



Kingdom of the Netherlands

Precision farming technologies in the Ukrainian agricultural sector

2021

Commissioned by:
the Netherlands Enterprise Agency (RVO), the Embassy of
the Kingdom of the Netherlands in Kyiv, Ukraine

Implemented by:
Ukrainian Agribusiness Club
ucab.ua
info@ucab.ua



№	Table of contents	Page
	INTRODUCTION	3-4
1.	Summary <i>Executive summary</i>	5-9 5
2.	Characteristics and structure of crop production in Ukraine <i>Agricultural sector of Ukraine. General information</i> <i>Most popular crops in Ukraine</i> <i>Agricultural companies. General information</i> <i>Agroholdings</i> <i>Middle-size agricultural companies</i> <i>Farmers or small agricultural enterprises.</i>	10-21 10 12 17 19 20 21
3.	Situation on the Agritech market in Ukraine <i>Initiators of the introduction of digital technologies</i> <i>Hardware</i> <i>Software</i>	22-25 22 22 25
3.1.	Survey results <i>Electronic field maps</i> <i>Heading indicators / autopilot</i> <i>GPS monitoring (tracker) and fuel control sensors</i> <i>Satellite maps / NDVI</i> <i>Drone/ UAV</i> <i>Weather station or soil moisture sensor.</i> <i>Forecasting programs (pests, diseases).</i> <i>Farm management system (FMS).</i> <i>Key findings of the study per categories of farmers:</i>	26-45 28 30 32 34 37 38 40 41 44
4.	Policy and Legal situation <i>Main policies regarding precision farming</i> <i>Rules and regulations applicable to the import</i> <i>Certification, registration, and localization requirements</i> <i>IPR</i>	46-51

5.	Opportunities and challenges	52-63
	<i>Current challenges of the agricultural producers that can offer opportunities for introduction of innovative solutions</i>	52
	<i>Suggestions and recommendations (types of equipment, segments, customer profile, regions of cooperation)</i>	56
	<i>Current market opportunities (for Ukrainian and Dutch companies)</i>	57
	<i>Exhibitions, forums, conferences, media in precision farming in Ukraine</i>	58
	<i>Corporate Social responsibility and Doing Business in Ukraine</i>	63
6.	CONCLUSIONS	64-65
7.	Annex I. Sowing area	66-76
8.	Annex II. List of companies (Hardware& Software)	77-85
9.	Annex III. Matrix of opportunities	86-88
10.	Annex IV. List of Dutch companies interviewed	89

INTRODUCTION

The Ukrainian Agribusiness Club has been commissioned by the Embassy of the Kingdom of the Netherlands in Kyiv and the Netherlands Enterprise Agency to carry out the study of the market in Ukraine for products and services in the field of precision agriculture and the opportunities for the Dutch companies to do business and collaborate with the Ukrainian companies and projects working in the open-field smart farming.

Precision agriculture or Smart Farming means that plants (or animals) get precisely the treatment they need, determined with great accuracy thanks to the latest technology. A range of forms of technology are used to this end, including GPS, sensor technology, ICT and robotics (WUR).

The Ministry of Agriculture, Nature and Food Quality of the Netherlands is investing in the development of data-driven technologies and robotics for new, diverse, thriving, nature-inclusive cultivation systems. Field labs and professional networks are established for that purpose. The agricultural counsellor in Ukraine is exploring local and regional opportunities to which relevant Dutch expertise can contribute. Promotion of Dutch knowledge and expertise in digital solutions in agriculture (data-driven technologies and robotics) is a component of sustainable agriculture and the line theme for the activities in top sectors.

The interest among the Ukrainian agricultural producers towards precision farming is increasing year over year. According to the findings of the [Global Innovation Index](#) ranking of innovation performance of 130 countries around the world in 2020, Ukraine ranks #2 in its group (lower middle income, after Vietnam). Agriculture is one of the most developed sectors in the country with a clear ambition to contribute to solving the world's food supply problem, and at the same time is facing the challenges of climate adaptation, environmental and social impact. Precision agriculture technologies have already proved their feasibility in Ukraine by an increase in yields and savings from 7-50%, according to the [Ukrainian National Innovation Agenda](#) (AgroHub, Raiffeisen Bank Aval, 2016).

These developments create the opportunities for the Dutch suppliers and knowledge institutions to become more active on the Ukrainian market, establish contacts with the local representatives and service providers.

The primary focus of the study is the agri-technologies related to open field crop production: technologies used on the farm during field planning, soil preparation, fertilizing, controlling water levels and plant protection, planting and crop management, and harvesting. Consumer-oriented innovations and technologies related to processing and marketing were not included.

We have focused our research on the following questions:

- How is the Ukrainian agricultural sector organized?
- Who are the main players, what are the major challenges they are facing in their operations?
- Who are the initiators of introducing digital technologies among major groups of producers?
- What precision farming techniques are applied by each group of market players and for which purpose. How well are they spread?
- How do suppliers of these technologies reach the farmers?
- What is the government policy and legal aspects regarding precision farming?

- What are the opportunities for cooperation with current projects/ research institutions and research projects active in the field of precision farming in Ukraine?
- What are the opportunities for the Dutch companies on the Ukrainian market and major challenges?

Based on the input from the terms of reference and results of the interviews with the Dutch companies, a questionnaire survey of 500 Ukrainian agricultural producers from different regions of Ukraine was conducted in the period of April-May 2021.

This report will provide an overview of the most important technologies available and demanded in the field of precision agriculture in Ukraine, more specifically, in the crop production, legal aspects related to application of technologies, major events and educational project with the aim to identify opportunities for the Dutch SMEs, supplying solutions in the precision agriculture at the Ukrainian market. Also problematic aspects for certain technologies, implementation or use problems will be briefly described. The reader can find a lot of insights in the current state of application of precision farming technologies, customer preferences and readiness to apply new technologies.

1. Summary

Executive summary.

Agriculture is the fastest growing sector in Ukraine's economy

Ukraine is a country with a rich and ancient history, colored by international trade, foreign invasions and many aspects of scientific and cultural life. The territory within the internationally recognized borders is 603,549 km². and is the first European state in terms of territory, entirely located in Europe. It shares borders with Belarus in the north, Poland, Slovakia and Hungary in the west, Romania and Moldova in the southwest, Russia in the east, northeast and, de facto, south. In the south and southeast it is washed by the Black and Azov seas; it has sea borders with Romania in the Black Sea and with Russia - in the Black and Azov.

Ukraine is an important industrial and agricultural producer specialized predominantly in production of raw materials. Country's economic complex includes mining (coal, oil and gas, iron and manganese ores), machine-building, ferrous and non-ferrous metallurgy.

Since 1991, Ukraine has implemented economic and political reforms and steadily strengthened its political and trade cooperation with the European Union. Partnership and co-operation agreement between the European community and Ukraine of 1994, was replaced by the Association Agreement in 2014. The Association Agreement laid the basis for political association and economic integration of Ukraine and the European Union. Ukraine has become an important supplier of food to the EU member states, this strengthened export orientation of the country's agricultural sector.

Ukraine is a leading exporter of agricultural products and foodstuffs. About 2/3 of the agricultural products produced in Ukraine are exported to 175 countries. In 2020, the share of ag. and food products in total Ukrainian exports amounted 45%, or \$ 22.2 billion. Since 2001, export volume of agricultural produce has been growing by 15%, every year. Export volumes always prevailed over imports in agriculture.

Ukraine's primary focus is on the cultivation and export of agricultural products with low added value: corn, wheat, barley, etc. Ukraine is the worlds' largest supplier of sunflower oil, #2 exporter of grains, and #8 in rapeseed oil. Such specialization was mainly caused by the delayed land reform. In the last 20 years, it was only possible to rent agricultural land, so the farmers did not have incentives to grow marginal crops and invest into long-term projects, like growing nuts, berries, irrigation, etc. Changes in the structure of crops/ plantations are to be expected after 2024, when the companies will be able to buy agricultural land.

Why we expect expanding precision farming technologies in Ukraine

Meanwhile, Ukraine has become an interesting market for ag-tech: suppliers of agricultural equipment and technologies. Considering the large areas of land, and fluctuations in the size of enterprises from 5 hectares to 500 thousand hectares, there is increasing demand for a wide range of agricultural equipment: tractors of different capacities, different sizes of trailed equipment, etc. The demand for precision farming technologies will grow in Ukraine. It will be fueled by the global trends of more efficient use of land resources, while minimizing application of agrochemicals. The impetus for application of more innovative technologies helping to reduce the cost of production will

grow as well, since there is an increase in prices for resources and equipment - fuel, fertilizer, gas, equipment (due to increase in cost of ores), etc.

Current challenges and developments that affect activities in the Ukrainian agricultural sector, like the opening of the land market, approximation to the terms of future agreements on the EU Green Deal, reform of irrigation. Also need to:

- implement precise accounting and monitoring of land resources and maintain soil maps;
- adapt the technological processes in the agricultural sector in the South of Ukraine to the temperature rise;
- take steps to mitigate climate change;
- adjust production practices to increasing water scarcity, soil degradation, and increasing lack of workforce.

Most of these issues and problems can be solved through the introduction of innovative technologies, and also makes it possible to offer solutions in the field of digital agriculture to various categories of agricultural producers.

At the same time, currently there are no programs of support or any other kind of stimulation for the use of innovative technologies or precision farming in Ukraine. The state loan programs for the agricultural sector are mainly short-term or medium-term. The pay-back period for individual innovations and update of equipment might take much longer than is covered by state loan programs.

What technologies are already used in Ukraine?

Precision farming technologies have already strongly penetrated the farming practices in Ukraine. Their level of application differs depending on the category of agricultural producers: small agricultural producers are using them less and large agriholdings are quite advanced, and have their own innovation departments. This study presents the results of the survey representing the current status of application of precision farming technologies by different categories of farmers: small (less than 1000 ha and 1000-3000 ha), middle-size (3-10 thous.ha) and large agricultural producers (more than 10 000 ha) per region. The following technologies were surveyed: use of electronic field maps, heading indicators/ autopilots, GPS monitoring (trackers) and fuel control sensors, satellite maps/NDVI, drones/UAV, weather stations and soil moisture sensors, forecasting programs (pests, diseases), and farm management systems.

Based on the results of the survey conducted as part of this study, the average percentage of application of precision farming technologies for all categories of surveyed enterprises is 51.2%.

As for the most popular technologies, electronic field maps are well used by middle and large –sized agricultural companies, with the percentage of digitized maps up to 91-95% among some groups of producers. Heading indicators, autopilots, GPS monitoring (trackers) and fuel control sensors are used by every 3rd small farmer and 85-92% of middle-sized and large companies. Satellite images /NDVI index use is about 16% with the smaller farmers and 71% with the large agriholdings.

While there is interest amongst companies of all types in agrochemical analysis, only 20-30% do mapping of soil compaction. Soil moisture sensors are used by 39% of the farmers. Farmers still focus on meteorological data and meteorological stations, owned or provided by servicing companies. Farmers are not used to maintaining moisture sensors in the field.

10% of farmers less than 1000 ha use drones, while 86% of large companies use them. Programs for forecasting the appearance of pests and diseases are the least spread (5% of small farmers and 43% of large agriholdings use them) due to limited possibility to take into account all factors, and programs of local diseases, pests, have quite predictable forecasts, which are already known to the agronomist of the enterprise.

Key findings of the study per categories of farmers:

Up to 1000 ha – farmers

- 85% don't have electronic field maps. At the same time, the farmers who have formed these maps are digitizing more than 90% of their lands;
- Only 1/10 use satellite images / NDVI and no more than 20% use their own weather stations and soil moisture sensors in their activities;
- These companies (in the majority) don't think about complex farm management systems – implementation of such a system requires both a financial component and a previously formed geoinformation base (at least) for your own company;
- Problems with the integrated and consistent use of precision farming technologies;
- Complicated access to financing for the possibility of purchasing more expensive equipment

1-3 thous.ha:

- Situation with field maps is better compared to farmers (47% versus 17%) and with a high percentage of digitization -almost every second farmer surveyed in this segment has digitized 90% + of their fields;
- In this segment, more than half of the respondents also use autopilots, GPS;
- About 38% use satellite imagery / NDVI;
- Problems with the integrated and consistent use of precision farming technologies (low percentage of use of management systems);
- Complicated access to financing for the possibility of purchasing more expensive equipment and machinery.

3-10 thous.ha:

- maps were formed by 67% + respondents, with a high% digitization -91% of their fields; 8 out of 10 farmers in this segment use autopilots, GPS trackers;
- much more interested in using satellite images / NDVI and meteorological stations / weather data;
- more consistent and deliberate implementation of technologies.

10+ thous.ha:

- Taking into account peculiarities of the work, implementation of the technology in all clusters is centralized (in most cases);
- The testing and scaling process for all clusters takes up to 3 years (Kernel's case);
- Digitized 93% + fields (using RTK, drones), 90 +% of the equipment with autopilots, GPS trackers, fuel control sensors;
- Using of satellite images, drones (both independently and by hiring appropriate companies), implementation of management systems such as FieldView, Cropio.

Dutch interest in Ukraine

To specify the Dutch interest in Ukrainian precision farming, a number of interviews with the Dutch companies were conducted in the period from March to May 2021 (list of companies in the **Annex III**). Some of the chosen companies are already present in Ukraine or showed their interest in learning more about the country. The idea was also to interview the companies working in different segments: supplying hardware, software and complete solutions. This is why some companies were selected and approached by us with the idea that they could become interested in Ukraine.

Majority of the companies expressed their interest in learning more about the Ukrainian agricultural sector and were open to thinking about approaching this market. Some companies (5 companies) have declared that they are not able to offer their products on the Ukrainian market or have not expressed a desire to take part in this survey for unknown reasons.

Recommendations.

Considering the large areas of agricultural land in Ukraine, a big number of agricultural enterprises and farmers working in various climatic and natural zones, there is an opportunity to find a free niche for almost every product, test it in various conditions and at different types of enterprises.

Dutch companies offer a whole range of solutions starting from sensors, pressure based liquid level sensors and sprayers to satellite monitoring and data transmission. Not all of them have experience in the agricultural sector, and only some have experience of work in Ukraine. To facilitate the search and the option of cooperation, and for major technologies represented by the Dutch companies was developed a matrix of opportunities (see Annex III).

The study also contains the list of 24 companies active in Ukraine in supply of hardware in precision farming, 13 software providers, and 16 mobile apps that are available (**in the list are presented key and most popular companies and services, but it is not exhaustive**). There are at least 11 events throughout the year where precision farming technologies are presented. 5 educational projects are active in this field for farmers and students.

Dutch companies and other foreign companies entering the Ukrainian market were provided with a number of recommendations and key points of which it is recommended to follow:

- Find a representative or a dealer/distributor of services or equipment who will be able to maintain direct contact with the farmers and be able to provide technical support.
- Ensure possibility for customization/ language adaptation of software and applications.
- Be patient when approaching the agroholdings, they take decisions slowly and quickly responsive with middle-sized and “small” agricultural producers.
- Set up cooperation with existing educational projects, join exhibitions and events. Regional events are gaining more popularity.
- Clearly define for yourself the pricing policy in Ukraine so that the price of the product / service is clear and can be comparable with the price of competitors. Given the fact that there are no subsidies/ co-funding from the Ukrainian government.

- Consider prospects/options for cooperation with medium sized agricultural companies or agricultural holdings as part of existing GIS platforms companies that offer satellite monitoring services for the state of crops and the state of fields especially etc.
- Separately, these services can try to start partnerships with local governments in obtaining up to date data on the course of the harvest, as well as violations of land use, burning of plant remains, and so on. Also, it is planned to carry out changes in tax policy, and establish a minimum tax burden per hectare - that is, payment of the minimum amount of taxes per hectare of agricultural land. Agrarians pay more than 70% of taxes to local budgets, and local authorities will be interested to know how much land they have in their communities, how much land is cultivated, how much taxes are paid, what to grow on them, etc.
- Try to start partnership with local governments in obtaining up to date data on the course of the harvest, as well as violations of land use, burning of plant remains, and so on. Also, it is planned to carry out changes in tax policy, and establish a minimum tax burden per hectare - that is, payment of the minimum amount of taxes per hectare of agricultural land. Agrarians pay more than 70% of taxes to local budgets, and local authorities will be interested to know how much land they have in their communities, how much land is cultivated, how much taxes are paid, what to grow on them, etc.
- It is necessary to be on the "shorthand" with the farmer/agrarian.
- Joining efforts for a group of companies will provide additional benefits for approaching the local governments and large agriholdings.

2. Characteristics and structure of crop production in Ukraine

Agricultural sector of Ukraine. General information

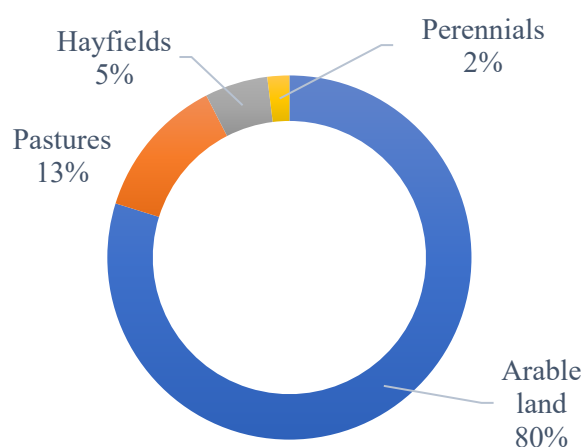
The agro-industrial sector is one of the key sectors of the Ukrainian economy and occupies the main positions in total exports. Briefly on key indicators:

- The agricultural GDP: USD 14.4 billion;
- Share of the national GDP: 9%;
- Share of working population: 18%;
- Structure of agricultural sector, share in GDP: 76% - crop production, 24% - animal production;
- The average annual growth rate of animal production for the last 10 years: 0.4%;
- The average annual growth rate of crop production for the last 10 years: 4.8%;
- The overall volume of agricultural export: USD 22.2 billion;
- Share of agricultural export in overall exports: 45.1%;
- The main products for export were cereal grains (42.4%), animal and plant fats and oils (25.9%), oilseeds and fruits (8.2%), meat (2.8%);
- In the world, Ukraine ranks first in the export of sunflower oil and sunflower meal, the second in the export of rapeseed and millet and the fourth in the export of corn and barley exports.

The total area of agricultural land in Ukraine is about 41.8 million hectares - arable land, pastures, hayfields, etc. The vast majority of land - 80% is arable land, which is used by farmers and citizens to produce agricultural products.

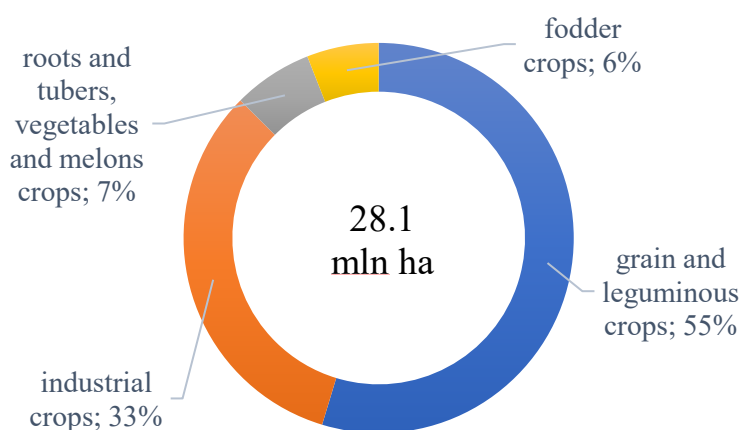
The structure is as follows:

- arable land – 80%;
- pastures – 13%;
- hayfields – 5%;
- perennials – 2%.



If we look at the distribution of the arable land, because, after all, Ukraine at this stage is more focused on crop production, the structure of crops is as follows:

- grain and leguminous crops – 55%;
- industrial crops – 33%;
- roots and tubers, vegetables and melons crops – 7%;
- fodder crops - 6%.



Sowing crops

Due to the large area of agricultural land, Ukraine is more focused on growing export crops of grain. The vast majority of oilseeds are processed (almost all sunflowers are processed in Ukraine) and most of the oil is already exported. Crop areas for recent periods are as follows:

Culture (thous. ha)	2019	2020
Winter wheat	6639	6408,5
Corn	4973,9	5451,3
Winter barley	1057,6	1046,8
Spring barley	1558,3	1376,8
Sunflower	5849,3	6383,3
Soy	1578,9	1340,5
Winter rape	1257,4	1296,2

Crops for the harvest of 2021*	thous. ha
Winter wheat	6907,5
Spring wheat	192,6
Winter rape	975,9

Winter barley	1337
Spring barley	1388,8
Sunflower	6509,7
Soy	1280,8
Corn	5474,8

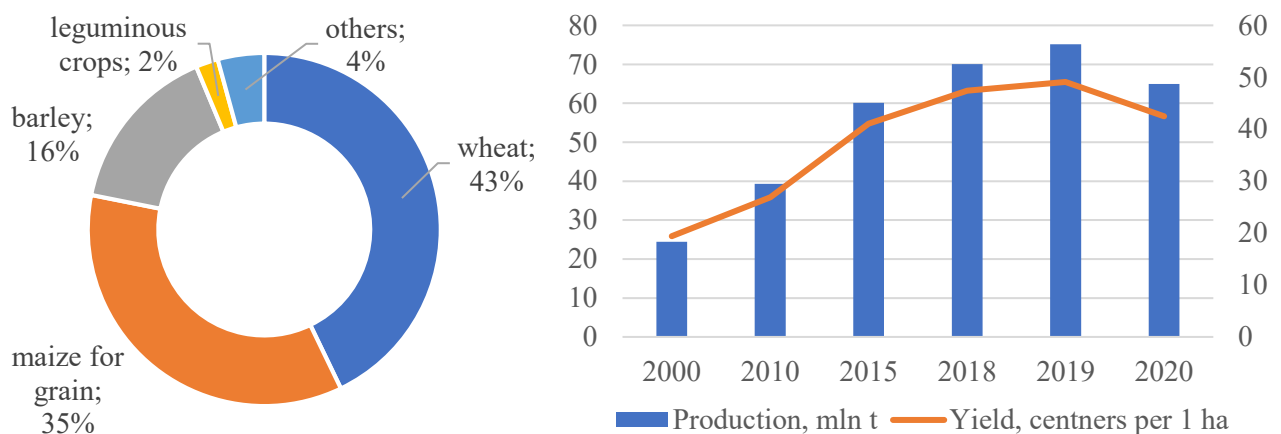
* enterprises and households

Map with details per region is in the Annex.I

Most popular crops in Ukraine.

Grain and leguminous crops. Corn, wheat, and barley are the main crops in Ukraine for cultivation and export. Over the past 5 years due to the elimination of newer equipment, the purchase of better quality seeds, PPE, fertilizers and production according to technology, gross production and grain yields have increased significantly. Over the past 5 years, with the exception of 2020 (when drought occurred and many crops in the southern regions of Ukraine were lost, and general decline in yields throughout Ukraine by an average of 25-30% was registered), there were records for gross production of these crops. Also, due to the above, there are good yields.

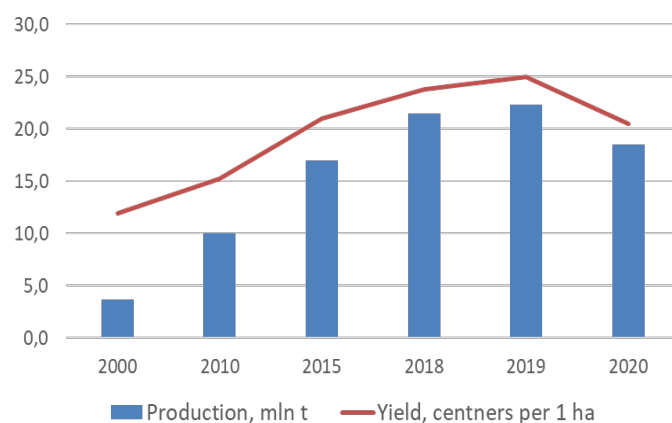
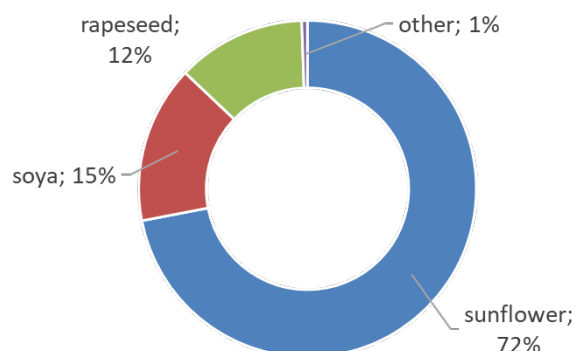
Structure of the sown area and production and yield (2020)



Oil crops. Sunflower, soybean, rapeseed – 70 +% of them are sunflower crops. Sunflower in Ukraine is processed almost entirely, due to the presence of a fairly developed processing infrastructure, at the same time for rapeseed and soybeans - here the situation is somewhat different, as Ukraine exports half of the harvest mostly to EU countries.

As for the productivity of production, the situation is similar to that of grain. Agrarians in recent years began to pay more attention to the technology of cultivation, development of technical maps, the acquisition of better equipment and hybrids of seeds.

Structure of the sown area, production and yield (2020)



The cultivation of grain and oil crops is more typical for agricultural enterprises due to the need to attract more equipment, as well as better profitability on large areas. On average, 80 +% of the total volume is produced by agricultural enterprises (with the exception of barley and rye where the share of the total production of enterprises does not exceed 60%) and show high yields by an average of 31% compared to households.

Production volume (in % of total)

Culture	Enterprises	Households
Wheat	21%	79%
Corn	14%	86%
Barley	42%	58%
Rye	40%	60%
Soy	10%	90%
Winter rape and colza (spring rape)	1%	99%
Sunflower	13%	87%

Key cultures:

1) **Winter wheat:** the main growing regions* - Zaporizhia, Odesa, Kharkiv, Dnipropetrovsk, Kherson region (from 480+ thousand hectares in each region, winter wheat crops for the harvest of 2021, a similar situation is observed in previous years). The total sown area for the harvest of 2021 for this crop decreased by -5% (by 295,6 thousand hectares) compared to the previous period and amounts to 6,112 million hectares.

2) **Corn:** main growing regions* - Poltava, Chernihiv, Cherkasy, Vinnytsia, Sumy regions (from 400+ thousand hectares in each region according to the results of sowing in 2020). The total sown area in 2020 increased compared to 2018 by 19%, and from 2019 by 10% (by 477 thousand hectares) and amounted to 5,451 million hectares.

3) **Barley:** main growing regions*:

- winter: Odesa, Mykolaiv, Dnipropetrovsk, Kherson, Zaporizhia (from 70+ thousand hectares in each region for sowing for the 2021 harvest). In total, 881 thousand hectares of winter barley were sown in 2021, which is 16% less than in the previous period.

- spring: Dnipropetrovsk, Kharkiv, Zaporizhia, Donetsk, Kherson (from 90+ thousand hectares in each region). A total of 1.37 million hectares of barley were sown in 2020, which is 12% less than the previous year.

