have Hungarian distributors who offer renting options, however drones aren't widely used since proper regulations were only introduced in 2021.

Currently there are no precise data available about the number of drones, but some predictions state that by 2025, around 65 thousand will be active. This would mean that a huge boom in drone application is imminent.

The rate between recreational and industrial drones at the moment is 90-10%, with the former category being 10 times larger in numbers. It is expected that once the regulations are updated and improved to match pilots' needs, the industrial category will soon grow, especially in agriculture.

Expert consulting services



In most cases, farmers in Hungary lack the proper time or knowledge to exploit the benefits provided by PA technologies, so integrators and advisors have a prominent role in the agricultural ecosystem.

Agricultural expert consulting services are essential for most PA investments because of subsidy requirements and/or the complexity of the technology. It is important to note that these services always happen in person and in the Hungarian language to build trust in farmers.

Currently, there are 3 main critiques for these expert consulting services according to experts:

- A lot of advisors only know one technology supplier's products and closed systems, which means that they lack a general perspective.
- The focus is mainly on selling the products, there are no supporting calculations which present the predicted economic outcomes.
- The approach towards agricultural expert consulting services needs to change, because it lacks true value at the moment.



5



Assessment of the sector and possible entry strategies

Chapter summary



The assessment of Hungarian agriculture in terms of PA adoption potential can be seen in the table below. In general, the sector has great foundations which could be built upon, especially with the upcoming EU initiatives, but there are some key weaknesses which could block innovation and therefore need to be addressed.

 Strengths	 Weaknesses
<p>Strong agricultural foundations:</p> <ul style="list-style-type: none">• Quality soil and lots of available fertile lands• Plenty of experience in cultivation• Extended network of expert consultants• Strong PA technology availability for local and international brands• PA software development is strong, there are several export products (eg. Agrovir)• Wide telecommunications network coverage <p>Continuous governmental support:</p> <ul style="list-style-type: none">• PA is a hot topic in all relevant institutions and government entities• EU regulations push the adoption of PA• Adequate financial support and incentives are offered by the state• Digital tendering / funding application systems are widespread	<p>Missing technical affinity:</p> <ul style="list-style-type: none">• The average age of farmers is above 60• Traditional agricultural mentality, most farmers aren't open to technological innovations• Higher education doesn't cover PA topics properly• Lack of machine handling experience• A lot of agricultural workers have low education• Low interconnectivity between equipments (not compatible with ISOBUS) <p>Lack of data usage:</p> <ul style="list-style-type: none">• Most data in the sector is unused or not structured• There are no proper data collecting methods, which can cause the usage of import services (eg. aeroespacial mapping by planes from AT)• ERP/Farm Management systems integration and utilisation is not working properly (eg: SAP is settled in the sector but not optimised) <p>Trust and transparency can be low:</p> <ul style="list-style-type: none">• No clear database about the number of farming organisations• Declining number of farmers and increasing number of acquisitions• No proof needed for the application and utilisation of funds/subsidies• Lack of trust between market players
 Opportunities	 Threats
<p>Closing the gap in PA knowledge needs help:</p> <ul style="list-style-type: none">• In most operations only basic PA solutions are applied• The expert consultant network is widespread, but their technical knowledge could be improved• A generation change is happening in the sector, which brings a new mindset• Test before invest opportunities (data based investments) are in demand• Drone application is expected to grow in the following years• There's demand for specialised agricultural analytical services, which current Hungarian laboratories can't serve properly <p>Expectations from the EU push for modernisation:</p> <ul style="list-style-type: none">• Water management will be a crucial topic in the upcoming years• Expectations about a single European data space will push farmers towards data collection & sharing• Energy communities will be supported by the EU, in order to join, energy consumption data needs to be collected at machine and plant level	<p>Managing negative externalities:</p> <ul style="list-style-type: none">• The sector has to become more resilient to tackle climate change and difficult macroeconomic environments• There's a temporary setback in the willingness to invest due to 2022's events <p>Development limiting obstacles:</p> <ul style="list-style-type: none">• The area-based support system does not encourage development for smaller farms• Investments are mainly driven by subsidies, without funding the willingness would decrease <p>General distrust towards new players:</p> <ul style="list-style-type: none">• Weight of personal relationships in the sector makes market entries more difficult

Strengths and weaknesses

Strengths to build upon

Agriculture has strong foundations in Hungary

The country has quality soil, ideal climatic conditions and lots of available fertile lands. Most farmers have been cultivating for generations and accumulated plenty of experience. While the current PA uptake can be considered low, the availability of PA technologies combined with the extended network of expert consultants provides a great opportunity for modernising the sector. This is also supported by local software developers with globally competitive products and a strong telecommunications network coverage.