4) **Sunflower:** main growing regions* - Dnipropetrovsk, Kropyvnytskyi, Kharkiv, Zaporizhia, Mykolayiv regions (from 500+ thousand hectares in each region, according to the results of sowing in 2020). The total sown area in 2020 increased compared to 2018 by 5%, and from 2019 by 9% (by 534 thousand hectares) and amounted to 6,383 million hectares.

5) **Soybeans:** main growing regions* - Khmelnytsky, Poltava, Zhytomyr, Vinnytsia, Kyiv regions (from 100+ thousand hectares in each region, according to the results of sowing in 2020). In general, sown areas in 2020 decreased compared to 2018 by 22%, and from 2019 by 15% (by 238 thousand hectares) and amounted to 3,340 million hectares.

6) **Winter rape:** main growing regions* - Odesa, Dnipropetrovsk, Kherson, Khmelnytsky, Ternopil regions (from 60+ thousand hectares in each region, according to the results of sowing for the 2021 harvest). In general, the sown area in 2021 decreased compared to the previous period by 32% (by 415 thousand hectares) and amounted to 881 thousand hectares.

With regard to soybeans and rapeseed, the sown areas (significant reduction in recent years) were significantly affected by the amendments to the TCU adopted in 2017 - "soybean amendments". The norm was abolished in May 2020.

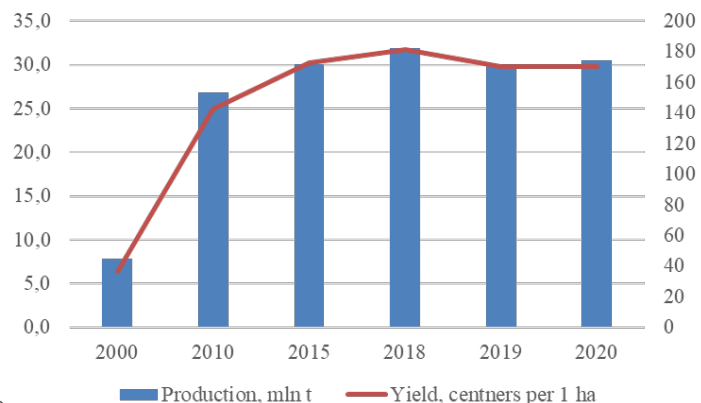
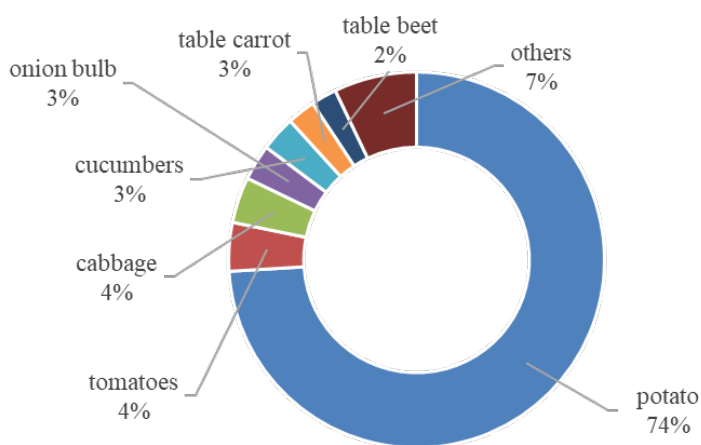
* - data taken on the basis of the results of sowing campaigns for previous years.

Vegetables and fruits/berries. This type of activity is mainly carried out by households. For vegetables it is 94%, for fruits and berries - 83% of the total production. Unfortunately, one of the reasons why we have few enterprises engaged in cultivation/production on an industrial scale is the land market, or rather its absence for a long time. Of course, for the last three years there have been programs of state support for gardening. This program already has an effect - an average of +1.5 thousand hectares per year of new gardens, also from this year will be provided support for the installation of drip irrigation. From July 1, the land market opened for individuals with certain restrictions and the effects directly on these crops should be analyzed over time. **Map with the details of the areas planted by the enterprises per region is in the Annex.**

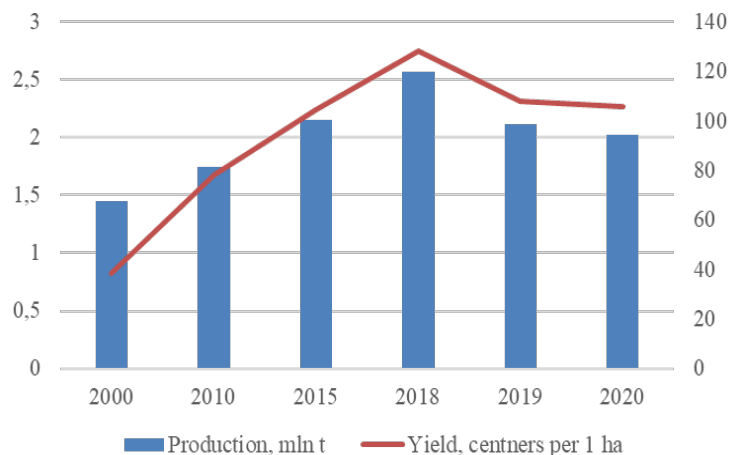
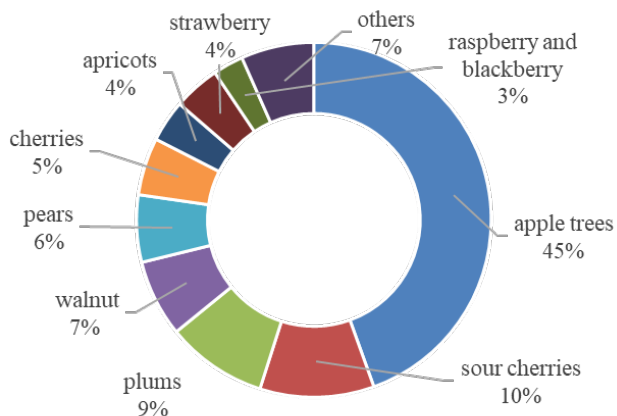
But since 80 +% of fruit and vegetable production is concentrated in households, the level of access to finance, technology, quality equipment and selection is much lower than potentially can be in enterprises, respectively, yield/productivity per hectare is much lower.

In terms of structure and productivity, the situation is as follows:

Structure of the area planted with open-field vegetables, production and yield (2020)



Structure of the area planted with berries, production and yield (2020)



Production volume (in % of total)

Culture	Enterprises	Households
Potatoes	1,87%	98,13%
Vegetables	18,93%	81,07%
Bulb vegetables	12,95%	87,05%
Root vegetables	10,97%	89,03%

1) **Potatoes:** 98,1% are grown by households without the use of high-tech / industrial production. However, it should be noted that on average, the yield of agricultural enterprises per hectare is 47% higher (on average 237,3 c / ha) than households (on average 159,9 c / ha).

2) **Vegetables:** 81% are grown by households without the use of high-tech / industrial production. On average, the yield of agricultural enterprises per hectare is 188% higher (on average 576,7 c / ha) than households (on average 200,3 c / ha).

3) **Bulb vegetables:** 87% are grown by households without the use of high-tech / industrial production. On average, the yield of agricultural enterprises per hectare is 97% higher (on average 279,3 c / ha) than households (on average 141,1 c / ha).

4) **Root vegetables:** 89% are grown by households without the use of high-tech / industrial production. On average, the yield of agricultural enterprises per hectare is 103% higher (on average 391,9 c / ha) than households (on average 193,4 c / ha).

Production volume (in % of total)

Culture	Enterprises	Households
Grain crops	24%	76%
Bone crops	3%	97%
Berry crops	10%	90%
Nuts	1%	99%
Grape	35%	65%

1) **Grain crops:** 76% are grown by households, on average household yield per hectare is 31% higher (on average by 13,9 t / ha) than agricultural enterprises (on average by 10,5 t / ha);

2) **Bone crops:** 97% are grown by households and on average the yield per household per hectare is 4.8 times higher (on average by 9,7 t / ha) than on agricultural enterprises (on average by 1,6 t / ha);

3) **Berry crops:** 90% are grown by households and on average the yield per household per hectare is 1.5 times higher (on average by 7,5 t / ha) than on agricultural enterprises (on average 2,9 t / ha);

4) **Nuts:** 99% are grown by households and on average the yield per household per hectare is 14 times higher (on average by 8,9 t / ha) than on agricultural enterprises (on average by 0,6 t / ha);

5) **Grape:** 65% are grown by households and the average household yield per hectare is 2,5 times higher (on average by 14,4 t / ha) than agricultural enterprises (on average 4 t / ha).

Agricultural companies. General information.

In general, 1,158,301 business entities (of different forms and private entrepreneurs) are registered in Ukraine, of which 72,214 (6.2%) are involved in agriculture.

Looking across regions, we see a relatively even distribution over most of the territory. An exception is the parts of central and southern Ukraine - Odessa, Dnipropetrovsk, Kirovograd, Mykolaiv. Business entities that carry out activities defined by the Classification of Economic Activities 1,11 - 1,63 (hereinafter referred to as enterprises) were taken as the main one. In total - 71332 subjects (as of 02/05/2020).

It should be noted that in Kyiv, there are mainly registered legal addresses / legal entities that can operate in other regions. If divided, then in the city. In Kyiv registered 2363 enterprises, in the Kyiv region - 4285 enterprises.

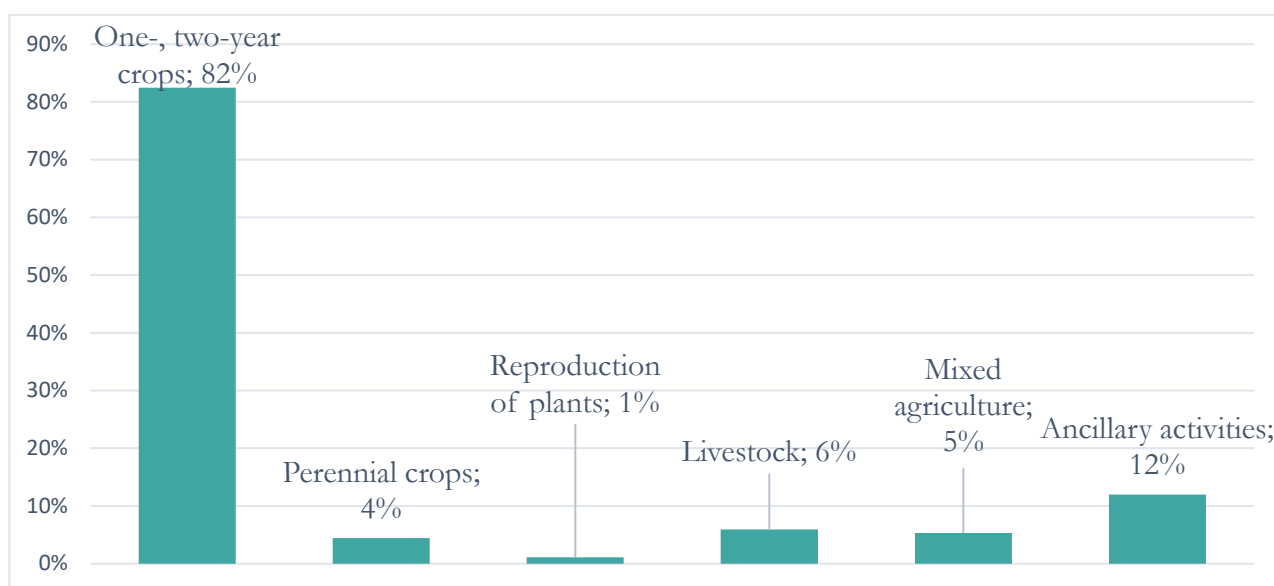
This section takes into account the activities of both legal entities (LLC, ODO, JSC) and individual entrepreneurs. An important point is that not all entities have registered land plots in their ownership or use.

That is, despite the complicated climatic conditions of 2020 and the corresponding financial losses due COVID-19, agrarians endured this period quite steadily.

If you look directly at the types of economic activities carried out by business entities involved in the agricultural sector, the unambiguous preference is given to the cultivation of annuals - cereals, oilseeds, some industrial crops (Table 6), in contrast to gardening, animal husbandry.

* Note: this refers to what percentage of entities from the total number that have a corresponding type of economic activity and carry out such an activity (an entity can have several types of activity and simultaneously engage in animal husbandry, crop production, reproduction, etc.).

Structure of the agricultural sector by type of economic activity



Source: Vkursi BI, State Statistics Service

This, in particular, is caused by the long payback period of investments, the lack of a land market, the possibility of attracting long-term credit funds by small and some medium-sized enterprises for more marginal projects: vegetable growing, horticulture, berry growing (long payback period, the need for irrigation, etc.), animal husbandry (long payback period, difficult access to markets, including external ones, an epizootic situation, tough competition in the market with foreign products).

Given the bias of Ukrainian agricultural producers on growing annual crops - wheat, barley, corn, soybeans, rapeseed and sunflower are mainly grown. These are the most common crops in Ukraine. In total, 56,342 subjects are registered in Ukraine, which are engaged in the cultivation of grain, oilseeds and legumes.

Classification of agricultural enterprises.

If you look at the actual number of enterprises who work / own land, report, etc., then the figure fluctuates in the range of 37-39 thousand entities.

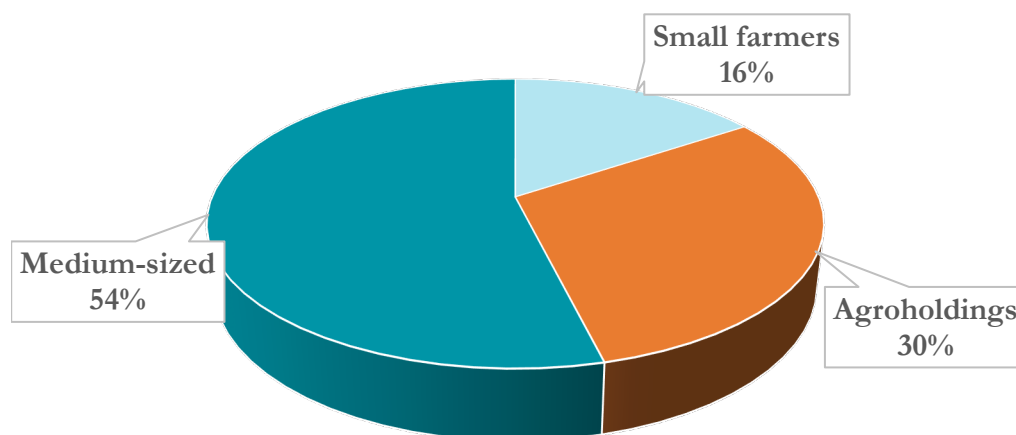
Most of the land, 54% of the total cultivated land, in quantitative terms is about 10,500,000 hectares, cultivated by **medium-sized enterprises** from 1000 to 10,000 hectares. There are close to 5-7 thousand such enterprises.

Agroholdings (over 10,000 hectares) cultivate 5,900,000 hectares (30% of the total). There are about 120 agricultural holdings in Ukraine.

Small enterprises or farmers (land bank from 50 to 1000 hectares) cultivate about 3.0-3.2 million hectares, which is 16% of the total area of land cultivated by enterprises. There are about 31 thousand of them (Table 8-8.1.).

Of course, there are still **individual farmers** - from 2 to 50 hectares, which are cultivated about 6-7 million hectares (the difficulty of determining the exact amount lies in the fact that most are cultivated in the "gray" and are not registered in any way), and land **OSG / vegetable gardens** - 4-5 million hectares (the lack of accounting, inventory does not allow to accurately determine the amount of land and persons, it is cultivated).

Table 8. Agricultural producers by the size on the land bank



Sources: State Statistics Service, UCAB

Agrohholdings.

A group of related legal entities (a collection of a management company and subsidiaries engaged in the production of food products). Often among the beneficiaries of agricultural holdings there are companies with offshore zones of foreign companies.

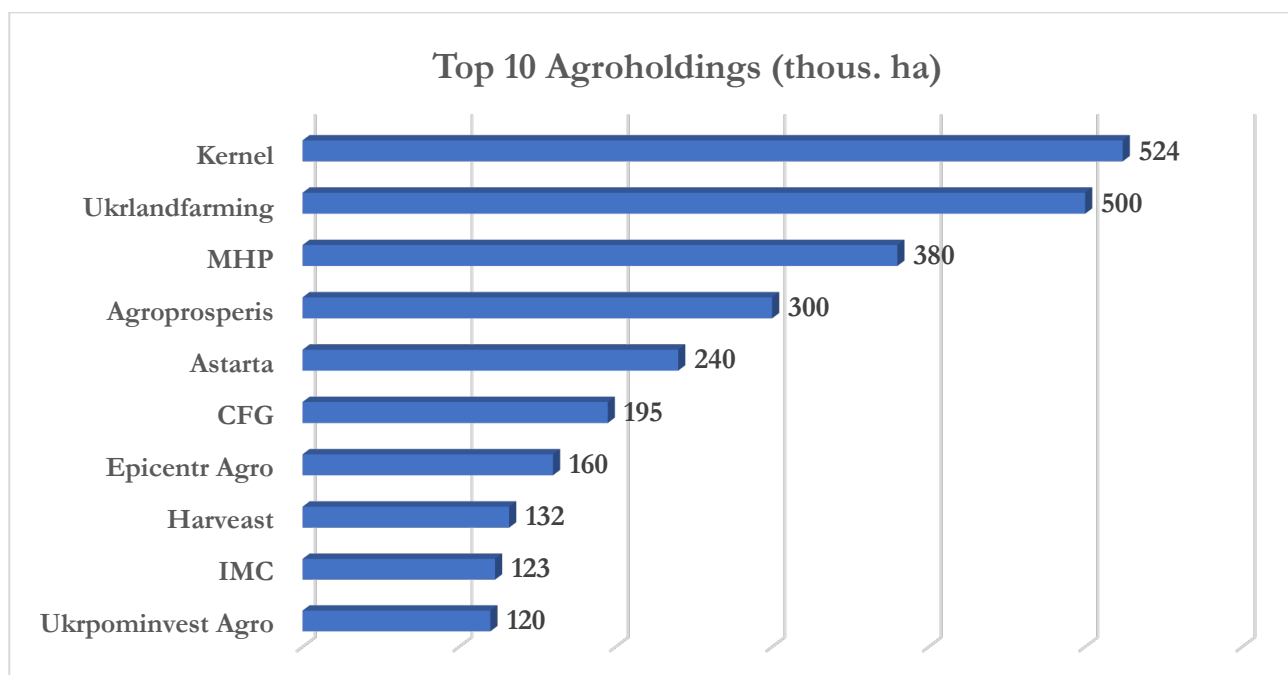
The advantages for an agricultural holding are more opportunities for access to financing, better conditions for cooperation with dealers, manufacturers of equipment and resources (for large resource companies, agricultural holdings are key clients), better production efficiency, including the possibility of purchasing the best samples of equipment, technologies, seeds, etc. When growing crops (corn, barley, wheat, sunflower, etc.), they are export-oriented - through their own trading structures, traders or direct deliveries abroad.

Land bank - from 10,000 hectares, which is subdivided into clusters, and activities are carried out in several regions of Ukraine.

Structure:

- 1) management company with appropriate management - the board, directors for areas, departments, incl. IT or GIS department responsible for the direction of precision farming;
- 2) cluster - production units where the production / cultivation of agricultural products is carried out. In most of the clusters, there are independent divisions, which are provided with their own management, agronomists, engineers, specialists in the field of precision farming, a fleet of equipment, in accordance with the land bank.

Often in the structure of an agricultural holding, as a separate legal entity, there are elevators (with access rails, transshipment points, etc.), livestock farms, processing plants, feed mills, orchards, etc.



Due to the need to manage large assets, a land bank, a fleet of equipment, staff, resources for production (plant protection products, seeds, fuels and lubricants, fertilizers), agricultural holdings are leaders in the use and implementation of IT technologies and precision farming technologies - differentiated application and seeding, GPS control and autopilots, electronic maps, satellite imagery, enterprise management systems, etc. It should be noted that most of the approach to implementation is complex, with data analysis and their use for their work.

Middle-size agricultural companies.

A company, usually with one or more owners (there are also companies whose beneficiary is also companies from offshore zones, but created by the owners themselves - citizens of Ukraine), which overwhelmingly cultivate land within one region or in two adjacent regions of Ukraine. Access to finance and bank lending depends on the financial performance of companies. Oriented both for export (sale of grain from traders) and the domestic market, selling products to processing plants.

Land bank - from 1,000 to 10,000 hectares, in the overwhelming majority without dividing into independent clusters.

Structure - director / owner, office with administrative staff and production unit (engineers, agronomists, etc.). Most of them have one material and technical base with a fleet of equipment in accordance with the area of cultivated land, tanks for storing fuels and lubricants and premises for other resources, and the like. They may have silos (for 10 thousand tons of capacity) in their structure (with a land bank of 2000 ha), dairy farms, orchards.

Enterprises from 3 thousand hectares are more equipped with innovative technologies than from 1 to 3 thousand hectares. 3 out of 4 farmers use direction indicators, GPS, disable of sections and nozzles on seeders and sprayers.

Farmers or small agricultural enterprises.

Enterprises usually with one or more owners (family members), who overwhelmingly cultivate land within the same district or settlement. Access to financing and bank lending is limited due to the lack of high-quality reporting for the bank and the passage of financial monitoring, as well as property for collateral. They are focused on covering domestic demand, due to the complexity of cooperation and the possibility of forming the required batch size, there are difficulties with export.

Land bank - from 50 to 1000 hectares.

Structure - owner / director and family members, who mostly perform basic functions and production processes (depending on the amount of land, tractor drivers or other temporary employees may be hired).

Due to limited funding, minimally automated processes, used equipment is used more, which may not be equipped with modern technologies (GPS, autopilots, etc.). At the same time, quite well equipped with equipment for precision seeding, diff application of PPE and fertilizers.

3. Situation on the Agritech market in Ukraine

Initiators of the introduction of digital technologies.

In most cases, the agricultural holdings are the drivers of implementation of the solutions in the field of precision farming in Ukraine, and startups / companies that want to work in the Ukrainian market try to focus on them:

- there is an opportunity (including financial) to make and launch projects that will pay off or have economic effects in just a few years;
- facing the problem of controlling the cluster, they experience the need for digitalization of processes, maximum collection and processing of information.

But startups and integrators are being created that are focused more on medium-sized agricultural companies and small farmers. After all, the costs of fuel, seeds, equipment are growing, and the costs of staff are growing. Accordingly, these medium-sized enterprises (from 1-10 thousand hectares), and in some cases, farmers will have to analyze their activities, improve work efficiency and introduce precision farming technologies.

From the point of view of hardware and software suppliers, according to Research and Markets, key players from the United States have the biggest influence on the development of the precision farming market, including Deere & Company, Trimble, AGCO Corporation, AgJunction, Raven Industries, AG Leader, Precision Planting, The Climate Corporation, Descartes Labs. In addition, the leaders of the industry include the Swiss company Gamaya (SoyFit), the Canadian corporation Decisive Farming (Optimize RX, TELUS Ag-weather stations). In particular, over the past couple of years, the use of spraying drones from XAG and DJI has begun actively, as evidenced by the growth of orders for the corresponding drones by Drone.UA and Quadro.UA, which are the largest dealers of these brands in Ukraine.

Hardware.

Important component of precision farming is hardware: sensors, robots, etc. At the same time, while analyzing the situation in Ukraine, we encountered a problem that there is almost no statistics available about production of most hardware equipment for agro, let aside the detailing and purpose of use of such equipment. For example, general information about navigation and radar equipment, also includes equipment for river and sea transportation, household items, etc.

However, by analyzing the data of international trade (export-import) of goods of these categories, it is possible to form an indicative situation with the turnover in **the market for the last 4 and a half years (2017-8M 2021).**

We can conclude that, despite the significant development of the agricultural sector, and the interest in automation and digitalization, the overwhelming amount of hardware equipment - GPS trackers, fuel control sensors, spray nozzles, UAVs, meteorological systems, etc., is imported to Ukraine. This is easily confirmed by the list of equipment that is offered by integrators of solutions in the field of precision farming, dealers of machinery and equipment for the agro-industrial complex.

1.GPS (radar / radio navigation and receivers)

The total turnover was 60.8 mln USD, of which 97% was imports (not only for the agricultural sector) - 59.4 million US dollars, and 3% exports - 1.5 mln USD.

Imports from - TOP 5 countries (for the period from 2017 to 08.2021):

- United States (18,9 mln USD);
- China (7,3 mln USD);
- Mexico (6,8 mln USD);
- The Netherlands (4,6 mln USD);
- Germany (2,6 mln USD).

Exports to - TOP 5 countries (for the period from 2017 to 08.2021):

- Moldova (0,2 mln USD);
- Switzerland (0,2 mln USD);
- Poland (0,12 mln USD);
- Belarus (0,11 mln USD);
- Hungary (0,07 mln USD).

2. Sensors for monitoring liquids / flow meters (fuel, water, etc.).

The total turnover was 83.5 mln USD, of which 91% of imports (not only for the agricultural sector) - 76.4 million US dollars, and 9% of exports - 7 mln USD.

Import from - TOP 5 countries (for the period from 2017 until 08.2021):

- Germany (18 mln USD);
- Switzerland (12.4 mln USD);
- USA (6.3 mln USD);
- Italy (5.9 mln USD);
- Netherlands (5.3 mln USD).

Export to - TOP 5 countries (for the period from 2017 until 08.2021):

- Russia (0.7 mln USD);
- Kazakhstan (0.6 mln USD);
- South Africa (0.4 mln USD);
- Georgia (0.4 mln USD);
- Slovenia (0.4 mln USD).

3. Meteorological stations.

The total turnover was 10.2 mln USD, of which 94% imports (not only for the agricultural sector) - 9.5 million US dollars, and 6% exports - 0.6 mln USD.

Import from - TOP 5 countries (for the period from 2017 until 08.2021):

- Germany (2 mln USD);
- China (1 mln USD);

- Finland (1 mln USD);
- United Kingdom (1 mln USD);
- USA (0,8 mln USD).

Export to - TOP 5 countries (for the period from 2017 until 08.2021):

- Belarus (0,2 mln USD);
- Russia (0,14 mln USD);
- Germany (0,06 mln USD);
- Moldova (0,04 mln USD);
- Azerbaijan (0,04 mln USD).

4. Sprayer / sprinkler nozzles

The total turnover was 19.3 mln USD, of which 85% imports (not only for the agricultural sector, but excluding printing components) - 16.8 mln USD, and 15% exports - 2.5 mln USD.

Import from - TOP 5 countries (for the period from 2017 until 08.2021):

- USA (2,8 mln USD);
- China (2,7 mln USD);
- Germany (2,7 mln USD);
- Italy (2,2 mln USD);
- Israel (1,6 mln USD).

Export to - TOP 5 countries (for the period from 2017 until 08.2021):

- Russia (1,6 mln USD);
- Poland (0,3 mln USD);
- Moldova (0,25 mln USD);
- Belarus (0,1 mln USD);
- Kazakhstan (0,09 mln USD).

If we talk about equipment suppliers and solution integrators, now almost every dealer of agricultural machinery of a foreign brand represented in Ukraine has its own technical service and specialists in the field of precision farming, and is also a supplier of such equipment or provides services for re-equipping old equipment. Also, there are a number of companies on the market that provide comprehensive implementation of precision farming technologies, support, analytical support, and the like.

Annex II contains a list of companies that provide hardware for the agricultural sector of equipment for precision farming, installation on equipment or re-equipment, maintenance and integration into the work of an agricultural enterprise. The list of companies and startups is not exhaustive, however, the listed market players who have already introduced their products to the Ukrainian market or have become major solution providers in Ag-Tech.

Software

Today, precision farming is no longer only about equipping machines with autopilots, disconnecting sections or field maps. To purchase modern, expensive machinery and equipment for precision farming is not enough. It is important to be able to structure all the collected information, input it into a single system, and then, on the basis of the processed data, build an algorithm for all subsequent actions. And it is at this particular stage companies face a lot of problems.

As can be seen from the survey data in section 3.1. data structuring, that is, the use of software for data processing and the use of more information solutions (NDVI, satellite images, forecasting programs, FMS) is mainly implemented in the agricultural holdings or enterprises of more than 3000 hectares.

Large agricultural holdings independently develop individual software solutions for accumulating information and making decisions specifically for the needs of their own equipment - seeders, sprayers, tractors, spreaders, focusing on their land bank in certain regions, etc. An example is DigitalAgriBusiness (Kernel), Digital Agritech (MHP), AP Agronomist (Agroprosperis), etc.

Small and some medium-sized enterprises have difficulties with data collection, as they do not have the technological infrastructure and sufficient expertise to consolidate and analyze data. Also, most do not have a full-fledged IT team. At the same time, for small enterprises, the main need is access to modern analytics functionality, such as satellite imagery or crop control, which in general can be covered with cloud solutions.

Cloud solutions are more profitable for small agricultural enterprises and farmers, as they help to reduce the cost of administration and purchase of servers, software licensing, backup and security. Along with this, the farmer and farmers are active users of tablets, smartphones, respectively, there is an opportunity at any time through cloud solutions to see the situation on the main production processes.

At the same time, the active users of mobile applications are not only business leaders, but also the agronomists equipped with a smartphone / tablet with constant Internet access, access to cloud services and software, where information from weather stations, soil analyzers, satellite navigation data, etc. is available. The maximum effect from the use of all these agricultural gadgets is achieved by using professional applications and software for agronomists.

Mobile applications for agronomists can be divided into the following groups:

- Directories (knowledge base, to search for information);
- Diaries;
- Calculators (applications for calculating the seeding rate or fertilizer application rate);
- Agronavigators (determine the optimal path of machinery, detect uneven processing, monitor plant growth);
- Area meters;
- Recognizers (application to determine the type of plant, insect pest, disease, etc.).

There is only a limited number of working systems that can unify all this data. Programs work according to different standards and are often difficult to synchronize, there are difficulties with the

integration of hardware. Also, small and medium-sized enterprises are rarely provided with their own analyst or programmer for processing and analyzing data sets.

Annex II contains software products that are actively used by Ukrainian farmers, and a number of mobile applications (for smartphones). The list is not exhaustive, given the active development of the agricultural sector and the availability of other software products for agriculture which are less focused on production processes and more on trade, document flow, etc.

3.1. Survey results

As a part of the study, we conducted telephone survey of the Ukrainian agricultural producers. **500 agrarians from** all over Ukraine were interviewed, except for those from the temporarily occupied Autonomous Republic of Crimea and some districts of Donetsk and Luhansk.

Respondents were divided into the following categories of agricultural enterprises:

- up to 1000 ha - farmers;
- 1-3 thousand hectares - small / medium agricultural enterprises farmers;
- 3-10 thousand hectares - average agricultural enterprises;
- 10+ thousand hectares - large agricultural enterprises / agricultural holdings.

The survey questionnaire was formed with consideration of results of the interviews with the Dutch companies, and based on own experience in the field of precision agriculture of the specialists involved. The survey was conducted to assess application of the following technologies:

1. The use of electronic field maps, the percentage of digitized fields, the formation process;
2. The use of direction indicators, autopilots or steering controls during various technological operations - sowing, tillage, spraying, as well as the percentage of equipment equipped with such technologies;
3. The use of GPS trackers and fuel control sensors, as well as the percentage of machinery provided with such equipment;
4. Use of satellite maps or NDVI in the activities of the agricultural enterprise;
5. Use of drones, including for spraying operations;
6. Use of soil moisture sensors and meteorological stations;
7. The use of software that predicts the appearance of pests and diseases;
8. Use of farm management systems.

Note: *for the enterprises with more than 10 thousand hectares (agricultural holdings), the maps are were not included. The reason is that the holding structures, after 1-3 years of testing this or that technology in one of the clusters, apply it to all other clusters in all regions of Ukraine. The display of data on the map was of minimal informative character and could be misleading.*

Below are the results displayed on the map of Ukraine. The maps show the percentage of farmers in each region who said they were using a particular technology. Also, in order to obtain more detailed information, in case of a positive answer, the agrarians were asked clarifying questions about the number of machines equipped with one or another system, implementation methods, software used, etc.

Electronic field maps. (*)

This means the presence of digitized field maps with plotted contours, recorded location, field area, which is actually a basic element for the introduction of tools for precision farming and land bank management.

Farmers up to 1,000 hectares - a very small percentage of use, about 16.9% of respondents in this segment. But farmers who generate these electronic field maps apply it for 92% of their total area. That is, once this technology is introduced on the enterprise, almost all land banks of the farmer become digitized.

- Forming method:** GPS tracker and cadastral map
- Self Formation & Services**—44% & 56%

Figure 1. Using of electronic field maps by farmers

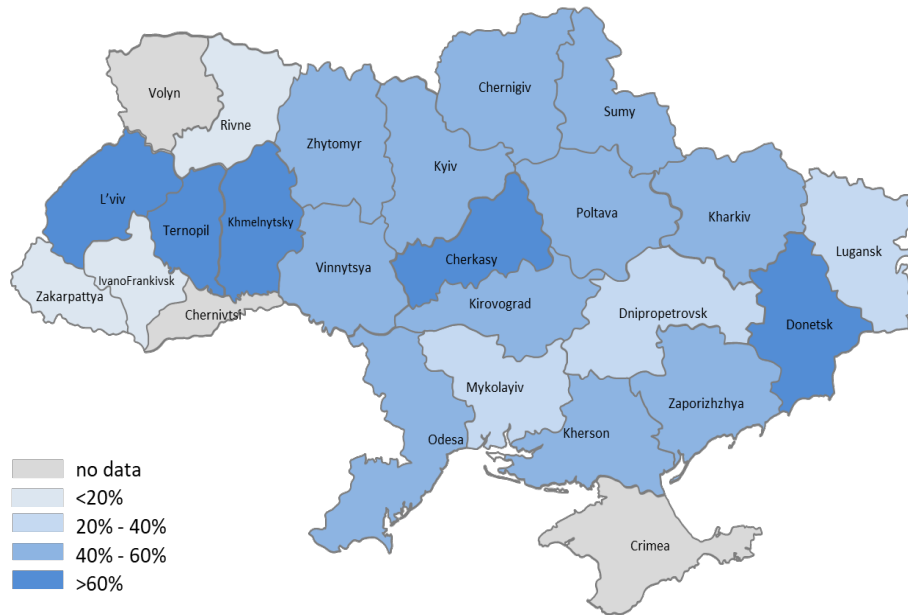


Farms size 1-3 thousand hectares - the percentage of use is 47.6% of the respondents in this segment.

Among farmers who confirmed forming electronic field maps - the percentage of digitized fields averages 91% of the total area.

- Forming method:** GPS tracker and cadastral map
- Self Formation & Services**—35% & 65%

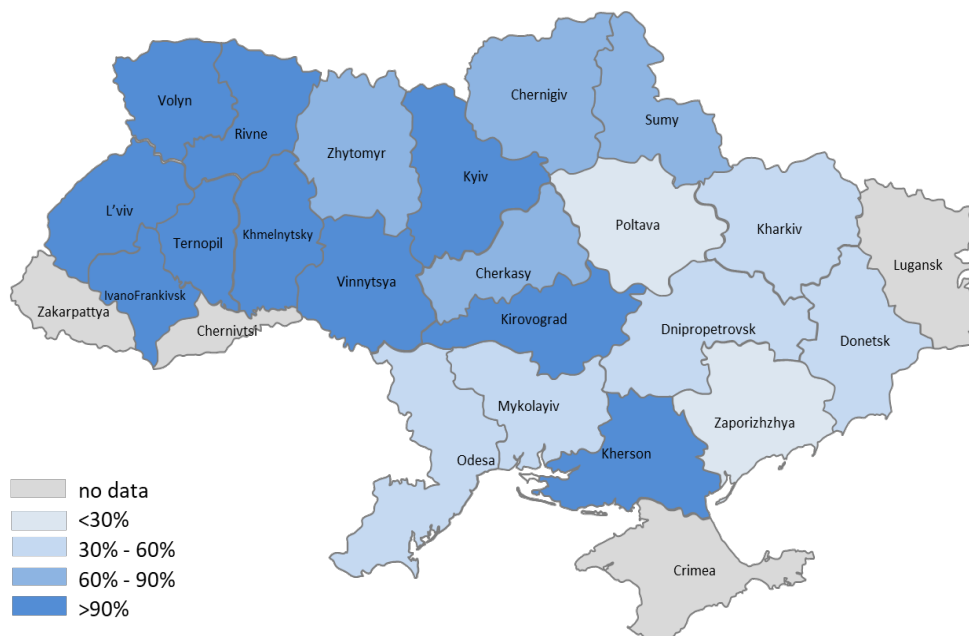
Figure 2. Using of electronic field maps in small agricultural company



3-10 thousand hectares - the percentage of use is 67.9% of the respondents in this segment. Among those farmers who confirmed that forms these electronic field maps - the percentage of digitized fields averages 97% of the total area. Among other categories of enterprises, enterprises have 3-10 thousand hectares of the highest percentage of digitized land.

- **Forming method:** GPS tracker and cadastral map
- **Self Formation & Services**—57% & 43%

Figure 3. Using of electronic field maps in medium-sized agricultural company



10+ thousand hectares - the percentage of use is 85.7% of the respondents in this segment. Among those farmers who confirmed that forms these electronic field maps - the percentage of digitized fields averages 94% of the total area. Also, as part of the survey, we communicated with the UCAB holdings - there are more GPS, RTK or satellites, and the maps were formed on our own and the average percentage of digitized fields is 98-99%.

- **Forming method:** GPS tracker and cadastral map
- **Self Formation & Services**—50% & 50%

Heading indicators / autopilot.

Designed to control agricultural machinery with maximum processing accuracy and as a result of reducing fuel consumption, fertilizers and seed.

Farmers up to 1000 ha - on average every 3rd farmer uses this technology, 34.8% of the respondents in this segment.

On average, 51% of farmers' equipment is equipped with this technology. However, given the more limited financial resources for the purchase of new equipment, which is already equipped with such systems, for the most part, this equipment is installed on the suction equipment.

Operations on which it is applied:

- Sowing**–61,4%
- Tillage**–44,3%
- Spraying**–65,7%

Figure 4. Using of heading indicators/autopilot by farmers



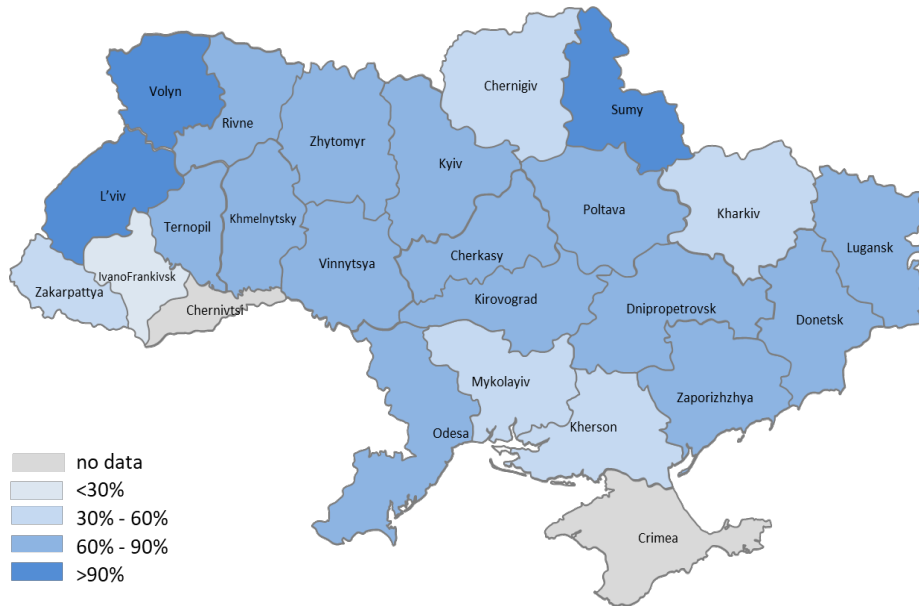
1-3 thousand hectares - the percentage of use of the equipment by 67% of the respondents in this segment.

Farmers who have confirmed the availability and use of this technology at their own enterprise, 71% of the fleet is equipped with direction indicators or autopilots.

Operations to which:

- Sowing**–75%
- Tillage**–63,2%
- Spraying**–67,1%

Figure 5. Using of heading indicators/autopilot in small agricultural company



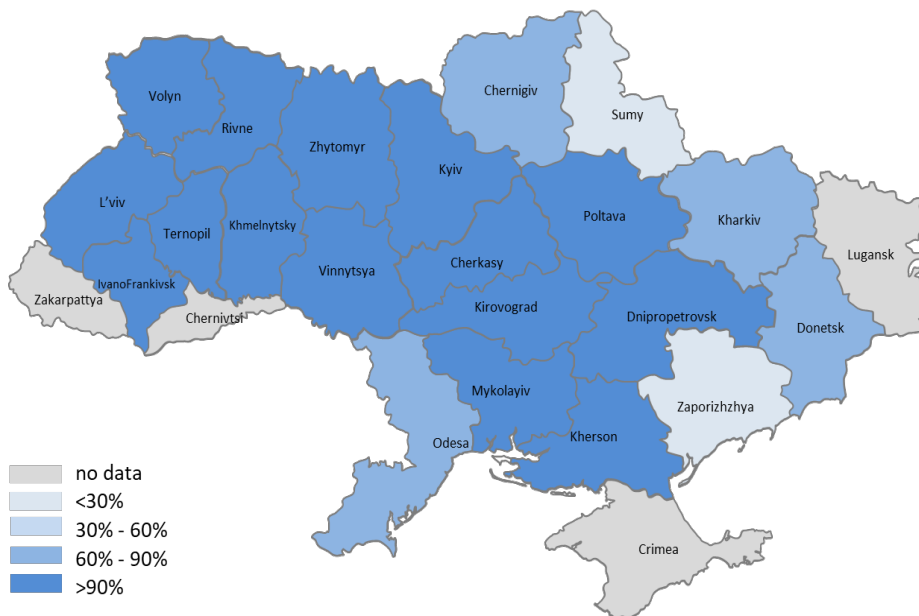
3-10 thousand hectares - the percentage of use of the equipment by 85,7% of the respondents in this segment.

Agrarians who have confirmed the availability and use of this technology at their own enterprise, 76% of the fleet is equipped with direction indicators or autopilots.

Operations on which it is applied:

- Sowing—81,3%**
- Tillage—79,2%**
- Spraying—83,3%**

Figure 6. Using of heading indicators/autopilot in medium-sized agricultural company



10+ thousand hectares - the percentage of use of the equipment is 92% of the respondents in this segment, among the surveyed members of UCAB - 100%.

At the enterprises which have confirmed existence and use of this technology 92% of park of equipment are equipped with course indicators or autopilots or systems of parallel management, at members of UCAB - 93%

Operations on which it is applied:

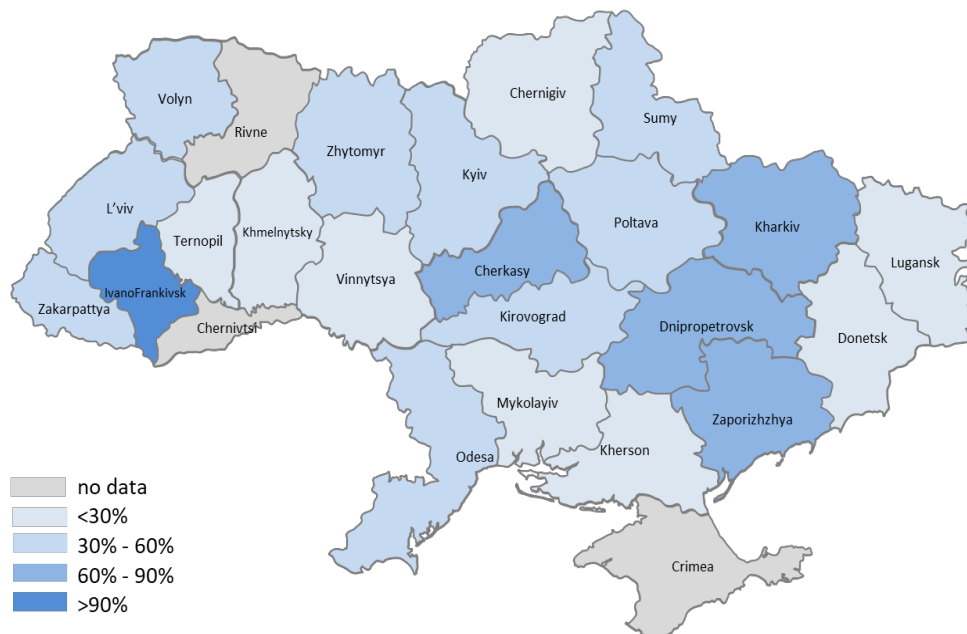
- Sowing – 61,4% (UCAB members – 100%)
- Tillage – 44,3% (UCAB members – 100%)
- Spraying – 65,7% (UCAB members – 100%)

GPS monitoring (tracker) and fuel control sensors.

The maintenance of agricultural machinery accounts for a significant part of the finances, given how much fuel is consumed. For these purposes, fuel monitoring and control systems are used in agricultural machinery. Also, on the other hand, agricultural enterprises need to solve other tasks related to agricultural activities, in particular, the fight against theft, as well as compliance with the law on fuel circulation.

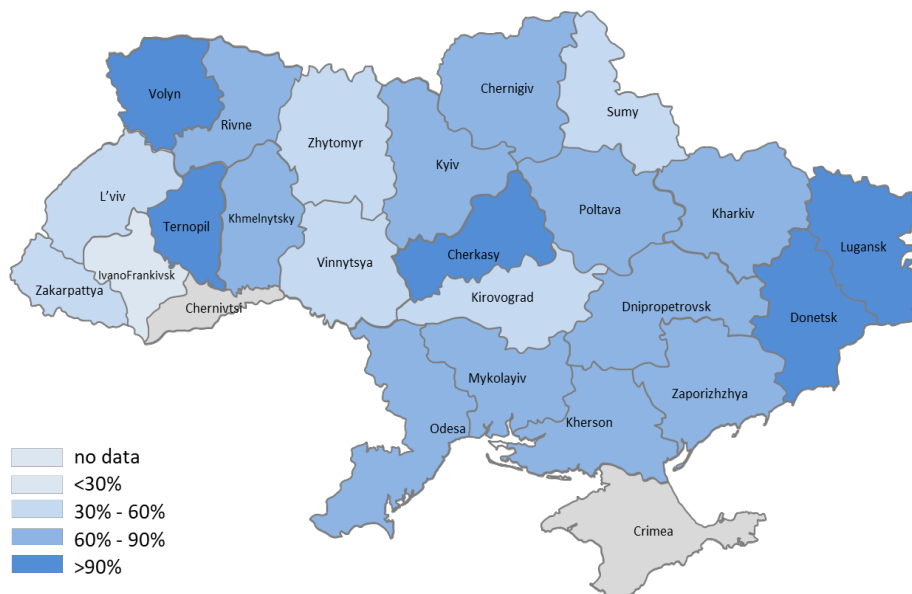
Farmers up to 1000 hectares - the percentage of use is 39.3% of the respondents in this segment. Farmers who have confirmed the availability and use of this technology at their own enterprise, 61% of the fleet is equipped with GPS-trackers and fuel control sensors.

Figure 7. Using of GPS monitoring (tracker) and fuel control sensors by farmers



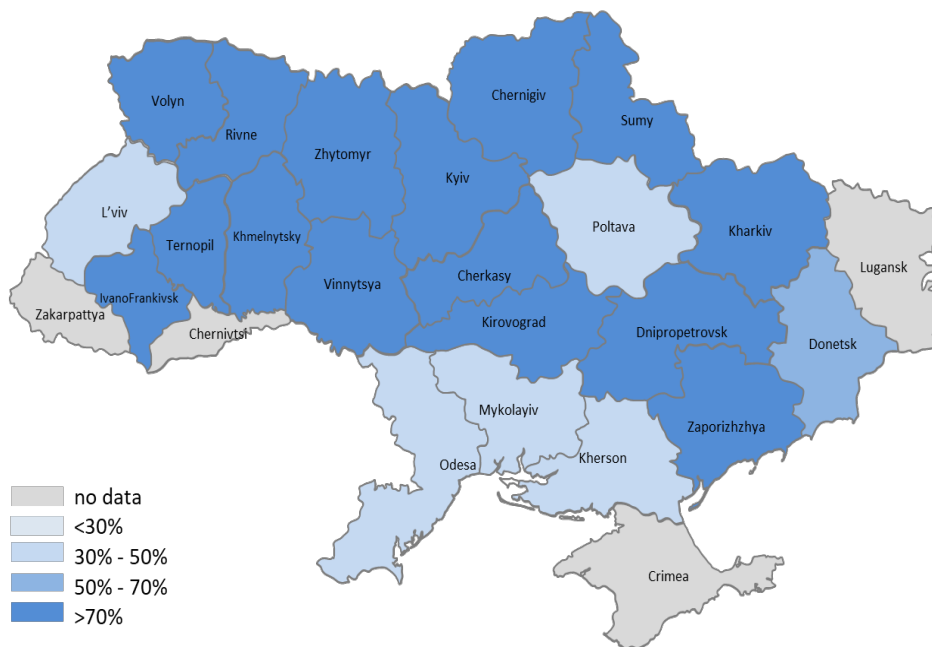
1-3 thousand hectares - the percentage of use is 66.1% of the respondents in this segment. Agrarians who have confirmed the availability and use of this technology at their own enterprise, 75.2% of the fleet is equipped with GPS-trackers and fuel control sensors.

Figure 8. Using of GPS monitoring (tracker) and fuel control sensors in small agricultural company



3-10 thousand hectares - the percentage of use is 83.9% of the respondents in this segment. At agrarians who confirmed existence and use of this technology at own enterprise, 91% of park of equipment are equipped with GPS-trackers and gauges of control of fuel.

Figure 9. Using of GPS monitoring (tracker) and fuel control sensors in middle-sized agricultural company



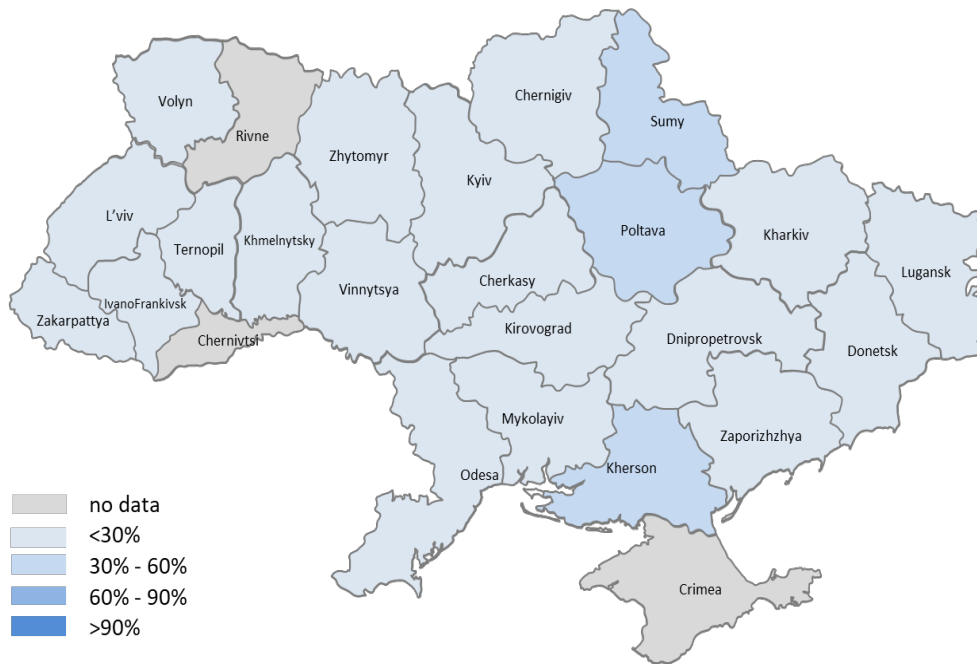
10+ thousand hectares - the percentage of use is 98% of those surveyed in this segment. Farmers who confirmed the presence and use of this technology at their own enterprise, 97.8% of the fleet is equipped with GPS-trackers and fuel control sensors. It should also be noted that enterprises also often equip not only agricultural machinery that works directly in the field, but also trucks and grain trucks.

Satellite maps / NDVI.

The NDVI index, or vegetation index, which is used to quantify vegetation cover during the growing season, varies throughout the season and has different rates during growth, flowering, and maturation due to fluctuations in chlorophyll pigment content in plants. Satellites take pictures in different spectral ranges and record the level of chlorophyll. This data is then processed, analyzed, and the completed result of the field performance is displayed in the system.

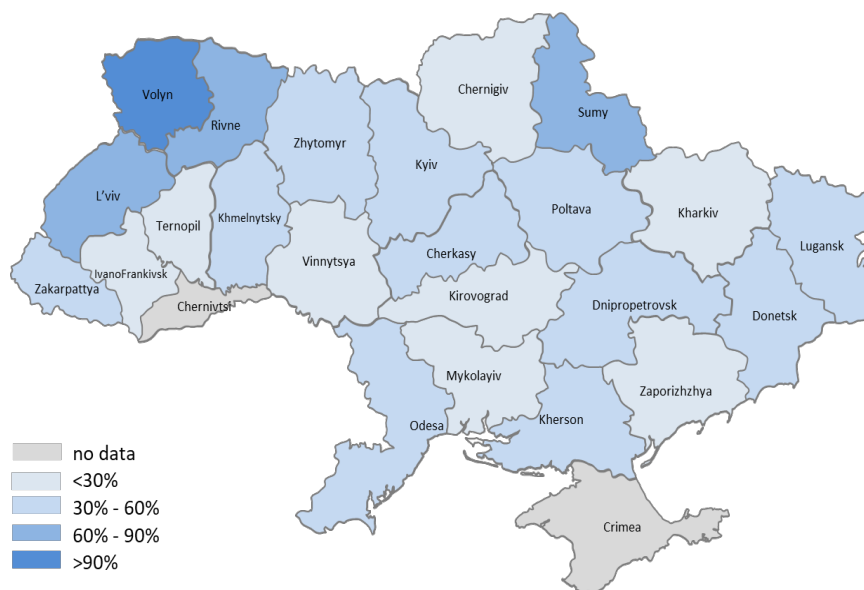
Farmers up to 1,000 hectares - a very small percentage of use, about 16.4% of the respondents in this segment.