Governmental support plays an important role in pushing the adoption of PA

PA has been a highlighted topic in Hungary for years, and with the new European initiatives this mentality should only strengthen. At the time of this study, the financial support and subsidy system provided by the government is a huge incentive for primary producers to invest.

Areas that need improvement

Most farmers don't have the needed technical affinity

The high average age of farmers, the traditional mentality and the lack of PA topics in education all make the modernisation of the sector difficult. At the moment a lot of workers and older machinery aren't compatible with new technologies.

Most data in the sector is unused or not structured properly

Generally, data collecting and data-driven decision making aren't applied in most farming operations. In some extreme cases, the sector is dependent on import services for collection. While some larger primary producers do use ERPs or farm management systems, many report that integration and utilisation isn't working properly.

The sector has low transparency

It is difficult to account for the sector, since there are no proper databases on the number of farmers and their utilisation of funds/subsidies. The number of farmers are declining which results in a lot of acquisitions and there is a general lack of trust between market players.

Opportunities and threats

Areas that define opportunities

There's a knowledge gap between the Hungarian and Dutch agriculture sectors regarding PA solutions

Most PA adopters only use basic technologies, which create a suitable basis for more complex solutions. In order to make farmers more open to these, the technical knowledge of expert consultant networks and the quality of analytical services (eg. test before invest opportunities, or lab analytics services) has to improve. This could happen at the same time as the current generational change trend, which could bring a new mindset into the sector.

Short-term expectations from the EU are pushing towards PA

The EU's expectations on the sectors improved sustainability, production quality and innovation capacity all bring the need for modernisation. A common Hungarian data space, where best practices could be shared, would also be welcomed by primary producers.

Threats that can be tackled

The Hungarian agriculture has to be more resilient

Negative externalities like the ongoing war, the drought in the Summer and the less ideal macroeconomic environment highly affect the sector, which needs to become more resilient to survive. PA is one of the main ways this could be achieved, but 2022's events have temporarily set back the willingness to invest.

There are several obstacles limiting development, especially for smaller farms

The area-based support system is not ideal for smaller farms, who usually can only invest in PA technologies if they are given funding. Smaller farms' dependence on subsidies also means that a change in the government's attitude towards the sector's subsidy systems could significantly lower investments.

A general distrust can be observed in the sector

The weight of personal relationships makes some primary producers distrustful towards new opportunities, which makes it difficult for new entrants in the market.

Possible market entry points

Offer expert consulting services

Consulting services are limited and are closely tied to integrators, which often means that they are not independent. There is room for improvement in the complexity, digital and technological ability and also in ways of supporting, developing and cooperating with them.



Complementary services, products and build partnerships

Integrators' product and service portfolios are often very similar to each other. There is room for new opportunities under collaboration/partnerships, especially with Tier 2 integrators that have limited offer.

Offer laboratory analysis services

Hungarian laboratories are offering basic analytical services that are not up to date with current needs. Farmers are looking for other factors and parameters which modern Dutch labs could provide.



Data management

There is no data collection either at plant or machine level in Hungary. The state is currently creating an interoperational single data space where all data will have to be uploaded. Dutch experience could help the creation of this data space by implementing data analytical solutions to farming operations.

Solutions to meet EU prerequisites

Due to new EU legislations (EU data collection, food safety and sustainability) there will be traceability requirements. PA solutions specially designed to help farmers meet these requirements could be great products for new market entrants.



Irrigation systems

Due to the historic drought in Europe, Hungarian farmers have realised that they don't have solutions for water management. There is a high demand for advanced irrigation parameters, water retention and experience.