Figure 10. Using of satellite maps by farmers



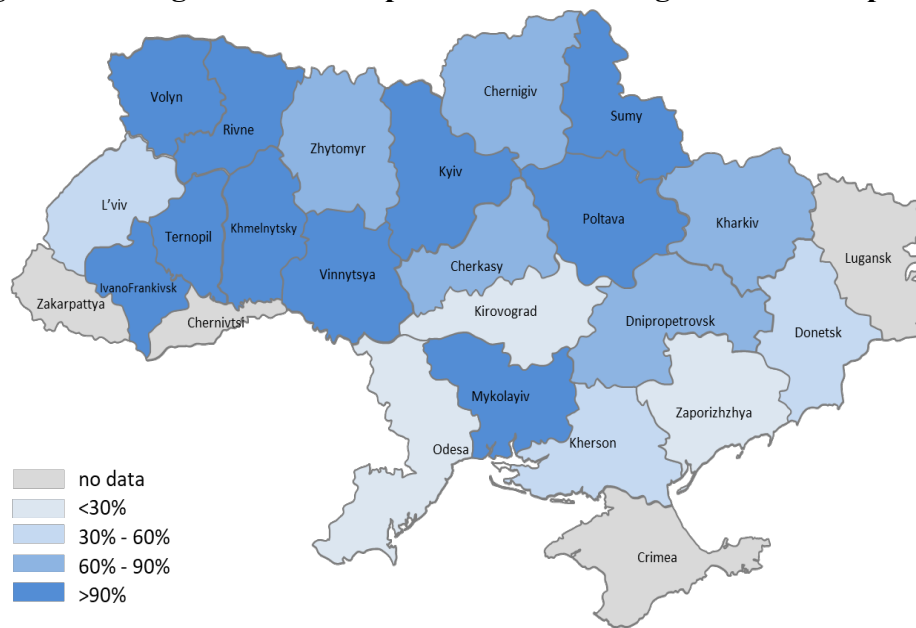
1-3 thousand hectares - percentage of use is by 37.9% of the respondents in this segment.

Figure 11. Using of satellite maps in small agricultural company



3-10 thousand hectares - percentage of use - 71.4% of the respondents in this segment.

Figure 11. Using of satellite maps in middle-sized agricultural company



10+ thousand hectares - the percentage of use is 92.9% of the respondents in this segment.

TOP-Services used by the surveyed farmers:

- Cropio
- OneSoil
- AgroOnline
- Climate FieldView

Agroholding companies often independently carry out satellite monitoring, order satellite images and process them on their own (sometimes even within the framework of their own software) – Sentinel, Landsat.

Drone/ UAV.

Farmers up to 1000 hectares - a very small percentage of use, about 10.9% of the respondents in this segment.

Use the services of service companies to fly over their fields - 27%.

Figure 12. Using of drones by farmers



1-3 thousand hectares - percentage of use of equipment - 22% of the respondents in this segment.

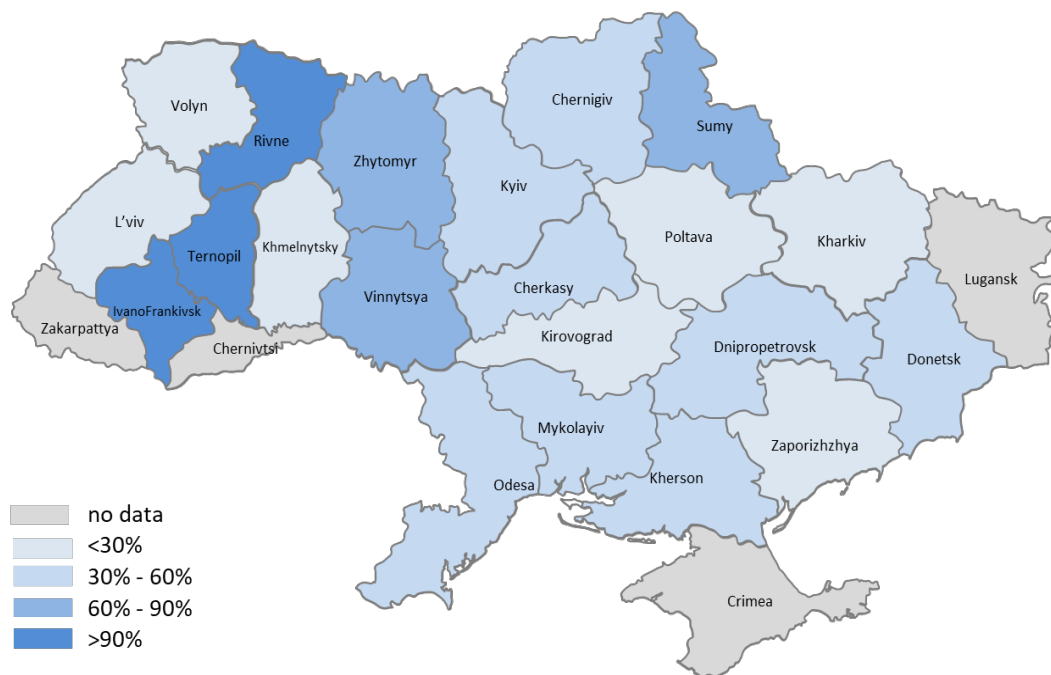
Use the services of service companies to fly over their fields - 12%.

Figure 13. Using of drones in small agrarian company



3-10 thousand hectares - the percentage of use of the equipment by 67.9% of the respondents in this segment. Use the services of service companies to fly over their fields - 8%.

Figure 14. Using of drones in middle-sized agrarian company



10+ thousand hectares - the percentage of use of the equipment by 85.7% of the respondents in this segment.

Use the services of service companies to fly over their fields - 10%.

If we talk about the presence of drones in enterprises, then on average, according to the survey, the situation is as follows:

Up 1000 ha	1
1-3 thous.ha	0,94
3-10 thous.ha	1,36
10+ thous.ha	3,5+

It should be noted that large enterprises may have separate drones for the security service, but they are not included here. Some farmers and agricultural companies use sprayer drones (services), but mainly for sunflower desiccation operations.

Weather station or soil moisture sensor.

Farmers up to 1000 hectares - a very small percentage of use, about 16.9% of the respondents in this segment.

Figure 15. Using of weather station or soil moisture sensor by farmers



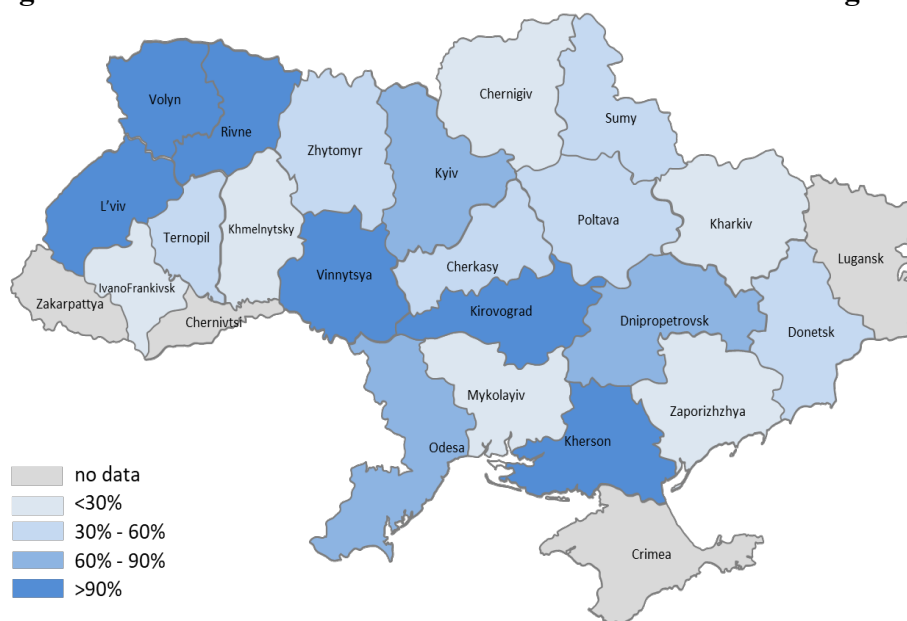
1-3 thousand hectares - the percentage of use of the equipment by 30.8% of the respondents in this segment.

Figure 16. Using of weather station or soil moisture sensor in small agrarian company



3-10 thousand hectares - percentage of use of the equipment by 51.8% of the respondents in this segment.

Figure 17. Using of weather station or soil moisture sensor in middle-sized agrarian company



10+ thousand hectares - the percentage of use is 78.6% of the respondents in this segment.

Average availability of weather stations and soil moisture sensors at the enterprises:

Up 1000 ha	1,9
1-3 thous.ha	1,5
3-10 thous.ha	1,4
10+ thous.ha	5,7

- 39% of farmers constantly / regularly use soil moisture sensors or weather stations;
- Soil moisture sensors: most farmers still focus on meteorological data and meteorological stations own or order monitoring as a counterbalance to soil moisture sensor;
- With the sensors there are problems with the constant maintenance of soil moisture sensors in the field (for example, can run into equipment during technological operations);
- Network of 130 weather stations and 50 soil moisture sensors with hourly updates one of the largest networks Kernel has set up to monitor the situation in their fields.

Forecasting programs (pests, diseases).

Software where the algorithm should analyze photos of crops with suspicious spots on leaves, pests, etc., providing appropriate recommendations.

Farmers up to 1000 hectares - only 5.5% of respondents in this segment said they used such programs.

Figure 18. Using of forecasting programs by farmers



1-3 thousand hectares - percentage of use is 18.5% of respondents in this segment.

Figure 19. Using of forecasting programs in small agrarian company



3-10 thousand hectares - the percentage of use of the applications 21.4% of the respondents in this segment.

Figure 20. Using of forecasting programs in middle-sized agrarian company



10+ thousand hectares - the percentage of warehouse use is 42.9% of the respondents in this segment.

Pest and disease forecasting programs are of minimal interest due to:

- the impossibility of taking into account all factors of the weather and the climatic zone;
- absence of certain local diseases, pests;
- have quite predictable forecasts, which the agronomist already knows based on the weather and experience in these conditions.

Farm management system (FMS) (*).

FMS – program for automation and control of agricultural production processes at the enterprise, geospatial binding of information about fields and plants, work with cartographic data, accounting of lease agreements, integration with accounting systems (different products may have telemetry units, control of agricultural operations) - FMS functionality gives the ability to plan production processes by establishing a logical connection between the blocks with configured access to information, as well as the ability to create management reports on the results of work.

TOP-Services used by the surveyed agrarian:

- Cropio
- Climate FieldView
- OneSoil
- AgroOnline

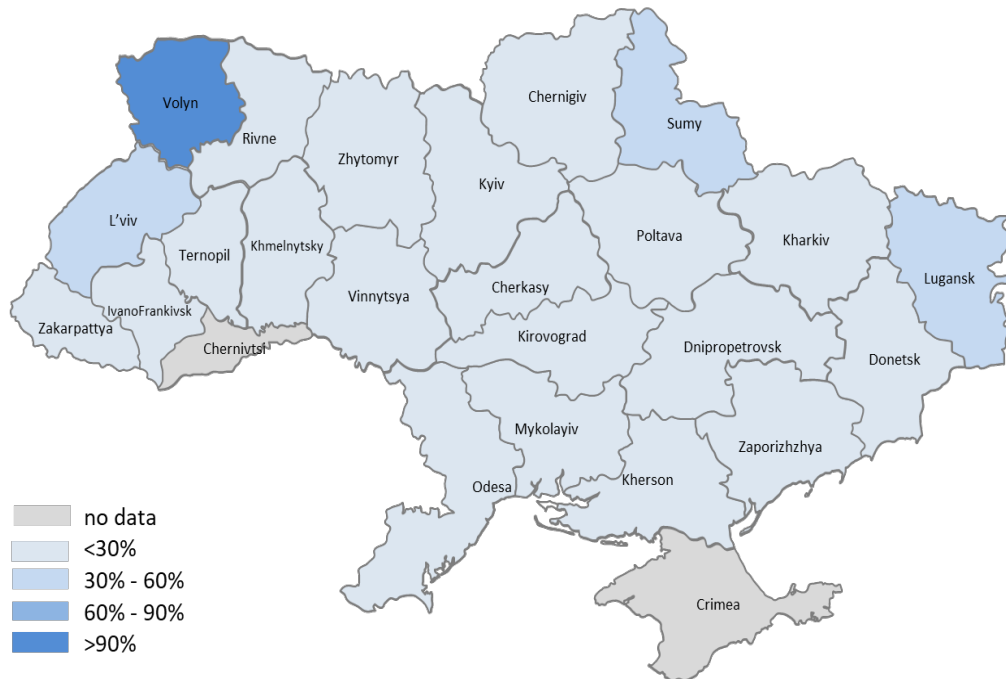
Farmers up to 1000 ha - almost do not use, only 2.5% of respondents in this segment said that they have / use such software.

Figure 21. Using of farm management system by farmers



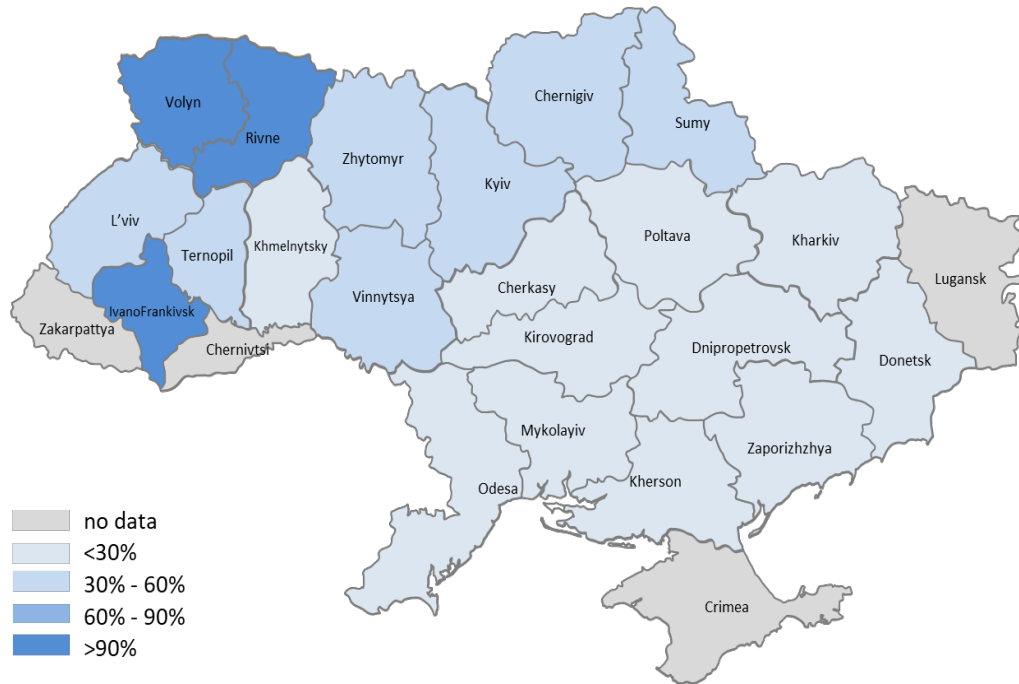
1-3 thousand hectares - the percentage of use of such software was 9.3% of respondents in this segment.

Figure 22. Use of farm management systems by the small agrarian companies



3-10 thousand hectares - the percentage of use of such software was 26.8% of respondents in this segment.

Figure 23. Using of farm management system by middle-sized agrarian companies



10+ thousand hectares - percentage of use of such software was 64.3% of respondents in this segment.

Many holding companies have their own developments or management systems, integration into 1C, etc. Also, due to their complex structure, a large fleet of equipment/machines, land and other assets, operational processes, employees - it is the holdings that are the key users of such complex systems.

(*) IMPORTANT NOTE

The survey also included the following questions:

- Do you use disconnect sections/nozzles on seeders or sprayers?
- Do you map field data?'
- Do you carry out differentiated application of fertilizers and pesticides, or do you apply at a differential rate?

After we interviewed farmers up to 1000 and 1-3 thousand hectares and evaluated the results of the survey, we had some questions about the use of the indicated technologies by these categories of farmers. For the high-quality and efficient use of these technologies and equipment, an important component is the availability of electronic field maps and FMS, where this data can be stored, and then according to which a map is formed for differential application, other technological operations or the formation of field analytics. And after we summarized the results, we faced significant inconsistency in the results on electronic fields maps and FMS and the results about use of indicated technologies by farmers up to 1000 and 1-3 thousand hectares.

There could be several possible explanations for this situation:

- 1) Ignorance / misunderstanding of the sequence of introduction and application of certain technologies, and the necessary prerequisites for their quality use. That is, before carrying out

differentiated application of pesticides or other "point" operations in the field using technology, the farmer must first have digitized field data, mapping data, etc;

- 2) Misunderstanding of the technology. Some farmers could perceive the question, in the context of using it not within the same field, but the use of different sowing rates, application of plant protection products, etc. on different fields.
- 3) Target audience in the survey. During the survey, communication in these segments was conducted mostly with directors or owners who potentially could not know the entire component of the technical operation, in contrast to agronomists. However, at such enterprises, the owners / managers quite often perform several functions, including agronomist, engineer or machine operator, and sometimes all together.

To be able to determine the indicators of the application of these technologies in the enterprise more precisely, it will be necessary to conduct internal analysis of the activities and communicate with each company separately.

In this regard, these results were not included in the final report, because, in our view, at this stage they could distort and provide incorrect data.

Key findings of the study per categories of farmers:

Up to 1000 ha – farmers

- 85% don't have electronic field maps. At the same time, the farmers who have formed these maps are digitizing more than 90% of their lands;
- Only 1/10 use satellite images / NDVI and no more than 20% use their own weather stations and soil moisture sensors in their activities;
- These companies (in the majority) don't think about complex farm management systems – implementation of such a system requires both a financial component and a previously formed geoinformation base (at least) for your own company;
- Problems with the integrated and consistent use of precision farming technologies;
- Complicated access to financing for the possibility of purchasing more expensive equipment

1-3 thous.ha:

- Situation with field maps is better compared to farmers (47% versus 17%) and with a high percentage of digitization -almost every second farmer surveyed in this segment has digitized 90% + of their fields;
- In this segment, more than half of the respondents also use autopilots, GPS;
- About 38% use satellite imagery / NDVI;
- Problems with the integrated and consistent use of precision farming technologies (low percentage of use of management systems);
- Complicated access to financing for the possibility of purchasing more expensive equipment and machinery.

3-10 thous.ha:

- maps were formed by 67% + respondents, with a high% digitization -91% of their fields; 8 out of 10 farmers in this segment use autopilots, GPS trackers;
- much more interested in using satellite images / NDVI and meteorological stations / weather data;
- more consistent and deliberate implementation of technologies.

10+ thous.ha:

- Taking into account peculiarities of the work, implementation of the technology in all clusters is centralized (in most cases);
- The testing and scaling process for all clusters takes up to 3 years (Kernel's case);
- Digitized 93% + fields (using RTK, drones), 90 +% of the equipment with autopilots, GPS trackers, fuel control sensors;
- Using of satellite images, drones (both independently and by hiring appropriate companies), implementation of management systems such as FieldView, Cropio.

4. Policy and Legal situation

Main policies regarding precision farming

Rules and regulations applicable to the import

Certification, registration, and localization requirements

First of all, it should be noted that in Ukraine in general there is no regulation or individual policies, programs, directions in the context of precision agriculture. There are common regulations applied to the types of equipment (hardware) when put into circulation in Ukraine (production and release on the market of own equipment or imports).

In most cases, hardware used in precision farming is defined by Ukrainian law as radio frequency / radio equipment or electromagnetic equipment. These are the same GPS trackers, sensors, etc. in addition, there is a separate regulation when using a UAV.

Main legislation regulating this field of activities.

1. Technical regulations of radio equipment - Resolution of the Cabinet of Ministers of 24.05.2017 No.355 (harmonized act in Ukraine in accordance with the provisions of the Directive of the European Union No.2014 / 53 / EU) - this Technical Regulation establishes requirements for radio equipment (or radioelectric) that is placed on the market and put into operation in Ukraine regardless of the form of supply, including the sale of radio equipment way.

It should be noted that the provisions of the Technical Regulation approved by this resolution do not apply to radio equipment that is installed and intended for use in the construction of wheeled vehicles - tractors, combines, sprayers, etc.

What equipment does it apply to:

‘Any product(s) that, according to their characteristics, are assigned (a) for the emission and / or reception of radio waves, or the composition (delivery set) of which includes devices intended for it, is considered as radio-electronic equipment and emitting device - REE (RD). The presence of REE in products affects: Bluetooth, WiFi (or 802.11xx, where xx are letters of the Latin alphabet, or their combination), GSM, 3G (or CDMA, UMTS, WCDMA, etc.), 4G (LTE, LTE-U, etc.), RFID (NFC), Wireless, Radio Frequency (RF, RF Transmitter), Transceiver.» - clause 1 of the Decision of the NCCIR dated 13.02.2018 No. 78 On the Procedure of import from abroad and sale of radio-electronic equipment and emitting devices in Ukraine’.

To be placed on the market, manufacturers must either carry out a conformity assessment of the radio equipment, or have the results of such assessment. A declaration of conformity is drawn up on radio equipment and marked with a sign of conformity to technical regulations. The Regulation provides for a conformity assessment procedure stipulating analysis of technical documentation, expertise, etc. It should be noted that the procedure is the same as in the EU.

The importer (any individual or legal entity that is a business entity - a resident of Ukraine and which puts into circulation on the territory of Ukraine equipment originating from another country) must make sure that:

- the manufacturer has carried out an appropriate conformity assessment procedure;
- the equipment does not violate the requirements for the use of the radio frequency resource of Ukraine;
- available technical documentation;
- the equipment is marked with a sign.

To import (import to Ukraine) such equipment, the company should check the following:

- availability of equipment in the General Register;
- absence in the list of types (species) prohibited for use and import into the territory of Ukraine;
- availability of a declaration of conformity with the requirements of the Technical Regulations for radio equipment.

Distributors (dealers / distributors, if they do not act as importers) need to make sure the radio equipment is marked with a mark of conformity to technical regulations, accompanied by documents provided for by this Technical Regulation, instructions and safety information.

It should be noted that software installed in the radio equipment (for example, firmware that is written on an integrated microcircuit and controls the operation of the radio module, a personal computer control program), which may affect the compliance of the radio equipment with the requirements of the regulations, and the manufacturer intends and provides the user with the opportunity to freely change or replace it, the software version is given in the declaration of conformity. The manufacturer sets the format for the description of the software version in such a way that it can be identified.

In Ukraine, several organizations are authorized to conduct tests, accept documents, etc. regarding compliance with the norms of this Technical Regulation:

- State Enterprise "All-Ukrainian State Research and Production Center for Standardization, Metrology, Certification and Consumer Protection";
- Research and production collective enterprise "Standard-Service";
- Limited Liability Company "Certification Body "Center for Certification of Materials and Products";
- State Enterprise "Ukrainian State Center of Radio Frequencies";
- Omega Testing Center Limited Liability Company;
- State Enterprise "Ukrainian Research Institute of Radio and Television";
- State Enterprise "Odessa Research Institute of Communications";
- Limited Liability Company "ASU Certification Expert Center".

Approximate terms of conformity assessment / certification works:

- Decision-making on the application / processing of the Applicant's application - up to 3 working days;
- Conformity assessment / certification - up to 30 working days;
- Testing of product samples - up to 15 working days.

It should be noted that these deadlines are met if the Applicant complies with all legal requirements and the full package of documents.

The cost of work on assessing the conformity of products is calculated based on the actual labor costs in accordance with the Resolution of the Cabinet of Ministers of Ukraine dated July 12, 2017 No. 514 (in the case of an order from subjects of state ownership). The cost of working with private structures is negotiated individually.

At the same time, the value of the cost of work is affected by:

- a list of technical requirements for compliance with which the conformity assessment / certification is carried out (which determines the scope of tests and, accordingly, affects their cost);
- certification schemes / module for assessing compliance with technical regulations (different schemes / modules provide for different procedures)
- the number of declared types and models of products, their design differences, which affects the complexity of the analysis of the submitted documentation, preparation and execution of documents for conformity assessment / certification.

2. Technical Regulation on Electromagnetic Compatibility of Equipment - Resolution of the Cabinet of Ministers of 16.12.2015 No.1077 (developed on the basis of Directive 2014/30 / EC of the European Parliament and of the Council of 26 February 2014 on harmonization of the laws of the Member States on electromagnetic compatibility) to equipment in order to ensure the provision on the market of Ukraine of equipment that meets the appropriate level of electromagnetic compatibility.

The regulation is the same as in the EU directive - applies to any equipment or stationary installation, may cause electromagnetic interference or whose operation may be affected by such interference. The exceptions are:

- equipment covered by the Technical Regulations for radio equipment (described above)
- products of aviation technology, and intended exclusively for use in the air, namely: aircraft, except for unmanned aircraft; unmanned aerial vehicles;
- single sets are made by special order;
- which does not create electromagnetic radiation.

In Ukraine, several organizations are authorized to conduct tests, accept documents, etc. regarding compliance with the norms of this Technical Regulation:

- State Enterprise "Western Expert and Technical Center of the State Labor Service";
- State Enterprise "Kharkiv Regional Research and Production Center for Standardization, Metrology and Certification";
- Limited Liability Company «TESCO»;
- State Enterprise "All-Ukrainian State Research and Production Center for Standardization, Metrology, Certification and Consumer Protection";
- State Enterprise "Kyiv Expert and Technical Center of the State Labor Service";
- Research and production collective enterprise "Standard-Service";
- Limited Liability Company «Promelectronics»;
- State Enterprise "Certification Testing Center for Heating Equipment";
- State Enterprise "Vinnytsia Research and Production Center for Standardization, Metrology and Certification".

A total of **35 organizations**, a complete list behind the link - <https://astr.me.gov.ua/CommonDocs/Docs/View/33009/49995/33023>

Conformity assessment procedures and obligations of manufacturers and obligations of importers and distributors when placing such equipment on the market and price forming do not differ significantly from those described in relation to the Technical Regulations of Radio Equipment.

Drones.

The drone is subject to a conformity assessment (certification) procedure in accordance with **Technical regulations of radio equipment - Resolution of the Cabinet of Ministers of 24.05.2017 No.355.**

Directly, the use of UAVs in Ukraine is currently regulated at the level of aviation rules, but in general the legal framework in the field of UAVs still needs to be finalized..

As of now in Ukraine, the Order of the State Aviation Service - "Rules for the use of airspace of Ukraine", which provides for the following:

- 1) Personal use: if you have a drone whose maximum take-off mass (MTOM) does not exceed 20 kg, and use it for entertainment or sports activities, you can use it without registration (Article 39 h. 8 TCU) and obtaining special permits subject to a number of rules, namely: to fly within line of sight, not exceeding 120 m, at a speed not exceeding 160 km / h, outside the areas of prohibitions and restrictions, avoiding crowds and dense buildings;
- 2) Commercial use If you need to use a drone for commercial purposes, take photos or videos in the city, fly in a restricted area, or otherwise go beyond the norms of "free" use of drones, you must coordinate your activities with the relevant authorities and services, and apply for the use of airspace.

It should be noted that there are [areas](#) over which it is forbidden to fly, or you need to get permission ().

Now it is expected to consider and adopt a bill, which introduces a number of changes to the legislation in the field of UAVs. In particular, the definition is prescribed: "unmanned aircraft system", "unmanned aerial vehicle", "remote pilot". In addition, they establish cases when it is not necessary to obtain an operator certificate, provide for the formation of the foundations for creating a simplified accounting system for drones that do not require obtaining certificates, and establish separate requirements for the training and competence of a remote pilot. Also, the bill takes into account another equally important nuance, namely, the pilot's liability insurance to third parties. This is very relevant, especially if flights take place within settlements, industrial facilities or infrastructure, over crowded places.

After the adoption of these changes, it is planned to update the aviation rules, where it is planned:

- Solve the issue of registration and certification of drones;
- Introduced universal criteria for determining the class, safety and technical requirements for drones;
- Define requirements for operators, etc..

Customs rates.

Regarding customs rates when importing equipment or components to Ukraine for installation or use, the main types of equipment (hardware) were surveyed.

Type	HS code	Customs rate
GPS trackers	8526 10 00 90 8526 91 20 90 8526 92 00 90	0% + 20% VAT 0% + 20% VAT 10% (EU, EFTA, Canada, Israel, Britain – 0%) + 20% VAT
Fuel control sensor	9026 10	0% + 20% VAT
Sprayer nozzles	8424 90 80 00	2% (EU, EFTA, Canada, Israel, Britain – 0%) + 20% VAT
Weather stations	9025 80 20 90 9025 80 40 90	5% (EU, EFTA, Canada, Israel, Britain – 0%) + 20% VAT
Drones / quadcopters*	8525 80 30 00 (for example Phantom 4) (for drone-sprayer used 8802 11 00 00)	0% + 20% VAT

* the process of determining the HS code depends on a number of factors, therefore, other codes can be used.

As for the FMS, forecasting programs and other software, its provision in Ukraine is considered a service and accordingly does not require certification or other registration actions. Also, in this regard, there is no HS code, as for equipment or accessories.

The implementation of equipment or software, or representative functions are usually carried out through business entities registered in Ukraine. **Most of these business entities are registered as:**

- **Limited liability company** (presence of an office / representative office in Ukraine in the status of a legal entity with the payment of profit tax - 18%, or in the case of small financial turnovers, on a simplified taxation system - 5% of income);
- **individual entrepreneurs** (have a contract for representing interests in Ukraine from a particular foreign company with payment of taxes on a simplified system - 5% of income).

In general, it should be noted that in the field of precision farming, the use of drones and other aspects related to the provision of services related to precision farming are not burdened with any kind of regulation. On the contrary, in the current situation, due to the minimal influence of the state on this area of business, this sector is developing in Ukraine. Companies are being created that provide spraying services from drones, a whole range of services (including flights from drones) related to GIS, installation and operation of sensors, sensors, software development for the agricultural sector.

Intellectual property in software.

It is worth noting that in a situation of active growth of the IT sector in Ukraine and synergy with the agricultural sector, there is also the issue of protecting intellectual property rights not only for hardware, which in most cases are protected by patents or industrial designs, but also for software.

Software in Ukraine can be protected by copyright or patent.

Copyright.

The advantage of this method is that copyright arises from the moment the object is created and does not require any additional actions, and registration is not mandatory. To protect the copyright of a computer program, only the existence of the copyright of the work is required. Also, it can apply to the program or its individual parts. However, it should be noted that copyright protection applies exclusively to the text of the code, and not to the functions of the program code.

Patent.

With the help of a patent, the essence contained in the basis of a computer program is protected, its internal content, that is, it gives the exclusive right of ownership to the idea itself and the ability to prevent inconsistent use. But the process of obtaining a patent takes a very long time, and the software must meet the criteria for patentability.

5. Opportunities and challenges

Currently, the Ukrainian agricultural sector faces a number of challenges and shortcomings that have arisen over the past few years.

1. Opening of the land market: the positive reform that has been expected for a couple of decades, albeit in a limited format:

- Until January 1, 2024, only citizens of Ukraine can buy agricultural land with a total area of not more than 100 hectares;
- Legal entities (agricultural holdings, companies, banks) cannot officially buy land until 2024.

At this stage of land reform, we see, first of all, the need for agro-it solutions (software and hardware) to address a number of issues related to:

- registration of all land plots for lease of enterprises and their synchronization with contracts, shareholders, etc;
- drawing the contours of land plots on cadastral maps / electronic maps of fields (this is relevant for both private and state structures);
- carrying out revaluation of land according to the new method of determining monetary valuation;
- carrying out agrochemical analysis of lands and certification of fields.

Land reform + Opening of the land market enables communities and regions to earn more money and generates demand for quality information about land and its quality. It is expected that opening of the land market will stimulate investments from owners of other successful businesses who will expand their approach to apply more modern practices in agriculture.

2. The increase in the cost of machinery and elevator equipment due to the global rise in prices for metals and ores, respectively, significantly increased the already planned costs for the construction of a grain storage facility. According to the Ukrainian plant of elevator equipment "Lubnymash" - almost doubled the cost of metal, rolled products and other components for the elevation of elevators.

Also, in the case of a wider application of soil cultivation technologies - low-till, no-till, strip-till, it is necessary to partially update trailed equipment (tillage and sowing) within agricultural enterprises and the purchase of appropriate equipment for precision farming.

3. Climate change: According to the National Academy of Sciences of Ukraine, climate change has significantly affected the agricultural sector of Ukraine:

- in recent decades, the borders of the country's natural and climatic zones have actually shifted by 100-150 km to the north
- growing conditions in the traditional subzone of the northern steppe (Dnipropetrovsk, Kirovograd and other regions) in recent years should already be attributed to the subzone of

the southern steppe. According to the climatic regime, the steppe part of Ukraine is gradually approaching dry subtropics;

- fluctuations in maximum temperatures during the growing season can lead to the need to irrigate even those crops that previously did not require it (for example, wheat), which will lead to a significant increase in financial costs;
- there was a shift in the cultivation of maize and sunflower to the north (towards Polesie), where earlier agro-climatic conditions did not allow the use of these crops, since they did not have time to ripen due to insufficient temperature.

In this regard, in addition to joining the Green Deal, it is planned to implement a set of measures in the field of irrigation. In 2019, the Government approved a strategy for irrigation and drainage in Ukraine, in accordance with this strategy, in 2020 it adopted a plan of measures to implement the strategy. The main measures are:

- inventory of reclamation infrastructure,
- energy audit of pumping stations,
- audit of the use of reclaimed lands,
- introduction of the institute of organization of water users,
- development of feasibility study,
- creation of a business entity.

Also, it is planned to carry out legislative changes and create water user organizations (private entities), which will be transferred to the use / ownership of part of the irrigation / irrigation infrastructure. This will accordingly encourage such entities (mostly farmers) to invest in irrigation and economic use of water.

4. Green Deal: new EU policy aimed at significant reforms and changes related to the environment may have a significant impact on the Ukrainian agricultural sector. Accordingly, the readiness of Ukrainian farmers to comply with the requirements set out in the «Green Deal», including carbon footprint, needs to be assessed.

5. Soil degradation: This is a problem that, combined with climate change, will have a significant impact on the agricultural sector if not addressed. However, there are a number of factors that affect land degradation:

- suboptimal ratio of land and structure of sown areas;
- delayed land reform, which led to a violation of agricultural technologies and reduced soil fertility;
- underestimation of the real threat of degradation processes, their misunderstanding in society, the inability of farmers to maintain soil fertility;
- lack of fertilizers per hectare of land (low use of organic and mineral fertilizers, availability of chemical ameliorants), and, as a consequence - a deficient balance of nutrients;
- lack of effective mechanisms for enforcing land protection laws;
- lack of an objective price of soil resources, fair taxation and an appropriate fund of funds needed to maintain soil fertility;

- insufficient level of state management of land resources, lack of state, regional and regional soil protection programs.

At the same time, the introduction of the technology of the so-called "lean farming" has great potential in Ukraine. Ukrainian agricultural companies are actively experimenting with zero tillage and other soil conservation technologies. Some companies, especially in the south, operate almost exclusively with no-till. Companies actively using lean soil cultivation methods include Kernel, Vinnitsa Agro-Industrial Group, Agro Generation, I&U Group, KSG Agro, Agromino, UkrAgroCentre, Ukrlandfarming, and others.

At the same time, an additional assessment is required of the scale of investments required for a wider application of such technology in Ukraine. So, for example, dedicated no-till seeders are at least 30% more expensive than standard agricultural seeders.

Also, as long as there is a cultural barrier to the use of lean tillage, as farmers are accustomed to traditional methods of tillage (formed and verified technical maps, availability of equipment, etc.) and it is difficult to switch to new technologies, especially considering the efficiency risks during the conversion period. With traditional tillage equipment available, farmers can sometimes revert to traditional tillage methods, while lean tillage takes time to reap the benefits of improving soil quality.

6. Staff and qualifications: To implement more soil-saving tillage technologies - low-till, no-till, strip-till, to replace the traditional tillage technology (deep loosening, cultivation), there are not enough specialists to implement it. Also, in the direction of soil conservation, in the context of the agricultural sector, and land cultivation on technologies - low-till, no-till, strip-till, there are no curricula in universities. Also, there is currently an insufficient level of training and the number of so-called "field managers" in enterprises that would have a sufficient level of knowledge in engineering, agronomy, precision agriculture for integrated implementation and determining the effect of new technologies of tillage, sowing, diffusion of PPE and fertilizers.

7. Water availability/ water pollution: Ukraine is on the list of countries with a shortage of water resources. We rank 32nd out of 40 European countries on this indicator - only 4% of the country's territory is occupied by water bodies. Water reserves are replenished mainly through precipitation. Therefore, the abnormal heat and the excess of temperature by 1-2 degrees on average from the norm (according to NASU), which we observe more and more often in recent years, only exacerbates the water deficit. In the last ten years alone, the amount of precipitation in Ukraine has decreased by 15-27% in the summer. And less water means an increase in the concentration of pollution in it.

At the same time, there are problems with financing the costs (capital and current) of measures for the treatment of return waters and the protection and rehabilitation of soils, groundwater and surface water. In some areas, we only return to the funding figures of 2008 or 2013.

<i>thous. USD</i>	Current expenditures		Capital investments	
Year	wastewater management	protection and remediation of soil, groundwater and surface water	wastewater management	protection and remediation of soil, groundwater and surface water
2008	498 721,1	35 916,4	115 919,1	98 413,0
2009	538 314,5	30 029,9	110 315,7	50 178,2
2010	629 431,7	59 531,7	91 832,9	39 990,3
2011	673 545,4	74 091,3	90 165,7	79 890,4
2012	774 388,7	92 933,4	105 869,4	67 564,6
2013	771 989,7	115 404,5	104 264,4	40 622,5
2014	374 104,1	64 315,8	74 810,0	23 995,0
2015	267 914,7	46 479,9	34 229,1	15 655,6
2016	302 329,0	46 402,9	44 962,4	16 278,6
2017	298 713,1	36 436,4	47 278,9	47 574,1
2018	356 425,0	47 717,6	62 690,4	53 492,3
2019	402 694,2	58 663,9	64 958,1	63 775,0
2020	401 000,4	58 844,4	58 888,1	95 306,9

Regarding the state of water resources, the State Water Agency monitors and environmental assessment of water resources, which is reflected on the interactive map - <http://monitoring.davr.gov.ua/EcoWaterMon/GDKMap/Index> .

At the same time, there is currently a problem of accounting for the use of water resources, as not all water users, even businesses, are required to report on water use and, accordingly, there is no control over the use and level of waste disposal.

Also, in some regions of Ukraine arable land makes up more than 80% of the territory. This destroys the natural water "buffer" - the ability of the landscape to accumulate and store water, affects water quality and its balance in general. Therefore, drought in the fields is observed in May.

8. Lack of quality mobile internet all over Ukraine: There is a problem of covering the entire territory of Ukraine with high-quality Internet. One of the reasons is the rise in the cost of taxes for Internet providers, telecom companies, etc. for the use of frequencies. Also, there are difficulties in obtaining permits for their use. In this regard, farmers are quite often forced to independently resolve issues of communication, navigation, etc., using RTK stations or starting cooperation with Internet operators.

Legal&Tax problems:

1. Tax innovations. The sharp increase in the role of the agricultural sector over the past 5-7 years is actually the result of tax changes that have created more favorable conditions for work, taxation and administration. However, a number of legislative initiatives have already been registered from MPs to double the tax burden on the agricultural sector, complicate the administration of VAT and a number of other problems and legislative innovations that could significantly affect the profitability of the agricultural sector.

2. State support for the agro-industrial complex: the amount of state support for the agricultural sector in the last 2 years will not exceed 160 million US dollars, which is ten times less than subsidies to the agricultural sector in the EU. At the same time, a program of state support for agricultural producers in the field of irrigation was launched, especially for the purchase and installation of drip irrigation systems.

At the same time, at this stage, there are no direct or indirect subsidies from the state, support programs in the case of using / purchasing equipment / ordering services in the field of precision farming.

Suggestions and recommendations (types of equipment, segments, customer profile, regions of cooperation)

According to the results of a survey of agricultural / farms (Section 3), it can be concluded that the average percentage of equipment and use of innovative technologies (described) in production is as follows:

Category of enterprises	Average percentage
up to 1 thous. ha	27%
1-3 thous. ha	41,9%
3-10 thous. ha	59,3%
10+ thous. ha	76,8%

The most potential categories of enterprises for the promotion of precision farming technologies (described above) can be medium-sized enterprises from 1 to 10 thousand hectares.

In the vast majority of cases, these enterprises are twice as far ahead of small agricultural enterprises and farmers up to 1,000 hectares in almost all types of technologies.

Also, medium-sized enterprises have better access to finance and a larger financial cushion for long-term investments / projects, for example in strip-till, no-till, or investing in re-equipment / purchase of equipment. At the same time, these companies, given the higher percentage of penetration of technologies into production processes, have experience in implementing new technologies.

However, medium-sized enterprises in the segment of 1-3 thousand hectares, have a significant subsidence in the application / implementation of software products, in contrast to hardware (GPS, sensors, injectors, etc.). For example, in the segment of 1-3 thousand hectares, only 37.4% of respondents use data from satellite images / NDVI, weather stations / humidity sensors use only about 31%, and forecasting and FMS programs use 18.5% and 9.3%, respectively . For comparison, in the segment of 3-10 thousand hectares the figure is almost 1.5-2 times higher.

Category of enterprises	Satellites / NDVI	Meteorological sensors / soil moisture sensors	Pest prediction programs	FMS
1-3 thous. ha	37,9%	30,8%	18,5%	9,3%
3-10 thous. ha	71,4%	51,8%	21,4%	26,8%

In addition, questions arise about the presence of analytical and IT departments in medium-sized enterprises (like those of agricultural holdings), which would be able to process the collected information in software products in a quality manner.

Regarding the regions, taking into account current climatic trends, cultivation of key export crops (corn, barley, sunflower, etc.) will gradually concentrate in the north of Ukraine and certain central regions, due to the unpredictable weather situation in the south of Ukraine and need to invest in the renewal of equipment park for new technologies of soil cultivation, irrigation, in order to continue growing traditional agricultural crops. At the same time, it is the southern and western regions of Ukraine that use more meteorological systems and soil moisture sensors, which, in particular, are associated with the presence of industrial producers of potatoes and some vegetables and fruits in these regions.

As for other types of technologies, their application is relatively evenly distributed throughout the territory of Ukraine, as can be seen from the maps in section 3.1. Also, based on research data, tables, personal experience and understanding of the current situation in Ukraine was prepared a **matrix of opportunities** (Annex III) where, in the context of each surveyed technology, groups of enterprises and opportunities for cooperation were indicated.

Current market opportunities (for Ukrainian and Dutch companies)

Currently, a significant part of the niches in the field of precision agriculture in Ukraine already have market representatives providing services or hardware / software support - that is, they are already competitive markets. There are a number of areas that in light of recent legislative changes will require the use of high-tech products.

1. Land reform: Due to the opening of the land market in Ukraine, businesses and farmers are more likely to invest more in soil conservation and use of more sustainable technologies.

Also, it is planned to adopt the Land Conservation Procedure. The procedure determines the organizational basis for conservation of degraded and unproductive lands, the economic use of which is environmentally hazardous and economically ineffective, as well as technologically contaminated land plots where it is impossible to obtain environmentally friendly products, and presence of people on these land plots is dangerous to their health.

2. Irrigation reform: It is planned to adopt a number of laws, in particular "On the organization of water users and stimulation of hydrotechnical land reclamation", stipulating transfer of the maintenance of the lower-level amelioration infrastructure to water users, as well as creation of mechanisms for safe investment in the reclamation infrastructure, creation and development of private lower-level irrigation systems. In order to achieve this, it is necessary to create appropriate directions for the maintenance of amelioration infrastructure by water users and attract investments in it through establishment of water user organizations to maintain and renew reclamation infrastructure facilities and construct new facilities of reclamation systems by farmers and their associations.

At the same time, such associations will be interested in constant monitoring of water resources, the state of reclamation systems and control over the use of water in their own fields.

3. Green Deal: Considering that about 40% of Ukrainian goods are exported to the European markets, entrepreneurs will be faced with the need to adapt to new European trends. First of all, this applies to agricultural producers. Especially in the context of applying the Carbon Border Adjustment mechanism, as well as:

- Reducing use of hazardous pesticides by 50%;
- Reducing use of antibiotics in animal husbandry by 50%;
- Reducing use of fertilizer by 20% and removing nutrients from the soil by 50%.

Another component of the new strategy is a target to increase organic production in the EU to 25% by 2030. Last year in Ukraine, according to the Ministry of Economy, the total amount of land with organic status was about 468 thousand hectares, which is only 1.1% of the total area of agricultural land in the country.

Accordingly, if this Agreement is signed, it will become necessary to change agro-technological processes in a very quick manner, and to make a rather significant transition to organic production, which will require appropriate technologies and knowledge.

Exhibitions, forums, conferences, media in precision farming in Ukraine

In the past few years in Ukraine not only individual seminars and workshops on Ag-Tech but also individual events dedicated to digitalization and innovative technologies in the agricultural sector have begun to be held more often as part of major events and conferences.

Furthermore, within the framework of field events, we can observe more and more often that operation of drones, sprayers with sections disconnection or sowing is demonstrated using precision seeders, with sowing at different depths, at different speeds, etc.

At the same time, training programs from Ag-Tech companies are being launched, incl. in cooperation with universities.

Conferences / Events

1. **UCAB. Agrotechnology** – field event with comparative demonstration of technique in operation:
 - sowing demo plots of corn and sunflower with seeders of various brands at different depths and speeds. The sunflower sowing process was mapped using the innovative Climate FieldView platform;
 - operation of sprayers, with disconnection of sections;
 - operation of sprayer drones;
 - participation in the exhibition area of Ag-Tech companies;
 - work of combines with mapping and control of the harvested crop, etc..
2. **Battle of the Agrotitans** - field demonstration of agricultural machinery in Ukraine:
 - - sowing demo plots of sunflower and corn hybrids;
 - - work of trailed agricultural machinery;
 - - participation in the exhibition area of Ag-Tech companies;
3. **HiTech AGRO (AGRO)** - exhibition offers its participants and guests a division according to thematic areas:
 - software for the automation of production processes in agriculture and field computers;
 - precision farming systems and analytical forecasts
 - intelligent sensors and agricultural monitoring systems
 - GPS and GIS systems;
 - agricultural technologies and automation using drones and robotics;
 - automated irrigation systems and the like.
4. **Agro Innovations Forum (Agrocomplex/ InterAGRO)** – a conference where market representatives share their experience in introducing new technologies in the field of precision farming and digital agribusiness.
5. **All-Ukrainian Potato Day ("Potato Blockchain-2021")** - during the event, one can get acquainted with various types of irrigation, fertilization and protection systems, a demonstration of air pressure and the introduction of agrochemicals by drones, etc.
6. **AgroRing (OpenAgribusiness by Kernel)** – field day focused on innovation and discussion of problematic production issues.
7. **AGROSHOW** the exhibition is organized in the author's format of an expo-festival, while in the exhibition area and during the speakers' speeches, the popularization and demonstration of solutions in the field of precision farming takes place.
8. **Digital Field's Day (by AgriLab)** - the first landfill for agricultural innovations in Ukraine. A research project aimed at finding ways to optimize production costs and increase yields using precision farming technologies. During the event, farmers will be able to find out what solutions have helped to reduce the impact of critical moisture deficit and temperature fluctuations, and how the introduction of various modern technologies affects the economic result.
9. **OkAgro** - a business conference in the framework of which the heads of agricultural enterprises share their own experience in the implementation of technologies, innovations, and business management. Presentations consist of practical cases and recommendations..

10. [AgroExpo](#) - agro-industrial exhibition with field demonstration of equipment, thematic discussions on the application of technologies of cultivation, processing, sowing, etc..

11. [IT-Corner \(AgroComplex\)](#) - a specialized platform for digital technologies and smart solutions in agribusiness. All participants are accommodated in a common location in the open-space format, which allows them to present the entire range of technologies and their interaction. Thanks to this, visitors are completely immersed in the world of digital solutions and receive a comprehensive understanding of the process of use and the final effect.

12. [AgroIT Forum Oleynyk company](#) - annual event for digital solutions in agribusiness.

Media / specialized information agencies

If we talk about the media that are directly involved in the coverage of precision farming, there are not many of them in Ukraine, they are mostly limited to Internet resources. Of course, the agrarian media also write about precision farming, but this is more in the form of separate small news or blogs from experts, while not being focused on precision farming.

Specialized:

1. [Aggeek](#) - talk about modern agriculture and efficiency, practical cases from Ukrainian fields and share stories of startups, also write about innovations and the practice of their application. Recently, [Aggeek](#) presented «[Catalog of innovative solutions for agro](#)» - catalog presents the main functions of each company and the problems of farmers that the product allows to solve. In addition, the innovativeness of each solution and contact information are indicated. Convenient navigation and structuring in the main areas of activity will allow you to quickly find a solution that you need and immediately analyze such proposals.
2. **Intelligent Farming (IFarming)** - printed magazine and portal about intelligent technologies in agricultural business, which contains advice on their implementation in practice.

Of course, individual sites of service companies like AgriLab, Drone.UA also conduct news on their own sites, but they are mostly focused on those products that are sold by the same companies, therefore, this list is not reflected.

Agrarian media:

1. [AgroPortal](#) - online resource of exclusive, relevant, high-quality and useful information about the agro-industrial complex of Ukraine;
2. [Latifundist](#) - site for representatives of agribusiness, which contains all the most interesting about Ukrainian and world agriculture: news from offices and fields, expert opinions on the latest events, interviews with top managers, analytics and ratings, insiders and exclusives, various online projects;
3. [APK-Inform](#) - Analytic and Information Agency is a leading agribusiness consulting;
4. [Landlord](#) - agricultural media holding with daily coverage of events, analytics, own special projects, as well as adaptation of magazine content.
5. [AgroNews.ua](#) - a news agency that raises important issues of the agricultural sector, highlights the main problems that concern farmers, and provides analytical materials and expert comments from analysts of the agricultural industry..

6. [Propozitsiya](#) - the first agro magazine in independent Ukraine with its website, which offers its readers up-to-date and reliable information about agriculture in general and the agro-industrial complex in particular.
7. [Agro-business](#) - information-analytical newspaper (website and print edition) with relevant blocks of information and analytical content.
8. [AgroReview](#) - online resource about agro life of Ukraine, diary of successes of the agrarian branch, processes and personalities driving the agrarian sphere: fresh market analysis, interviews with leading experts, effective innovations and business cases, success stories of agrarian business.
9. [Agrarian News Agency «Agravery.com»](#) - news agency about the agricultural sector of Ukraine, with regular updates of news, problems of the agricultural sector.

In addition to these publications and agencies, large media agencies in Ukraine also write about the agricultural sector - Liga.net, Ukrainska Pravda, Novoe Vremya, UNN, UNIAN, etc. However, they are not specialized agricultural publications, compared to the list above, and usually publish the most resonant or important, according to the editors, news about the agricultural sector.

Education

1. [Agristart \(by AgriLab\)](#) - Master's program in precision agriculture "Agrochemical service in precision agricultural production" on the basis of the National University of Life and Environmental Sciences of Ukraine. The program was developed by Agrilab.
2. [Agrokebety \(UCAB\)](#) - it is an advanced master's program created in cooperation between business and educational institutions. Each participant of the program is accompanied by a Mentor (TOP manager of the agricultural company). The curriculum includes a course "Systems of Technology" with disciplines "Modern technologies in agronomy", "Agricultural Engineering", "Smart technologies in agromanagement".
3. **Master's program "Precision Farming Systems" (SNAU)** – master's program at Sumy National Agrarian University. [Description of the program and disciplines](#) (only in Ukrainian).
4. **Discipline "Precision Farming Systems" (NULES)** – discipline in the master's program "Processes, machinery and equipment of agro-industrial production" specialty "Agroengineering" in NULES and branches, to prepare specialists for the positions of researchers, specialists of research and production institutions and institutions of agro-technical profile, as well as service and consulting services.
5. [Clear Precision Farming \(Cultivaria\)](#) - training course of the educational platform Cultivary, where specialists will analyze in detail the process of improving the efficiency of agribusiness, starting from the technological foundations (tillage, fertilizers and pesticides, sowing) and ending with specific strategies for the company's development. The course program consists of 23 animated video lectures of 30 minutes each and 23 structured presentations on various agronomic topics.
6. [Education Grow Academy](#) – online courses on agronomy of specific crops, the whole spectrum of knowledge for effective crop growing.

At the same time, some agricultural companies conduct their own training, both for their employees and recruiting students from universities for practice. Also, service companies periodically conduct training for their customers on the use of new products or training.

Unfortunately, at the moment there are no known products or projects in the field of precision farming or related to it, developed by **Ukrainian scientific institutes or structures of the National Academy of Agrarian Sciences**.

Corporate Social Responsibility and Doing Business in Ukraine

According to the results of the study «CSR Development in Ukraine» implemented by the Center of Development of Corporate Social Responsibility in 2018, CSR has not yet become a part of strategic management at the Ukrainian companies. CSR programs/activities at the Ukrainian companies are not of a strategic nature and develop mostly under the influence of company's management. One fourth of companies develop their CSR programs based on ideas of their staff. More than half of the Ukrainian companies do not possess any company-wide tools for the CSR policy implementation.