Farm management solutions

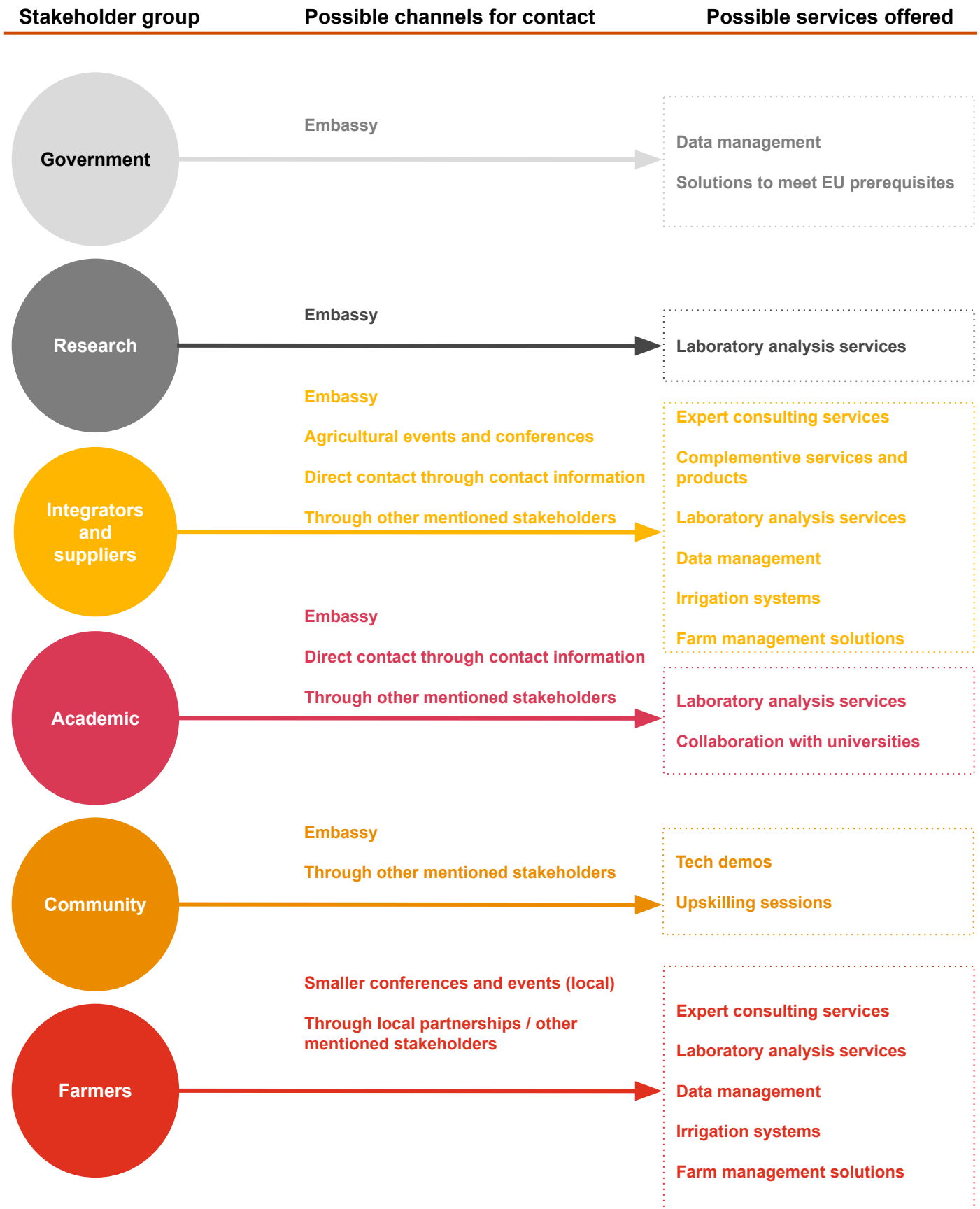
Few farmers use corporate governance systems. Operations are not interconnected and are not data driven. There is a lack of management approach.



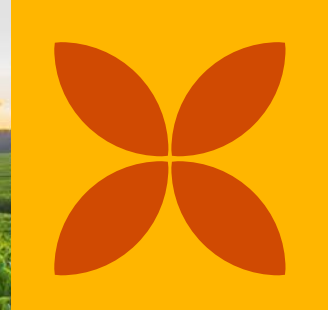
Collaboration with universities

Hungarian Universities are not equipped with the adequate technological tools for transferring the PA knowledge in practice to students. Dutch companies can offer their products as teaching tools thereby getting students used to dutch developed softwares and tools. Furthermore it could be a great opportunity for both students and companies as meeting platform.

There are different ways to make contact with relevant stakeholders



Key considerations



Before planning a possible entry strategy to the Hungarian market, some important considerations should be noted. The following takeaways are worth to remember on the specifics of the Hungarian agriculture sector.

#1 Hungarian market is dominated by Hungarian language

Most farmers prefer to communicate in Hungarian because of lower English language skills. They are also more trusting towards Hungarian speaking salesmen / consultants.

#2 Farmers are not easily convinced by promises, even if it is coming from a country recognized as advanced

A lot of Hungarian farmers are sceptic, therefore more resistant to offers which sell solutions that seem very different from current standards. Trying to understand their current situation and showing relevant facts about the returns of their investments should achieve better results.