Majority of surveyed companies (83%) implement CSR, only half (52%) of them have a social responsibility strategy (policy) and half as many own a budget for its execution (24%). Only one third of companies have experienced increase in budget dedicated to social responsibility. Main driver for the CSR policy implementation is moral consideration and, according to representatives of the companies, main barrier for non-implementation of the CSR policy is lack of financial resources, unstable political situation in the country, inadequate legal framework which would encourage this activity, and tax pressure.

According to the CSR Center survey among among business representatives in Ukraine, the most popular forms of implementing CSR policy in Ukraine are aimed at three key aspects:

- 76% - development and improvement of conditions for staff,
- 51% - investments into development of a region as well as protection and support to customers.
- 30% assistance to ATO warriors and residents of the ATO zone.

The most widespread practices of CSR implementation at the Ukrainian companies are:

In the field of labor relations: salary rise, payment of declared salary and bonuses. Almost half of the companies provide their employees with an opportunity to work under flexible working schedules and implement professional development programs.

Environmental responsibility: introduction of energy saving technologies and waste management and recycling programs, one third of the interviewed companies have not implemented any environmental protection measures.

Consumer relations: support to product quality, providing reliable information and commercial, staff trainings on customer service, elaborated system of complaints management and “hotline” (contact center) for consumers.

Development of regions: allocation of funds for charity and assistance in land improvement.

Anti-corruption practices: more than one third of the companies have not bribed to solve their business problems, and the same number of companies are ready to allocate half of their profit to fight against corruption

Most of their CSR begin to implement and develop Ukrainian companies that have switched to long-term development planning (not only their own business) and understand the strategic importance of CSR, including as a competitive advantage in working in foreign markets. These are mainly representatives of large businesses, some of them operate on the stock exchanges, constantly publish reports on their activities and plan their activities for 5-10-15 years in advance. Such companies include, for example: DTEK, Kyivstar, Metinvest, Nestle, Danone, WOG, MHP, Kernel, etc.

CONCLUSIONS

Taking into account the global trends regarding more efficient use of land resources, while minimizing application of agrochemistry and other harmful technologies, the demand and desire to introduce precision farming will definitely grow. The impetus for the application of more innovative technologies helping to reduce the cost of production will grow as well, since there is an increase in prices for resources and equipment - fuel, fertilizer, gas, equipment (due to increase in cost of ores), etc.

In the coming years Ukraine has to address a number of issues, such as the management of water - and land resources (especially in the context of appropriate use in compliance with all legal requirements), increasing prices for machinery and elevator equipment and keeping qualified staff. Due to the temperature rise in the southern regions and related drought and soil degradation issues, it faces the necessity to adapt technological processes in the agricultural sector, as well as the approximation to the terms of future agreements on the EU Green Deal.

At the same time, at present in Ukraine, there are no support programs or any other kind of stimulation for the use of innovative technologies, precision farming, and the state loan programs for the agricultural sector are mainly short-term or medium-term. In addition, launching individual innovations and getting effective takes more time and sometimes requires a major update of the equipment folder.

Considering the large areas of agricultural land on the territory of Ukraine, a large number of agricultural enterprises and farmers in various climatic and natural zones, there are opportunities to find niches for various (Dutch) solutions and services, to test them in various conditions and at various types of enterprises. These opportunities are enforced by several positive developments such as the opening of the land market and irrigation scheme and the adoption of the EU Green Deal by the Ukrainian Government.

As for the key points in the study and the categories of interviewed farmers:

Up to 1000 ha – farmers:

- 85% don't have electronic field maps. At the same time, the farmers who have formed these maps are digitizing more than 90% of their lands;
- Only 1/10 use satellite images / NDVI and no more than 20% use their own weather stations and soil moisture sensors in their activities;
- These companies (in the majority) don't think about complex farm management systems – implementation of such a system requires both a financial component and a previously formed geoinformation base (at least) for your own company;
- Problems with the integrated and consistent use of precision farming technologies;
- Complicated access to financing for the possibility of purchasing more expensive equipment and machinery.

1-3 thous.ha:

- Situation with field maps is better compared to farmers (47% versus 17%) and with a high percentage of digitization -almost every second farmer surveyed in this segment has digitized 90% + of their fields;
- In this segment, more than half of the respondents also use autopilots, GPS;
- About 38% use satellite imagery / NDVI;
- Problems with the integrated and consistent use of precision farming technologies (low percentage of use of management systems);
- Complicated access to financing for the possibility of purchasing more expensive equipment and machinery.

3-10 thous.ha:

- maps were formed by 67% + respondents, with a high% digitization -91% of their fields;
- 8 out of 10 farmers in this segment use autopilots, GPS trackers;
- much more interested in using satellite images / NDVI and meteorological stations / weather data;
- more consistent and deliberate implementation of technologies.

10+ thous.ha:

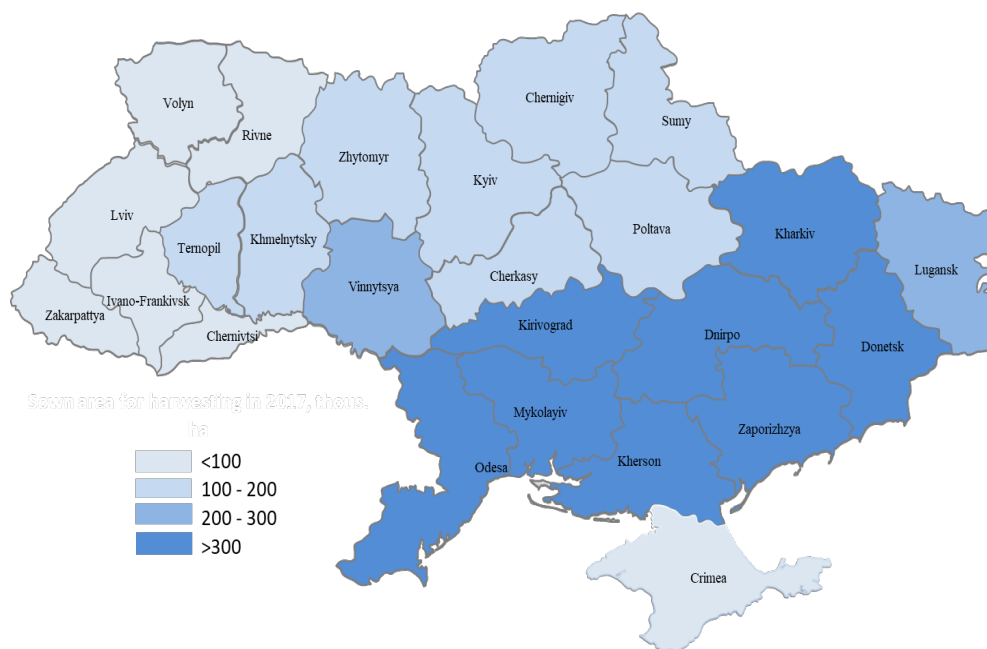
- Taking into account peculiarities of the work, implementation of the technology in all clusters is centralized (in most cases);
- The testing and scaling process for all clusters takes up to 3 years (Kernel's case);
- Digitized 93% + fields (using RTK, drones), 90 +% of the equipment with autopilots, GPS trackers, fuel control sensors;
- Using of satellite images, drones (both independently and by hiring appropriate companies), implementation of management systems such as FieldView, Cropio.

Annex I

Sowing area of major crops

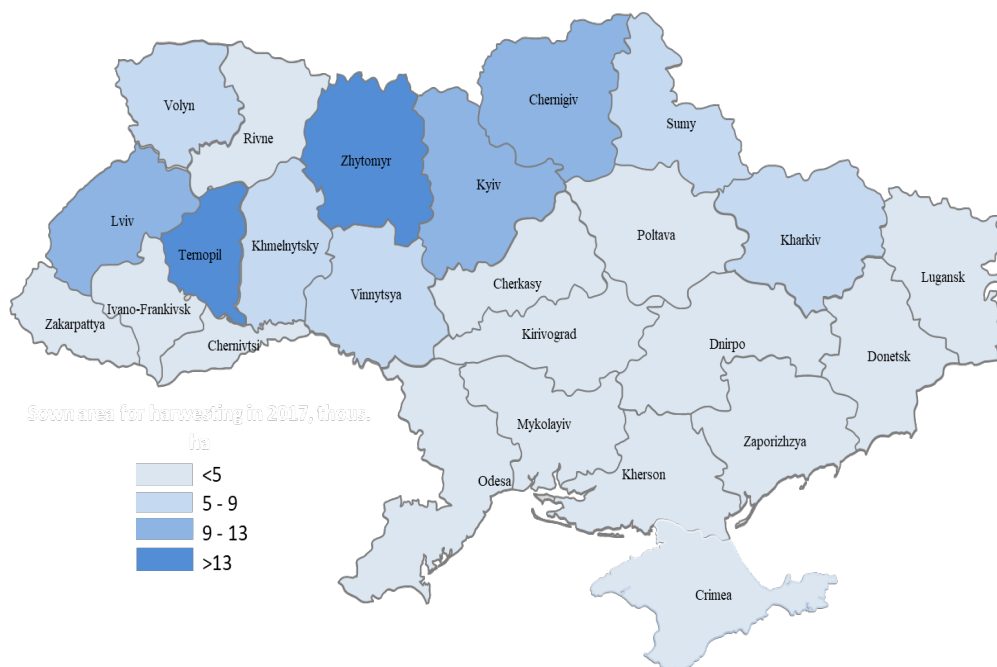
Enterprises (in thous.ha)

Winter wheat



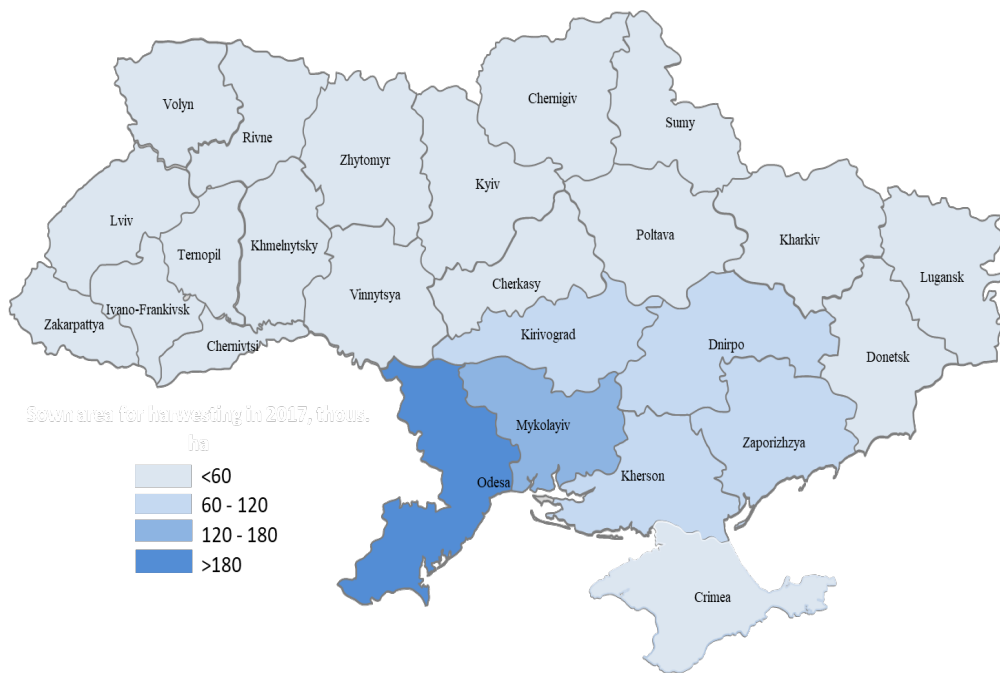
Region	Winter wheat
Vinnytsya	256,9
Volyn	76
Dnipropetrovsk	458,3
Donetsk	320,5
Zhytomyr	120,4
Zakarpattia	3,1
Zaporizhzhya	514,1
Ivano-Frankivsk	21,7
Kyiv	157,2
Kirovograd	312,1
Lugansk	236,7
Lviv	76,3
Mykolayiv	394,5
Odesa	478,5
Poltava	195,9
Rivne	55,6
Sumy	162,7
Terнопil	120,8
Kharkiv	488,4
Kherson	324,8
Khmelnitsky	175,8
Cherkasy	172,9
Chernivtsi	21,3
Chernigiv	152,7

Spring wheat



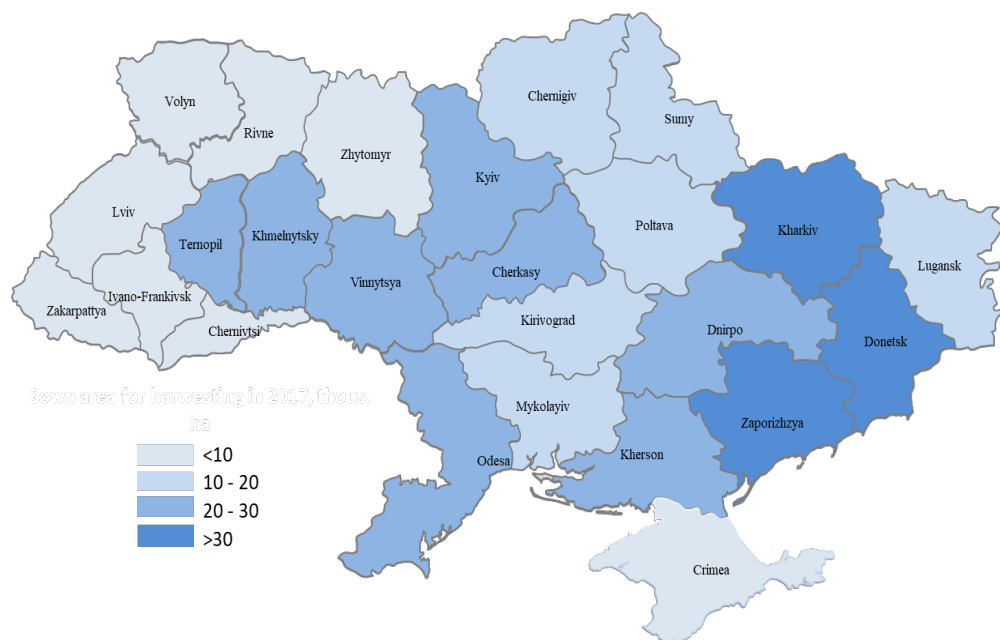
Region	Spring wheat
Vinnytsya	8,5
Volyn	7,8
Dnipropetrovsk	3,0
Donetsk	0,8
Zhytomyr	18,0
Zakarpattia	0,3
Zaporizhzhya	2,4
Ivano-Frankivsk	2,3
Kyiv	13,0
Kirovograd	2,3
Lugansk	0,8
Lviv	11,5
Mykolayiv	2,4
Odesa	3,2
Poltava	1,8
Rivne	4,0
Sumy	5,8
Terнопil	13,3
Kharkiv	8,3
Kherson	1,0
Khmelnitsky	7,6
Cherkasy	4,4
Chernivtsi	1,3
Chernigiv	11,0

Winter barley



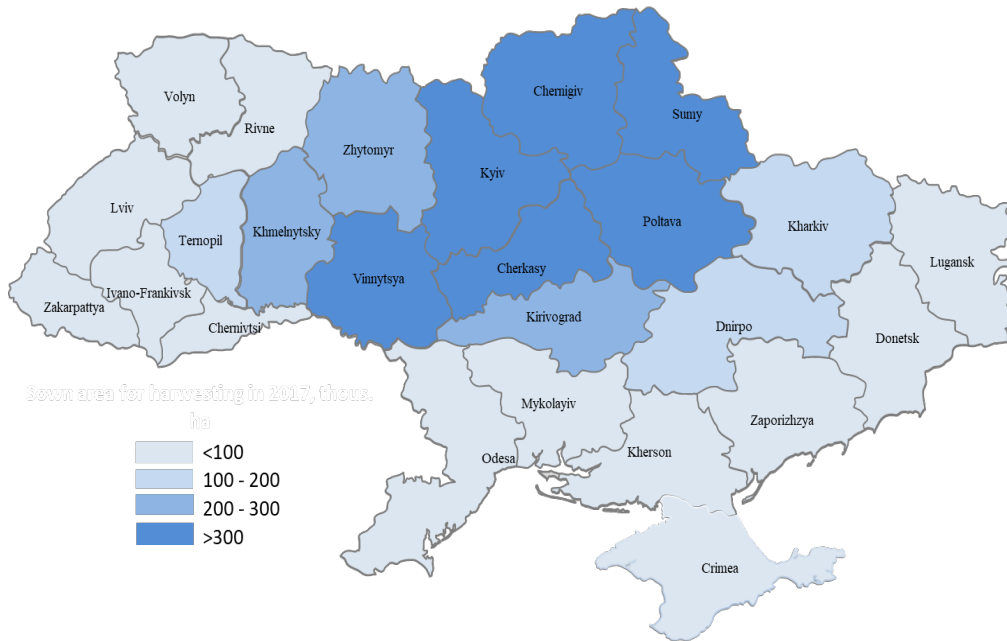
Region	Winter barley
Vinnitsya	28,8
Volyn	5,6
Dnipropetrovsk	84,6
Donetsk	14,1
Zhytomyr	7,6
Zakarpattia	0,3
Zaporizhzhya	82,2
Ivano-Frankivsk	5,9
Kyiv	7,9
Kirovograd	64,1
Lugansk	6,3
Lviv	18,5
Mykolayiv	163,4
Odesa	226,3
Poltava	9,4
Rivne	2,1
Sumy	3
Ternopil	11,1
Kharkiv	15,2
Kherson	97,1
Khmelnitsky	9,4
Cherkasy	13,2
Chernivtsi	3
Chernigiv	1,7

Spring barley



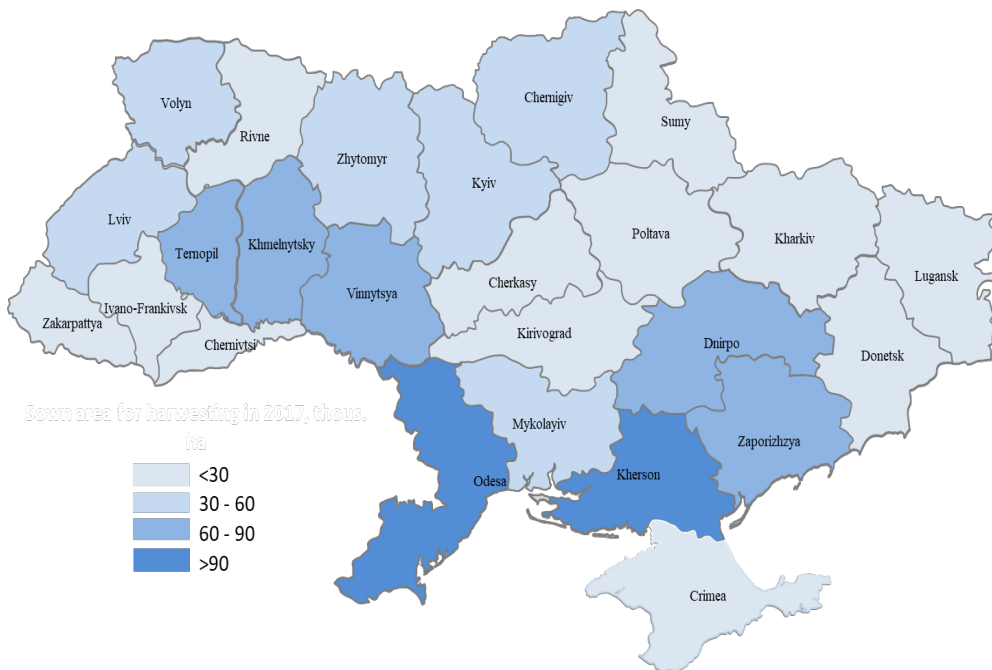
Region	Spring barley
Vinnitsya	23,1
Volyn	3,8
Dnipropetrovsk	24,8
Donetsk	40,6
Zhytomyr	9,3
Zakarpattia	0,1
Zaporizhzhya	32,9
Ivano-Frankivsk	4,8
Kyiv	27,1
Kirovograd	18,5
Lugansk	16,5
Lviv	5,1
Mykolayiv	15,8
Odesa	25,8
Poltava	18,9
Rivne	7,1
Sumy	11,7
Ternopil	24,4
Kharkiv	39,2
Kherson	25,3
Khmelnitsky	29,2
Cherkasy	20,9
Chernivtsi	2,3
Chernigiv	16,6

Corn



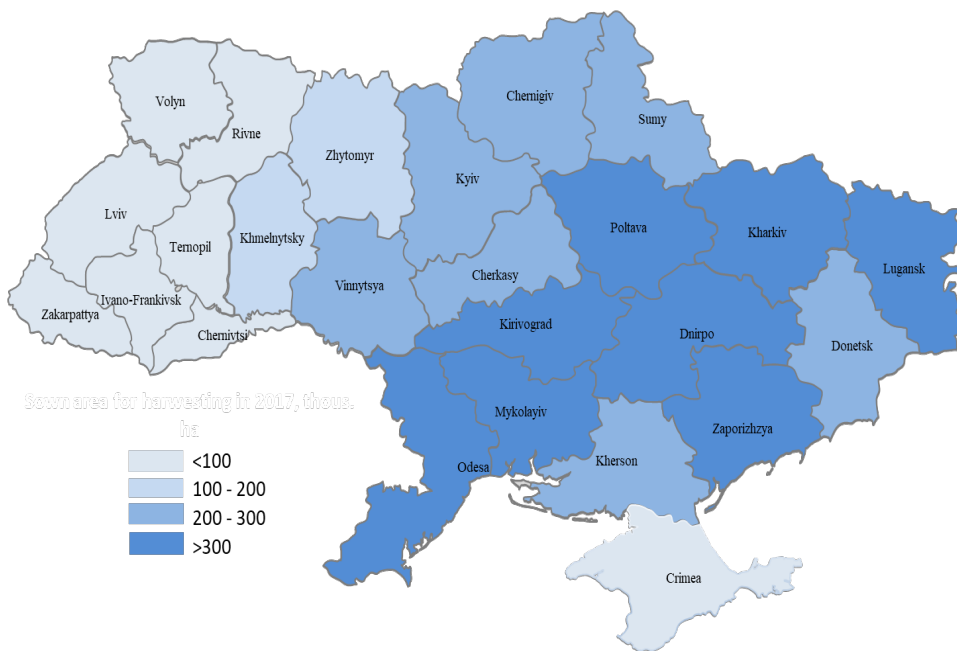
Region	Corn
Vinnvtsya	393,3
Volyn	52,1
Dnipropetrovsk	113,4
Donetsk	17,2
Zhytomyr	261,8
Zakarpattya	15,3
Zaporizhzhya	25,9
Ivano-Frankivsk	51,3
Kyiv	327,1
Kirovograd	256,4
Lugansk	33,9
Lviv	76,9
Mykolayiv	41,9
Odesa	76,8
Poltava	544
Rivne	99
Sumy	437,3
Ternopil	152,4
Kharkiv	185,9
Kherson	38,9
Khmelnvtskv	281,2
Cherkasy	345,9
Chernivtsi	16,7
Chernihiv	546,3

Winter rape



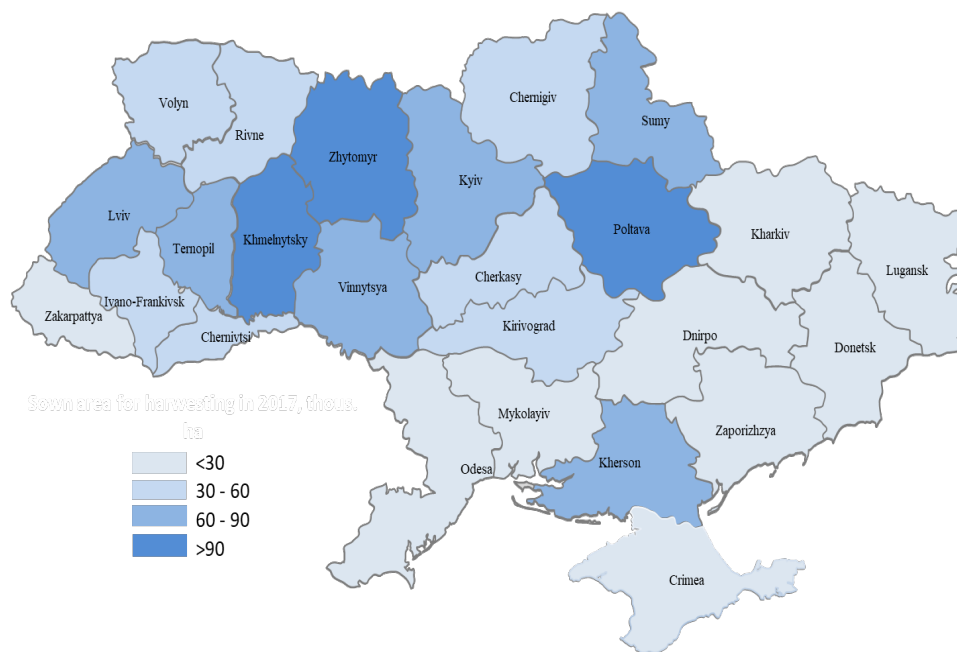
Region	Winter rape
Vinnvtsya	61,4
Volyn	46,7
Dnipropetrovsk	76,3
Donetsk	
Zhytomyr	38
Zakarpattya	
Zaporizhzhya	71
Ivano-Frankivsk	19,6
Kyiv	31,5
Kirovograd	26,4
Lugansk	
Lviv	51,4
Mykolayiv	57,7
Odesa	115,5
Poltava	10,5
Rivne	27,9
Sumy	21,2
Ternopil	67,5
Kharkiv	
Kherson	90,2
Khmelnvtskv	81,2
Cherkasy	15,3
Chernivtsi	
Chernihiv	33,2

Sunflower



Region	Sunflower
Vinnitsya	297,6
Volyn	36,4
Dnipropetrovsk	497,2
Donetsk	278,5
Zhytomyr	132,7
Zakarpattya	3
Zaporizhzhya	393,1
Ivano-Frankivsk	31,8
Kyiv	200,7
Kirovograd	438,8
Lugansk	353,6
Lviv	35,6
Mykolayiv	329,4
Odesa	317,9
Poltava	329,7
Rivne	36,6
Sumy	254
Ternopil	83
Kharkiv	495,4
Kherson	206,5
Khmelnitsky	161
Cherkasy	237,4
Chernivtsi	17,8
Chernigiv	236,8