#3 Trusted opinion leaders can influence wider audience

Relationship development and management is key on the Hungarian market. History and collaboration over time is highly valued by hungarian farmers. Partnerships with local key players can improve trustworthiness.

#4 Subsidies are in agriculture's DNA

The financial support and subsidy system provided by the government is a huge incentive for primary producers to invest and have a great impact on the development direction of the sector.

#5 Those challenges that are embraced by government get high attention

Goals and key strategic areas set by the Hungarian Government receive high financial support and privileges (tax cuts, extra funds, collaboration opportunities).

Thank you!



6



Appendix

List of non-highlighted (second Tier) integrators

- Agrofor Zala Kft.
- 343 Kft.
- 4M-97 Kft.
- Agro Fito Bt.
- Agro-Central Trade Kft.
- Agro-Coord Németh Lajos e.v.
- AGRO-ÉP 2000 Kft.
- AGROKÉMIA Mezőgazdasági Szolgáltató Kft.
- Agroker Holding Zrt.
- Agrolog-Hungária Kft
- Agromulti Kereskedőház Kereskedelmi és Szolgáltató Kft.
- Agrosziget-Chem Agrokémiai Kft
- AGRO-TÁR Mezőgazdasági Termelő és Kereskedelmi Kft.
- Agrotata Kft.
- Alba Növszer Kft.
- Austria Juice Hungary Kft.
- B. L. AGROKEM KFT.
- Beszerző és Értékesítő Mg. Szövetkezet
- Borsod Agroker Zrt.
- BOTÉSZ
- Centrum Jászapáti Kft.
- Chemical-Seed Kft.
- Dél-Balaton Mg. Zrt.
- Farmmix Kft.
- Gabonakom Kft.
- GIF Hungary Kft.
- Goldkern Kft.
- Granduo 2000 Kft.
- Gyenes Kft./Papp Agro Kft.
- Harkály Üzletház Bt.
- Hírös Agrária Kft.
- Horváth Sándor Növénypatika
- Hőgyészi Agrokémiai Kft.
- Input-Agro Kft.
- KÁNYA-KER Kft.
- Karintia Kft.
- Kerkagabona Gabonaszárító és Tároló Kft
- Lajtamag Kft.
- Mátragabona Mezőgazdasági Szövetkezet
- Mátramag Szövetekezet
- Medosz Kft.
- MEGÉR-TÉSZ Szövetkezet
- Molnár Farm '90 Kft.
- Móraagró Kft.
- Nagyréde-Agrár Kft
- Nagyrét Farm Kft
- Novochem Kft.
- Növény Kft.
- Nyír-Chem Kft.
- Óvár-Chem Kft.
- Pécsi Agroker Kereskedelmi és Szolgáltató Kft
- Pratus Product Mezőgazdasági Szövetkezet
- P. S. Agroker Kft.
- RWA Magyarország Kft
- Sinola-Agro Kft.
- Solti Rákóczi Zrt./Totyafarm Kft.
- SOMBÉSZ Szövetkezet
- Sombész-Agrár Kft
- Tolnai Agrokémiai Egyesülés
- Unser Lagerhaus Kft.
- Virág-CHEM Kft.
- Völgység Agrár Kft.
- Zalai Olajos Növények Szövetkezete

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- European Commission - Common Agricultural Policy (post 2020)
- European Commission - DIGITAL programme
- European Commission - European Strategy for Data (2020)
- European Commission - Farm to Fork Strategy
- European Commission - Goals for 2030
- European Commission - Horizon 2020
- Hungary's Artificial Intelligence Strategy (2020-2030)
- Hungarian Central Statistical Office (KSH) - Agrárcenzus (2020)
- Hungary's Digital Agriculture Strategy (2019-2022)
- Hungarian Ministry of Agriculture - Az új KAP társadalmi egyeztetése (2021)
- NAIK & AKI - A precíziós szántóföldi növénytermesztés helyzete és ökonómiai vizsgálata (2020)

Databases used:

- Eurostat
- Hungarian Central Statistical Office (KSH)
- World Bank

List of interviewee organizations	Organization type
Hungarian Ministry of Agriculture	Government
Digital Success Program	Government
Institute of Agricultural Economics	Research institute
University of Győr	Academic
Hungarian University of Agriculture and Life Sciences	Academic
AXIÁL Zrt.	Integrator
Agrotec Kft.	Integrator
Nemzeti Ménesbirtok és Tangazdaság Zrt.	Showcase farm

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