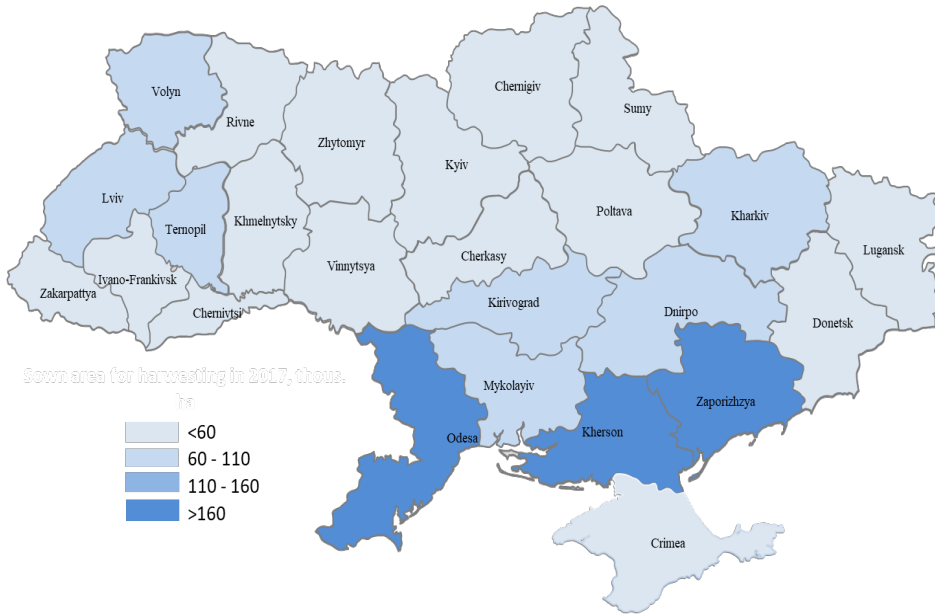
Soy



Region	Soy
Vinnitsya	72,2
Volyn	34,4
Dnipropetrovsk	5,4
Donetsk	
Zhytomyr	100,2
Zakarpattya	11,7
Zaporizhzhya	10,3
Ivano-Frankivsk	40,4
Kyiv	71,6
Kirovograd	31,7
Lugansk	
Lviv	83,5
Mykolayiv	1,9
Odesa	4,7
Poltava	95,5
Rivne	51,9
Sumy	69,5
Ternopil	78,9
Kharkiv	20,9
Kherson	66,4
Khmelnitsky	120,7
Cherkasy	53,2
Chernivtsi	32,7
Chernigiv	38,7

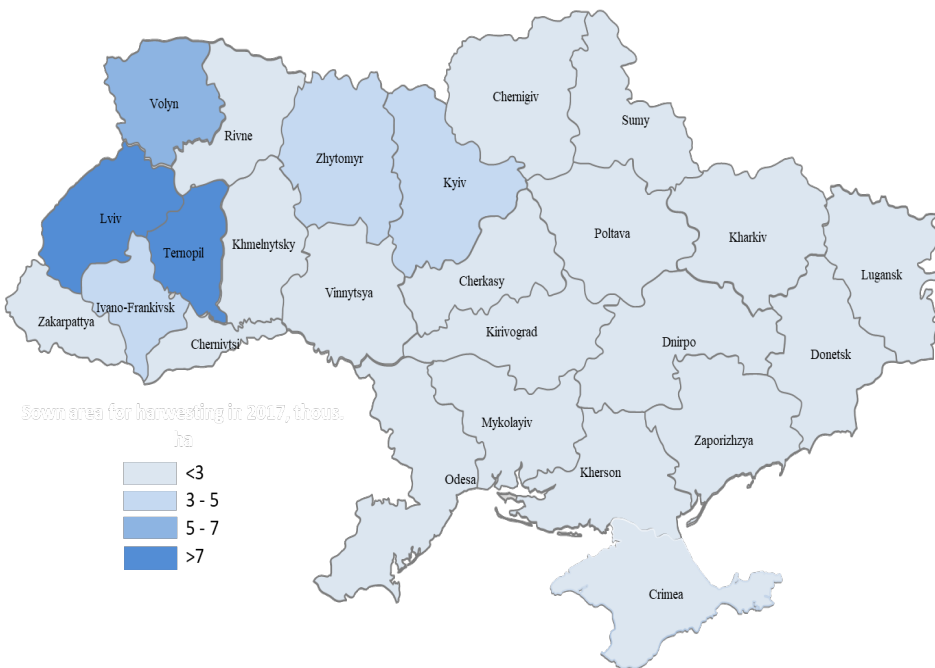
Households (in thous.ha)

Winter wheat



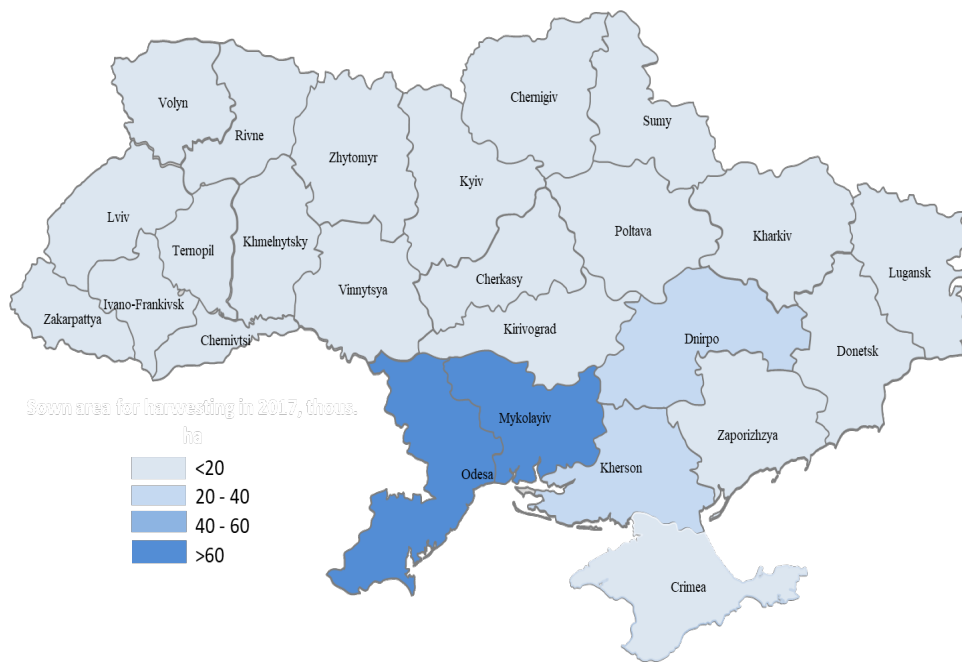
Region	Winter wheat
Vinnitsya	56,6
Volyn	75,4
Dnipropetrovsk	97,8
Donetsk	58,9
Zhytomyr	27,3
Zakarpattya	20,4
Zaporizhzhya	192,2
Ivano-Frankivsk	19,7
Kyiv	33,8
Kirovograd	71,1
Lugansk	41,7
Lviv	70,4
Mykolayiv	80,7
Odesa	191,3
Poltava	50
Rivne	52,8
Sumy	25,3
Ternopil	64,1
Kharkiv	88,6
Kherson	176,3
Khmelnitsky	33,8
Cherkasy	47,7
Chernivtsi	10,8
Chernigiv	23,6

Spring wheat



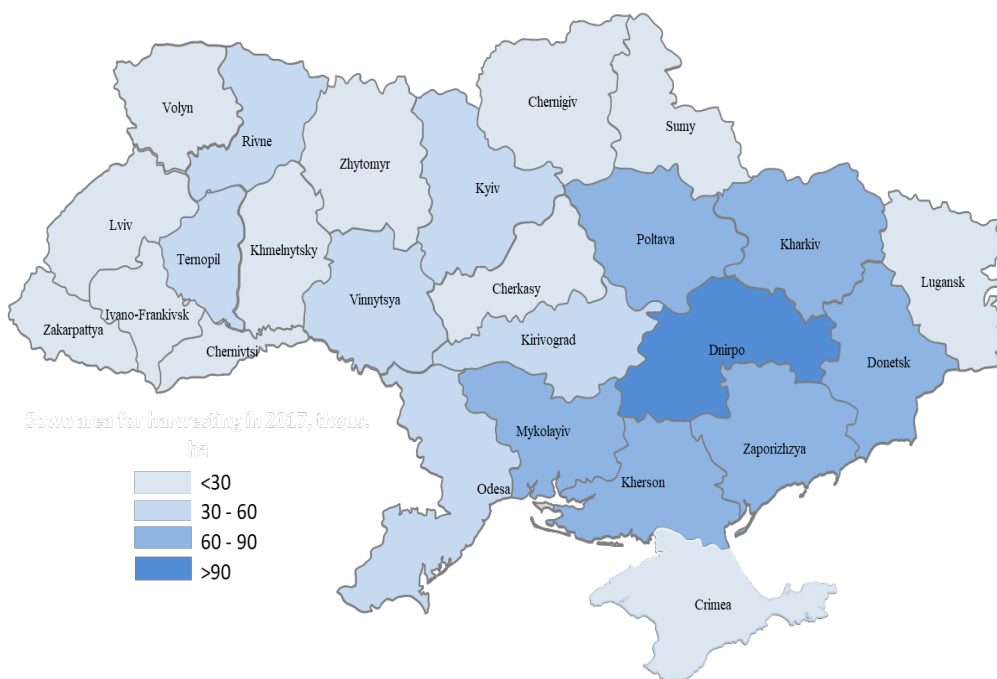
Region	Spring wheat
Vinnitsya	2,9
Volyn	6
Dnipropetrovsk	0,7
Donetsk	0,9
Zhytomyr	3,8
Zakarpattya	0,3
Zaporizhzhya	0,6
Ivano-Frankivsk	3,7
Kyiv	3,5
Kirovograd	0,8
Lugansk	0,3
Lviv	9,5
Mykolayiv	1,4
Odesa	2,4
Poltava	1,9
Rivne	2,5
Sumy	1,7
Ternopil	7,2
Kharkiv	2,2
Kherson	0,5
Khmelnitsky	1,9
Cherkasy	0,9
Chernivtsi	1,3
Chernigiv	0,4

Winter barley



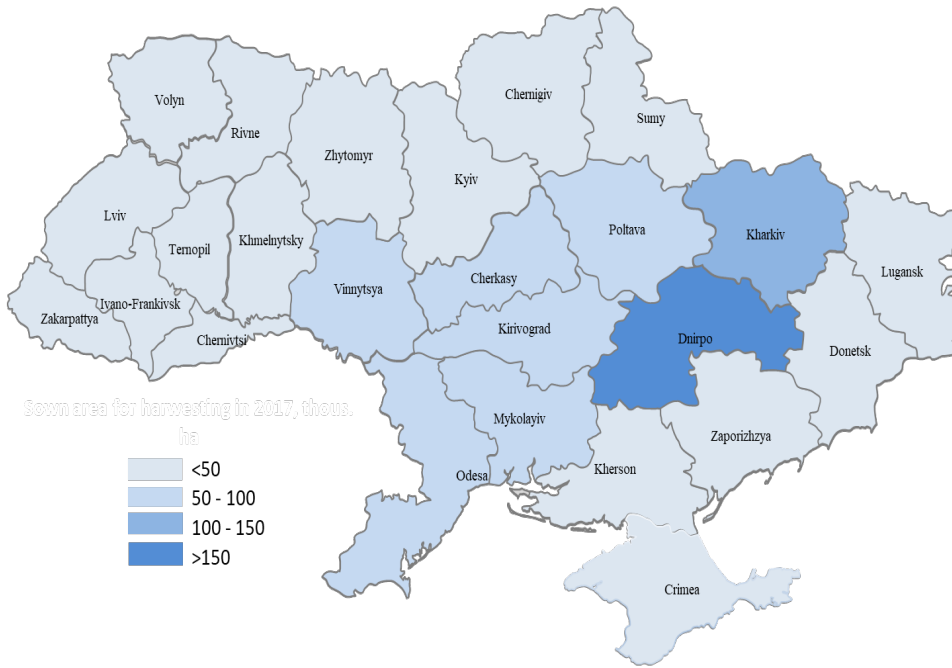
Region	Winter barley
Vinnitsya	7,1
Volyn	1,8
Dnipropetrovsk	22,1
Donetsk	0,5
Zhytomyr	3,3
Zakarpattia	0,8
Zaporizhzhya	5,4
Ivano-Frankivsk	2,7
Kyiv	0,6
Kirovograd	15,1
Lugansk	0,8
Lviv	3,3
Mykolayiv	65,7
Odesa	89,2
Poltava	1
Rivne	3,1
Sumy	0,1
Ternopil	5,7
Kharkiv	0,1
Kherson	21,4
Khmelnitsky	3,4
Cherkasy	1,5
Chernivtsi	2
Chemigiv	

Spring barley



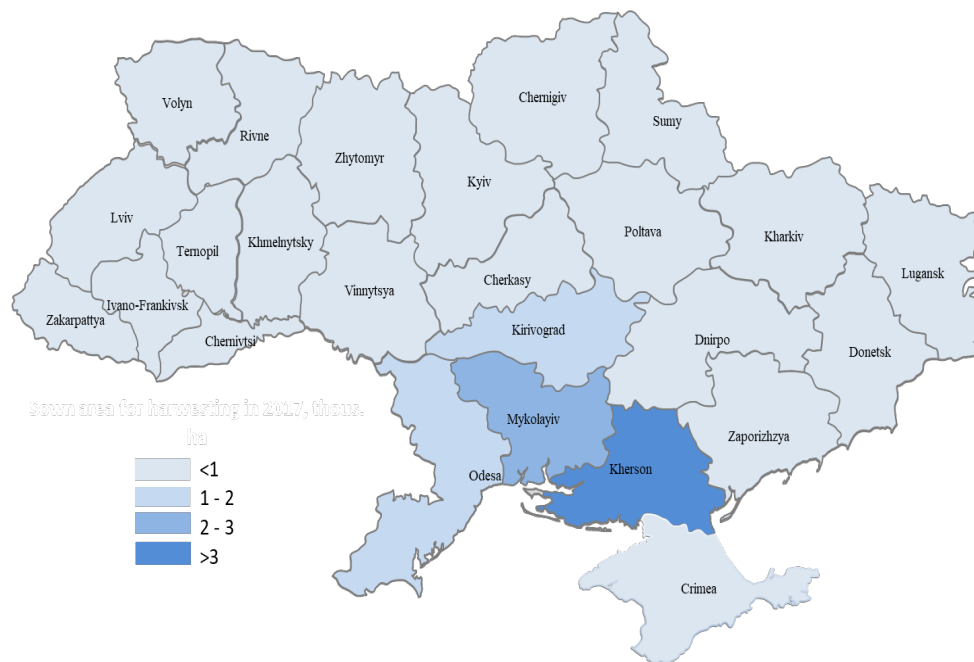
Region	Spring barley
Vinnitsya	35,9
Volyn	21,1
Dnipropetrovsk	118,5
Donetsk	61,8
Zhytomyr	11,6
Zakarpattia	0,8
Zaporizhzhya	74,5
Ivano-Frankivsk	11,8
Kyiv	35
Kirovograd	35
Lugansk	17,5
Lviv	10,7
Mykolayiv	63,7
Odesa	30,6
Poltava	60,3
Rivne	32,5
Sumy	19,1
Ternopil	42,6
Kharkiv	81,8
Kherson	65,9
Khmelnitsky	29,3
Cherkasy	18,9
Chernivtsi	11,3
Chemigiv	3

Corn



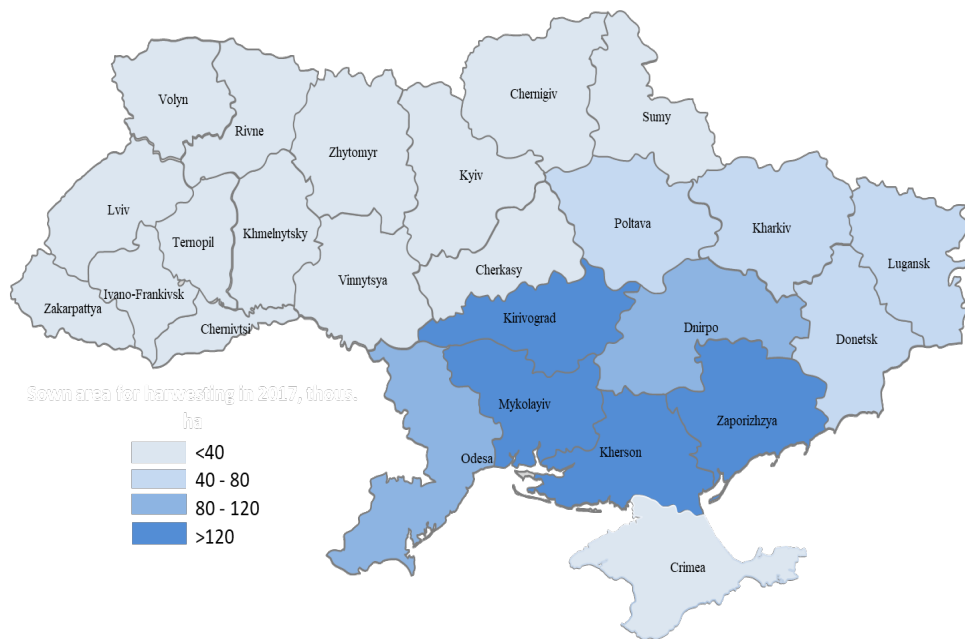
Region	Corn
Vinnitsya	65,6
Volyn	3
Dnipropetrovsk	190,1
Donetsk	38,6
Zhytomyr	17,6
Zakarpattia	37,8
Zaporizhzhya	10,3
Ivano-Frankivsk	19,4
Kyiv	18,8
Kirovograd	95,6
Lugansk	21,9
Lviv	7,5
Mykolayiv	80
Odesa	60,8
Poltava	99
Rivne	5,6
Sumy	24,1
Temopil	17,3
Kharkiv	100,6
Kherson	19,9
Khmelnitsky	22,7
Cherkasy	58,3
Chemivtsi	46,8
Chemigiv	22,6

Winter rape



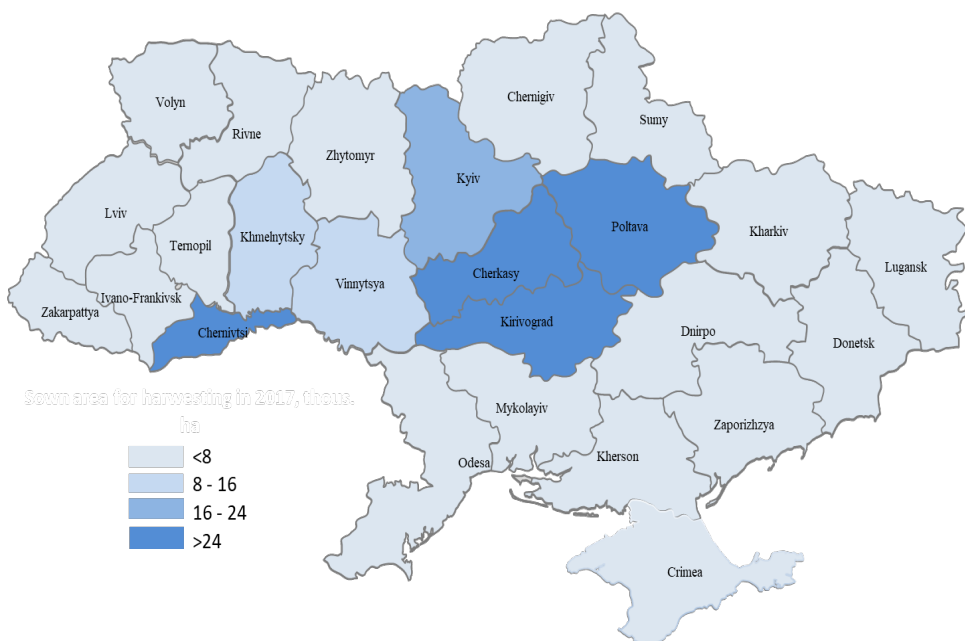
Region	Winter rape
Vinnitsya	0,5
Volyn	
Dnipropetrovsk	0,4
Donetsk	
Zhytomyr	0,1
Zakarpattia	
Zaporizhzhya	0,5
Ivano-Frankivsk	
Kyiv	0,2
Kirovograd	1,3
Lugansk	
Lviv	
Mykolayiv	2,7
Odesa	1,4
Poltava	0,2
Rivne	
Sumy	
Temopil	
Kharkiv	
Kherson	4,4
Khmelnitsky	0,6
Cherkasy	0,3
Chemivtsi	
Chemigiv	

Sunflower



Region	Sunflower
Vinnitsya	14
Volyn	
Dnipropetrovsk	100,9
Donetsk	70,8
Zhytomyr	13,2
Zakarpattya	0,4
Zaporizhzhya	138
Ivano-Frankivsk	0,1
Kyiv	2,8
Kirovograd	161
Lugansk	73,8
Lviv	
Mykolayiv	162
Odesa	80,4
Poltava	54,4
Rivne	
Sumy	8,6
Temopil	
Kharkiv	70,2
Kherson	131,6
Khmelnvtsky	0,9
Cherkasy	17,7
Chernivtsi	4,2
Chernigiv	0,2

Soy

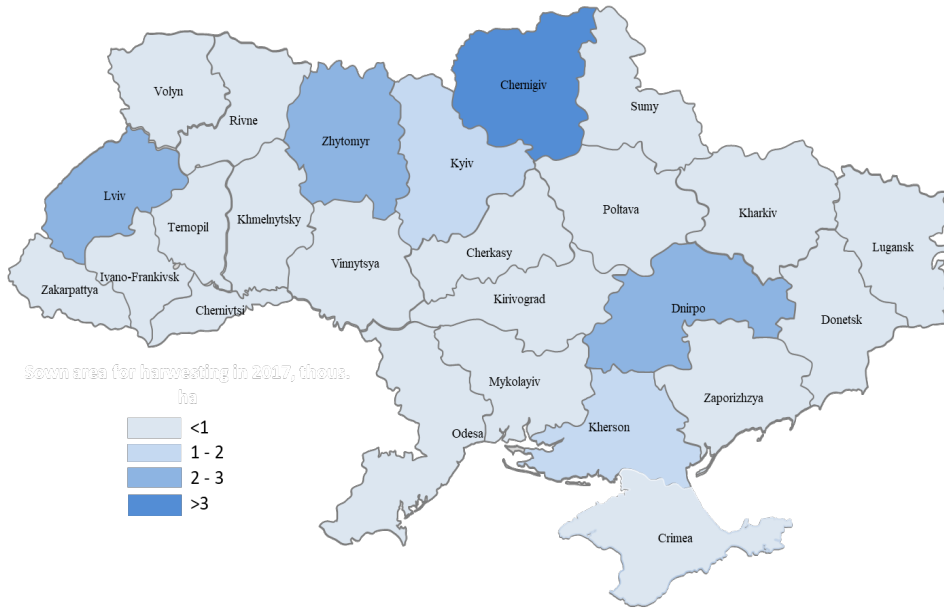


Region	Soy
Vinnitsya	11,9
Volyn	1,4
Dnipropetrovsk	0,5
Donetsk	0,2
Zhytomyr	6,4
Zakarpattya	
Zaporizhzhya	
Ivano-Frankivsk	0,6
Kyiv	21,8
Kirovograd	32,9
Lugansk	
Lviv	
Mykolayiv	3,6
Odesa	0,1
Poltava	26,4
Rivne	1,6
Sumy	2,1
Temopil	4,1
Kharkiv	1,8
Kherson	4,3
Khmelnvtsky	13
Cherkasy	24,9
Chernivtsi	25,7
Chernigiv	0,1

Sowing area (potato, vegetable)

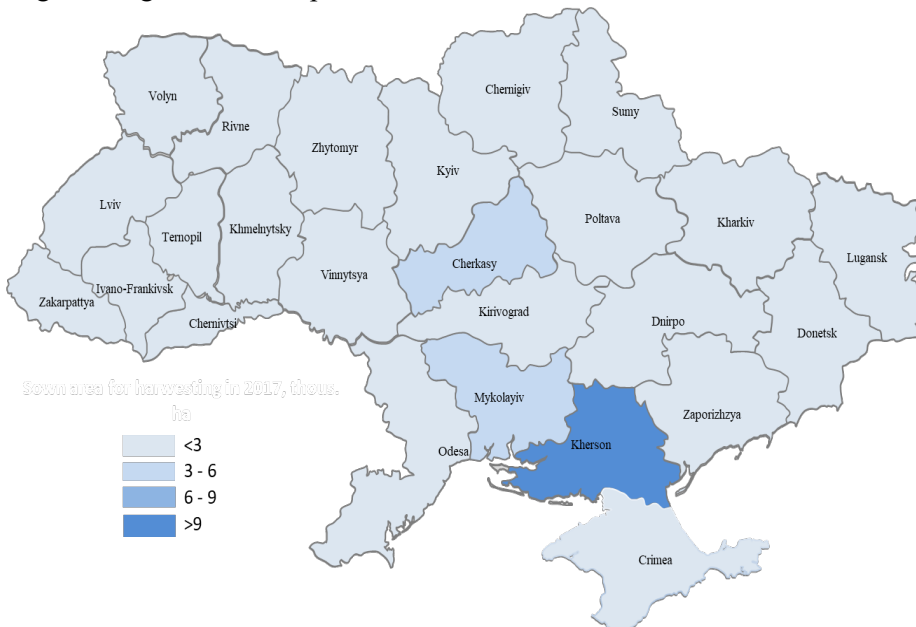
Enterprises (in thous. ha)

Potato



Region	Potato
Vinnitsya	0,2
Volyn	0,4
Dnipropetrovsk	2,1
Donetsk	0
Zhytomyr	2,2
Zakarpattia	0
Zaporizhzhya	0
Ivano-Frankivsk	0,1
Kyiv	1,4
Kirovograd	0
Lugansk	0
Lviv	2,3
Mykolayiv	0,2
Odesa	0,2
Poltava	0,7
Rivne	0,2
Sumy	0,4
Ternopil	0,9
Kharkiv	0,1
Kherson	1,2
Khmelnitsky	0,2
Cherkasy	0,9
Chernivtsi	0,1
Chernihiv	5,4

Vegetables grown in the open field

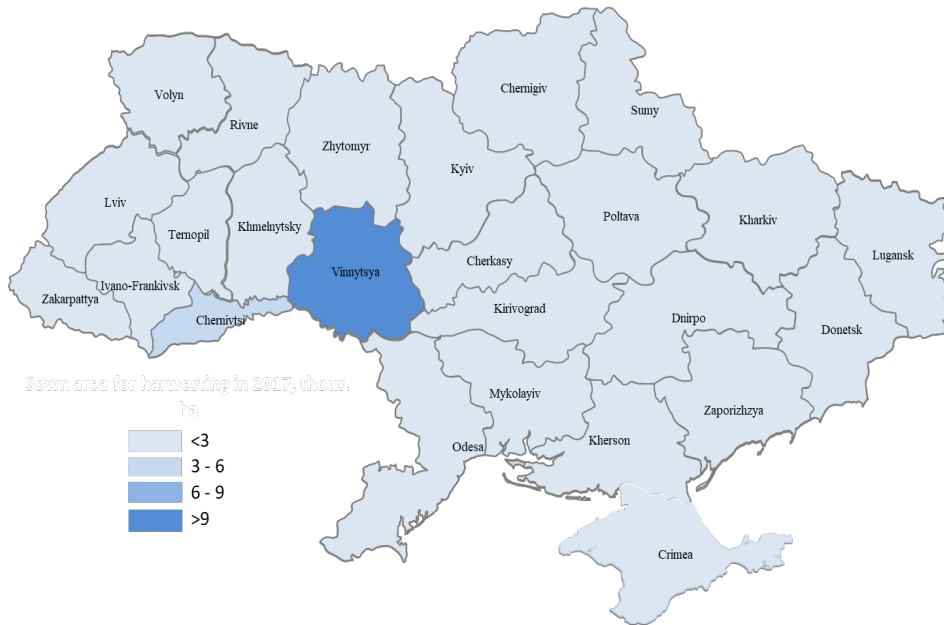


	vegetables grown in the open under
Vinnitsya	0
Volyn	0,7
Dnipropetrovsk	2,3
Donetsk	0,4
Zhytomyr	0,1
Zakarpattia	0
Zaporizhzhya	0,6
Ivano-Frankivsk	0,7
Kyiv	0,7
Kirovograd	0,7
Lugansk	0
Lviv	1,7
Mykolayiv	4,1
Odesa	1,7
Poltava	0,1
Rivne	0,3
Sumy	0,1
Ternopil	0,4
Kharkiv	0,2
Kherson	11
Khmelnitsky	0,1
Cherkasy	5,6
Chernivtsi	0
Chernihiv	0,2

Area (perennial crops - 2020)*

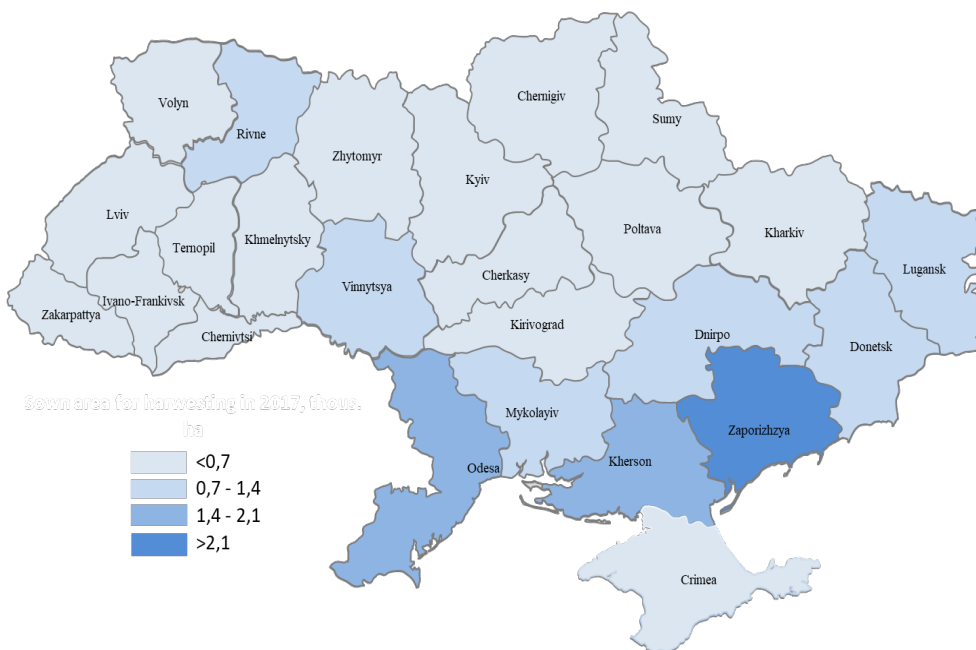
Enterprises (in thous.ha)

Pome fruits



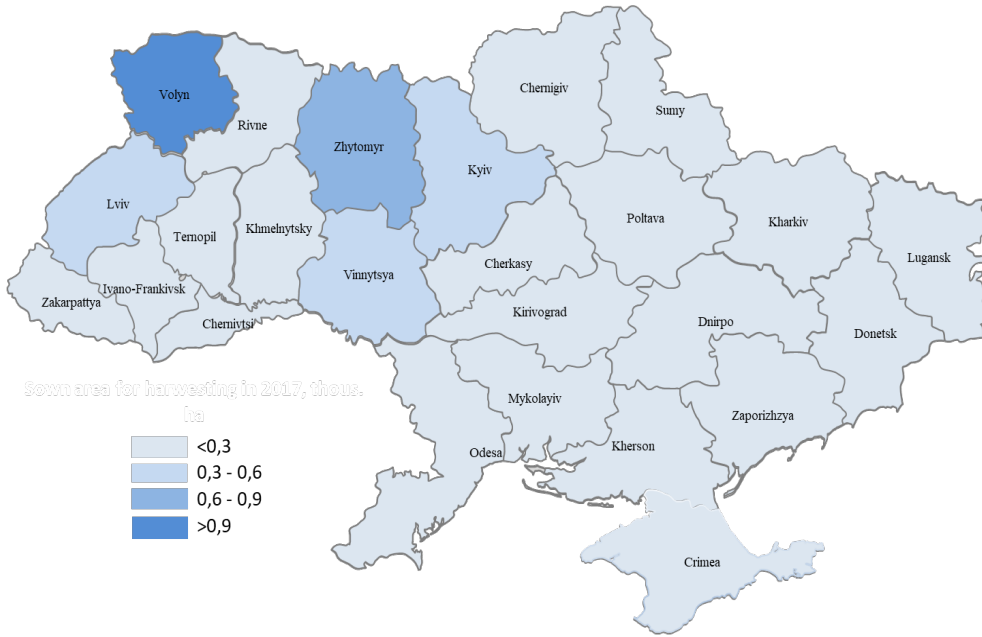
Region	Pome fruits
Vinnytsya	10,8
Volyn	0,2
Dnipropetrovsk	2,3
Donetsk	0,9
Zhytomyr	0,8
Zakarpattia	0,8
Zaporizhzhya	1,2
Ivano-Frankivsk	0,7
Kyiv	1,2
Kirovograd	0,7
Lugansk	0,9
Lviv	1,2
Mykolayiv	0,7
Odesa	0,6
Poltava	0,8
Rivne	0,1
Sumy	0,6
Ternopil	1,7
Kharkiv	1,3
Kherson	1,1
Khmelnysky	2,3
Cherkasy	1,1
Chernivtsi	3,2
Chemigiv	1,1

Stone fruits



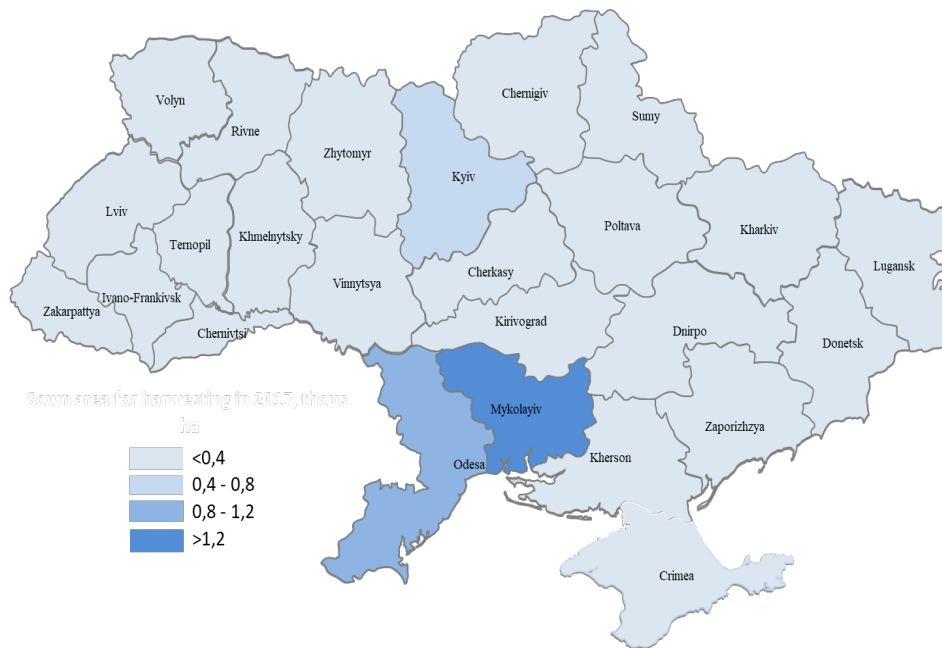
Region	Stone fruits
Vinnytsya	0,9
Volyn	0,2
Dnipropetrovsk	1,2
Donetsk	0,8
Zhytomyr	0,3
Zakarpattia	0,1
Zaporizhzhya	2,7
Ivano-Frankivsk	0,2
Kyiv	0,1
Kirovograd	0,7
Lugansk	0,8
Lviv	0,5
Mykolayiv	1,1
Odesa	1,7
Poltava	0,1
Rivne	0,9
Sumy	0
Ternopil	0,2
Kharkiv	0,1
Kherson	1,6
Khmelnysky	0,1
Cherkasy	0,5
Chernivtsi	0,2
Chemigiv	0

Berries



Region	Berries grown
Vinnytsya	0,5
Volyn	1,3
Dnipropetrovsk	0,1
Donetsk	
Zhytomyr	0,8
Zakarpattia	0
Zaporizhzhya	0,1
Ivano-Frankivsk	0,3
Kyiv	0,5
Kirovograd	0,1
Lugansk	0
Lviv	0,6
Mykolayiv	
Odesa	0
Poltava	0,2
Rivne	
Sumy	0,1
Ternopil	0,2
Kharkiv	0,1
Kherson	0,3
Khmelnysky	0,2
Cherkasy	0,3
Chernivtsi	
Chernigiv	

Nuts



Region	Nuts
Vinnytsya	0,4
Volyn	
Dnipropetrovsk	
Donetsk	
Zhytomyr	
Zakarpattia	
Zaporizhzhya	0,2
Ivano-Frankivsk	0,2
Kyiv	0,5
Kirovograd	0,3
Lugansk	0
Lviv	0,2
Mykolayiv	1,4
Odesa	1
Poltava	
Rivne	
Sumy	0
Ternopil	
Kharkiv	0,3
Kherson	0,1
Khmelnysky	0,1
Cherkasy	
Chernivtsi	
Chernigiv	0

* Gaps in the tables - no exact data.

Annex II

List of companies (Hardware)

Company	Type	Directions	Link
IT INNOVATIONS	GPS trackers and fuel control sensors Soil moisture sensors and meteorological stations	Development and implementation of complex projects for transport monitoring and fuel control at enterprises. Meteorological monitoring, development of sensors and IoT systems.	https://www.itinnovations.ua/en/
«Discovi Systemy» LLC (Bitrek)	GPS trackers and fuel control sensors	Development and production of equipment for GPS-monitoring and transport control	https://bitrek.ua/about-company
RKS Telemetry	GPS trackers and fuel control sensors	Production of equipment for transport navigation using a GPS satellite system, as well as equipment for fuel consumption control.	
SAS	GPS trackers and fuel control sensors	Selection of equipment, installation of GPS-trackers and additional sensors, firmware of trackers and installation of SIM-cards, settings of retransmission of existing sensors.	https://sasagro.com/ua/inzhenerna-pidtrimka/
Skok Agro	Soil moisture sensors and meteorological stations Mapping	Ukrainian manufacturer of soil hardness testers and automatic samplers «Romashka». Performs custom production of meteorological monitoring systems for self-propelled sprayers, and installation of modular meteorological stations.	https://skokagro.com/index.php?lang=en
METEOTREK	Soil moisture sensors and meteorological stations	Product of cooperation between BITREK®, IT INNOVATIONS® and Smartfarming LLC. Production of meteorological stations, processing of collected data and preparation of recommendations, etc.	https://www.meteotrek.ua/ua/

SmartFarming	Autopilots or steering controls GPS trackers and fuel control sensors Shutdown of sections / nozzles Mapping Differentiated application	Comprehensive integrator of technologies in crop production, providing a full range of services for land bank management and improving the efficiency of agricultural operations. One of the directions - re-equipment of agricultural machinery, introduction and development of parallel driving, re-equipment of seeders and sprayers, yield mapping.	https://www.smartfarming.ua/
DroneUA	Drones	System integrator of unmanned solutions - importer and distributor of drones. The company has its own engineering and production departments, a data processing center.	https://drone.ua/?lang=uk
Quadro.UA	Drones	Importer, distributor and integrator of DJI, DJI Agriculture, sells / maintains / repairs industrial DJI quadcopters / drones, ground robots and cars, development of robotic and unmanned solutions, production of payloads and additional modules / sensors, implementation of automatic air control systems traffic, data processing	https://quadro.ua/
Frendt	Autopilots or steering controls Shutdown of sections / nozzles Differentiated application	Retrofitting tractors with automatic driving systems, repair of agroelectronics (for all agricultural machines), personnel training in the direction of GNSS systems, sale and installation of parallel driving systems, installation of automatic emission rate control systems, disconnection of sections, monitoring of seeding	https://www.frendt.ua/en/
Kray	Drones	Ukrainian manufacturer of drones, including drones-sprayers.	https://kray.technology/
Poletehnika	Autopilots or steering controls Mapping	One of the largest dealers and suppliers of machinery and agricultural equipment in Ukraine, including Trimble Ag.	https://poletehnika.com.ua/ru/

Agrosem	Soil moisture sensors and meteorological stations Drones Autopilots or steering controls GPS trackers and fuel control sensors	One of the largest dealers and suppliers of machinery and agricultural equipment in Ukraine, including John Deere, Metos, DJI.	https://agrosem.ua/
AMACO	Shutdown of sections / nozzles Mapping Differentiated application	Dealer and supplier of machinery and agricultural equipment in Ukraine, including Trimble Ag and PRECISION PLANTING	https://amacoint.com/
Agri 2.0	Autopilots or steering controls GPS trackers and fuel control sensors Shutdown of sections / nozzles Mapping Differentiated application	Supplier of various goods, including equipment for precision farming, software solutions.	https://agri2.com.ua/
Agrotek	Autopilots or steering controls GPS trackers and fuel control sensors	Official dealer and supplier of John Deere equipment and solutions	https://agrotek.in.ua/
Albion	Autopilots or steering controls GPS trackers and fuel control sensors	Dealer and supplier of machinery and agricultural equipment in Ukraine, including TOPCON	https://www.albion.biz.ua/

Eridon-Tech	Autopilots or steering controls GPS trackers and fuel control sensors Shutdown of sections / nozzles Mapping Differentiated application	Dealer of agricultural machinery and equipment, incl. for precision farming - parallel control systems, differential application, etc.	http://www.eridon-tech.com.ua/
Zeppelin	Autopilots or steering controls	Dealer of agricultural machinery and equipment, supplier of Valtra automatic control systems	https://zeppelin-agro.com.ua/
Titan Machinery	Autopilots or steering controls GPS trackers and fuel control sensors Shutdown of sections / nozzles Mapping Differentiated application	Dealer of agricultural machinery and equipment, incl. for precision farming - parallel control systems, differential application, etc.	https://www.titanmachinery.ua/index.php
ABA «ASTRA»	Autopilots or steering controls GPS trackers and fuel control sensors Differentiated application Drone	Dealer of agricultural machinery and equipment, incl. for precision farming - parallel control systems, differential application, drone-sprayer, irrigation system etc.	https://astra-group.ua/
Soil Lines	Mapping Soil map	The Soil Lines analyzer is designed to determine the chemical composition of soil in the field in real time. It allows for effective, affordable, detailed monitoring of the composition of soils and the level of their pollution, to carry out reasonable fertilization of fields and to receive advice on further expedient work, it is necessary to carry out with the land.	

eFarmer	Autopilots or steering controls Mapping	Agricultural startup that offers a parallel driving navigation system via a smartphone for more accurate land cultivation with agricultural machinery, with the function of recording and analyzing these operations.	https://www.efarmer.nl/about/
GeoMeter	Autopilots or steering controls GPS trackers and fuel control sensors	Designed to measure the area of the fields using a satellite GPS / GLONASS signal	https://gpsgeometer.com/index.html

Software products

Module	Cropio (CY)	Climate FV (USA)	Farmers Edge (CA)	Agri-Chain (UA)	Soft.Farm (UA)	EFarmer (NL)	Xarvio (DE)	AgriLab (UA)	OneSoil (BL)	PreAgri (UA)	Geosys (USA)	Sensilize (IL)	Agro-Online (UA)
Land bank analytics	+	+	+	+	+	-	-	-	-	+	-	-	+
Soil testing	-	+	+		-	-	-	+	-	-	-	+	+
Downloading and analyzing data from UAVs	+	+	+	+	+	-	+	+	+	+	+	+	+
Satellite images	+		+	+	+	-	+	+	+	+	+	+	+
NDVI	+	+	+	+	+	-	+	+	+	+	+	+	+
Soil moisture maps	+	+	+	+	-	-	+	+	-	-	+		+
Soil maps		+					+	+	+	+	+	+	+
Weather stations	+	+	+	+	+	-	-	-	+	-	+	+	+
Weather forecasting	+	+	+	-	+	-	-	-	+	-	+	+	+
Soil moisture at different depths	+		+	-	+	-	+	-	-	-	+	-	-
Agrodiagnostics of fields		+	+	+	+	+		+	-	-	+	-	+
Prediction of diseases and pests	+		+	+			+						

Seeding control (productivity analytics)		+			+	-	-	-	-	-	-	-	+
Cost control (performance analytics)	+	+	+	+	+	-	-	-	-	+	+	-	+
Yield forecast (productivity analytics)	+	+	+		-	-	+	+	-	+	+	+	+

Source: <https://travelite.com.ua/tochne-zemlerobstvo-ta-agro-it-rishennia/>

Mobile Applications

Name	Type	Description
Connect Mobile (update) (USA)	Agronavigators	The John Deere Connect Mobile application is suitable for monitoring the operation of equipment and optimizing the operation process. Helps to understand in general, how during field works various knots of the car are loaded.
AkerScout (USA)	Agronavigators	Designed to monitor the condition of crops and identify areas that require immediate treatment
Farmobile Notes (USA)	Agronavigators	The application is designed to obtain data from the equipment on which the EFR equipment is installed (Electronic Field Records). This type of equipment is designed to collect data on agricultural machinery during the works.

Pocket Drone Control	Agronavigators	The application is designed to simplify work with UAV Crop Copter. Allows you to quickly determine the damage from meteorological events or pests
WineFlight Precision Ag (PRI)	Agronavigators Diaries	Application from UAV-IQ is designed to process data coming from UAVs, resulting in reduced losses, optimization of field processing costs, increased yields. When downloading the results of the field survey, places that require immediate cultivation, cultivation, and selective harvesting are automatically marked.
AgriXP (CA)	Diaries Directories	The platform is designed to store field status data. The application allows the farmer, employee or consultant to obtain information about all actions performed in this field
FieldAlytics Explorer (USA)	Diaries Directories	Platform for storage and processing of data on field cultivation and the results of agrochemical analysis of soil
XTEND (USA)	Agronavigators	An application that transfers the dashboard from the built-in Topcon in-cab display to the smartphone and displays the current speed of the equipment, readings from fuel sensors, and other data.
Taranis (IL)	Recognizers	Application to control the level of infestation of the field with parasites. According to the results of the field images, it finds "hot" places of infection.
Syngenta Ukraine (CHE)	Directories	The application includes all agronomist calculators, a guide to pests, diseases, plant protection schemes, etc. All standards in

		calculators and reference books are tied to Ukrainian legislation.
Agrobaza (LT)	Directories Recognizers	Encyclopedia of pests, weeds, catalog of diseases and pesticides. It has a built-in function to identify weeds, diseases and insects
Geometer (UA)	Agronavigators Area meters	Allows you to measure the area and breakdown of fields with subsequent storage of data in the cloud web service Agroprofile. It is possible to check the boundaries, points and locations of plots on the Geocadaastre map.
Geotrack EVO (UA)	Agronavigators	Application for parallel driving and agronavigation systems
Mobile agronomist (UA)	Diaries Directories	The official app from Kernel. Allows the agronomist to perform field management on the consumption of seeds, pesticides, goods and materials, etc.
Bayer: assistant agronomist (DE)	Directories	Includes a directory of plants and pests, linked to Ukraine, calculators for agronomists
Agrio (IL)	Directories Recognizers	A professional-level mobile application for detecting plant diseases and pests by photos, satellites and weather forecasts.

Annex III

Matrix of opportunities

	Solutions	Opportunities	Types of agrarian	Restrictions
1	Electronic field maps	<ul style="list-style-type: none"> ● Assistance in drawing up of maps ● As part of the land reform, land inventory ● Land accounting solution 	<p>up to 1000 ha 1-3 thous ha</p>	<ul style="list-style-type: none"> ● Software ● Training on further use
	Satellite maps or NDVI in the operation of agricultural enterprise	<p>Up to 3 thousand ha</p> <ul style="list-style-type: none"> • Assistance in generating or acquiring satellite and NDVI data <p>3+ thousand ha</p> <ul style="list-style-type: none"> • Increase in image accuracy and quality • Exclusion of the cloud factor <p>Communities:</p> <ul style="list-style-type: none"> • Land accounting for tax payments • Control of grass burning in fields and forest fires 	All	<ul style="list-style-type: none"> • Software • Training on further use • Need for electronic cards
	Mapping of the fields - agrochemical analysis, control of compaction or mapping of yield	<ul style="list-style-type: none"> ● Necessary for the subsequent use of technologies of differential application or sowing 	All	<p>Up to 3 thousand ha</p> <ul style="list-style-type: none"> ● Software and analysis ● Learn to use the obtained data in further work ● Need for electronic field maps ● Presence of competitors in the market

2	Direction indicators, autopilots or steering controls during various technological operations - sowing, tillage, spraying	Most of the farmers equipment is not fitted with such equipment due to the old age of the equipment, respectively, either a solution is needed to re-equip the equipment or replace it	up to 1000 ha 1-3 thous ha	Availability of a large selection of hardware and competitors on the market
	GPS trackers and fuel control sensors	<ul style="list-style-type: none"> • Changes in the law on the carriage of goods; • The need to track transport during the transport of goods and control weight; • The use of fuel and the daily report on the movement of fuel (established at the level of the law); 	up to 1000 ha 1-3 thous ha	Availability of a large selection of hardware and competitors on the market;
3	Drones, including for spraying operations	<ul style="list-style-type: none"> • Popularization of spraying in ultra-low doses and spot. For holdings - sale of drones, software, pilot training. For small and medium-sized agricultural enterprises and farmers - provision of services; 	All	<ul style="list-style-type: none"> • Part of the processes when spraying from a drone is not legally regulated; • Presence of big competitors in the market with their own software
4	Soil moisture sensors and meteorological stations	<ul style="list-style-type: none"> • Use in the South of Ukraine due to climate change • Irrigation (subsidies to farmers to purchase irrigation and drip irrigation equipment) • Cooperation with local authorities to control water resources 	All	<ul style="list-style-type: none"> • Need for constant communication with the farmer on the results of data and training in their correct use; • For more active use of moisture meters or water level sensors, it is necessary to make changes to the legislation to create associations of water users
5	Software predicting pests and diseases	due to climate change other types of pests and diseases may appear	All	<ul style="list-style-type: none"> • Great orientation of agronomists on their own experience;

				<ul style="list-style-type: none"> ● Holdings often have their own systems for identifying diseases and pests; ● Availability of the manufacturers and distributors of plant protection products with their own programs, to be sold or provided along with the products sold.
6	Farm management systems	<ul style="list-style-type: none"> ● There are few software products for farmers, they are rarely used because of the cost; 	Up to 3 thous ha	<p>difficult integration with small farmers due to:</p> <ul style="list-style-type: none"> ● availability of less innovative technology; ● a small number of digitized lands; ● little experience in using software products and analyzing data that can be collected from equipment (in the case of an apartment part); ● difficulties for owners in training personnel to work in integrated management systems, especially with regard to resources accounting;

Annex IV

List of interviewed Dutch companies

AgroCares - provide solutions for soil chemical analysis using a handheld scanner that uses spectral data for chemical analysis and data processing in software. In Ukraine they are represented through distributors who are responsible for the distribution of AgroCares solutions among small farms, agricultural holdings, agricultural consultants and other agricultural companies.

Netherlands Space Office (NSO) - Dutch government non-profit organization. Advocates and encourages increased use of satellite data in the Netherlands and beyond. Help Dutch companies grow their businesses internationally.

Agurotech - sensors for assessing the state of moisture, salinity and soil temperature with their own software algorithms for determining the crop water need in irrigation.

eLEAF - satellite monitoring of crops with a focus on biomass production and yield forecasting. At the moment, any satellite data can be used to obtain the desired accuracy (spatial and temporal resolution).

AgriFac - the manufacturer of the sprayer, the main feature of which is the high accuracy of plant protection products application - “every drop is in the right place”.

VanderSat - provides satellite monitoring services for crops and field conditions. There is a promising service for determining moisture reserves in the soil, as well as remote sensing algorithms that exclude the influence of clouds, so they can regularly provide up-to-date data on the state of crops.

Blik Sensing - pressure based liquid level sensors and remote sensing telemetry equipment (loggers). At the moment used only for ground water level monitoring. There are two versions of sensors:

Blik Water – use LoRa networks and can work up to 8 years with no maintenance.

Blik Global Water – use satellite data transmission from Hiberband. Additionally the company can offer a wide range of custom remote telemetry options with custom sensors.

Eijkelpamp Soil and Water - research level precision equipment for soil and water sampling, measuring and monitoring: laboratory and field research equipment; augering and soil sampling equipment; water and groundwater samplers; soil, water and weather sensors; sediment and manure samplers.

Dacom Farm Intelligence a high-tech company that develops and supplies specialized hardware, software and online advisory services to arable farms and the agribusiness around the world. Also products are available for aggregating yield, plot and climate data etc. Through centralized data collection and analysis, farmers have a better understanding of crop growth and can also integrate their operational processes.

AeroVision - an independent consultant for procurement of (geo) information in the areas of precision farming, monitoring systems based on data from UAVs or satellites, as well as the development of solutions for integrated plant protection in greenhouses

This is a publication of
Netherlands Enterprise Agency (RVO)
Prinses Beatrixlaan 2
PO Box 93144 | 2509 AC The Hague
T +31 (0) 88 042 42 42
E klantcontact@rvo.nl
www.rvo.nl / <https://english.rvo.nl>

This publication was commissioned by the Netherlands Enterprise Agency,
the Embassy of the Kingdom of the Netherlands in Kyiv, Ukraine

Implemented by: Ukrainian Agribusiness Club, ucab.ua, info@ucab.ua

© Netherlands Enterprise Agency | November 2021

Netherlands Enterprise Agency is a department of the Dutch ministry of Economic Affairs and Climate Policy that implements government policy for Agricultural, sustainability, innovation, and international business and cooperation. Netherlands Enterprise Agency is the contact point for businesses, educational institutions and government bodies for information and advice, financing, networking and regulatory matters.

Netherlands Enterprise Agency is part of the ministry of Economic Affairs and Climate Policy.