# B1.6 The use of mobile phones (smartphones) and tablets in precision agriculture

## Smartphone technology

Smartphone technology is showing great promise for agricultural development as it can both facilitate and improve many operational processes in agricultural production. It can also be used in combination with other technologies using elements of *precision agriculture*. Technical innovations such as computers, the *internet, mobile phones* and *smartphones* have been used and introduced for the first time, mainly in urban and peri-urban areas. Later, these technologies were also applied in more remote rural areas. Thus, mobile applications are mainly used in developed areas where they can be combined with elements of precision farming, depending on the availability of the *Internet*, which is currently very topical with the introduction of the 5G network.

Smartphones not only enable information gathering and provide better connectivity with suppliers and customers, but also, if used correctly, can largely reduce the financial costs of operations, for example, by using apps for controlled land fertilization. Smartphones are also increasingly being used to download and watch video tutorials and instructional or demonstration recordings. Smartphones with functional apps can also be used to facilitate data collection, processing and analysis in the field. They also allow easy interaction with *wireless sensors* in crop (soil moisture sensors with the ability to time irrigation starts, monitor temperature in warehouses, detect and analyze diseases, calculate application rates, search for market prices or link to *GPS* apps) and livestock (e.g., a sensor for continuous tracking of cattle), enabling farmers to stay connected to their farm wherever they are throughout the day. By allowing farmers to collect, store and analyze highly up-to-date data, these online applications facilitate their farm management *decision making processes*. This is a topical issue because many applications related to the introduction of modern elements in crop and livestock production depend on *"smart" systems*. In particular, it is about the potential for smart applications to be used across farms and enterprises, regardless of the location of the farm and therefore the production area or the gender and age of the users (1)

Figure 1: Examples of smartphone data display.sourced (2)

In the picture above we see an example of displaying or visualizing data on a monitor and on a smartphone. An essential element of *visualization* is the clarity of the displayed data, because in today's IoT world we already have a large amount of data that needs to be well interpreted.

## Visualization

Vsualization is the main access point to data for most users. It is a graphical representation of information and data. Visualization can be a relatively simple, and most importantly, a method of

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presenting the knowledge contained in the source data and information in a way that can be understood by the general public.

When using visual elements – a *graph*, *chart* or *map* – data visualization tools provide a way to see and understand status, trends, outliers and patterns in data.

The volume of data produced worldwide is growing rapidly every year. *Sensor data* makes up a large part of this volume, especially with the development of IoT. The usefulness of this data is mainly when some knowledge can be extracted from it and appropriate decisions can be made based on this extracted knowledge.

Various examples of graphical visualization of big data include:

- **Linear lists of items**, items ordered by a single element such as text.
- **2-D/planar/geospatial***:* cartograms, point distribution maps, proportional symbol maps, contour maps.
- **3-D/volume***:* 3D computer models, computer simulations.
- **Temporal***:* timelines, time series charts, connected scatter plots, arc charts, pie charts.
- **Multidimensional***:* pie charts, histograms, matrices, marker clouds, bar charts, tree maps, heat maps, spider charts, area charts, box and skew charts, bubble cloud, sphere chart, circle plot, Gantt chart, network, polar surface, scatter plot (2D or 3D), stream plot, wedge stack plot.
- **Tree/hierarchical***:* dendrograms, radial tree graphs, hyperbolic tree graphs.
- A basic type of sensor data visualization uses graphs and charts to represent measured data in a time series (3).

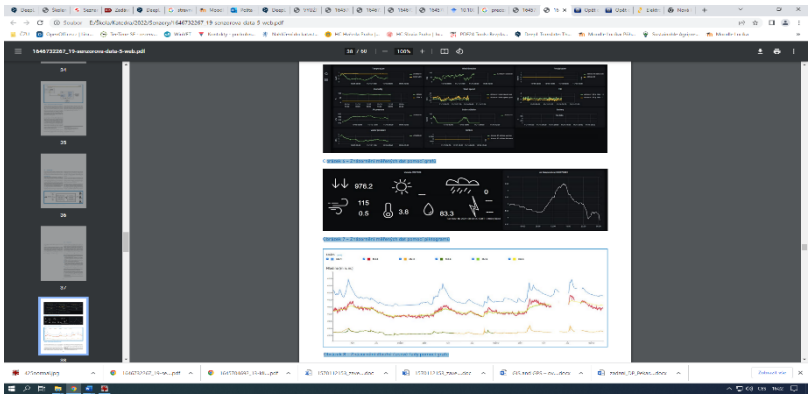

Figure 2: Data visualization - graphs diagrams. Source (3)

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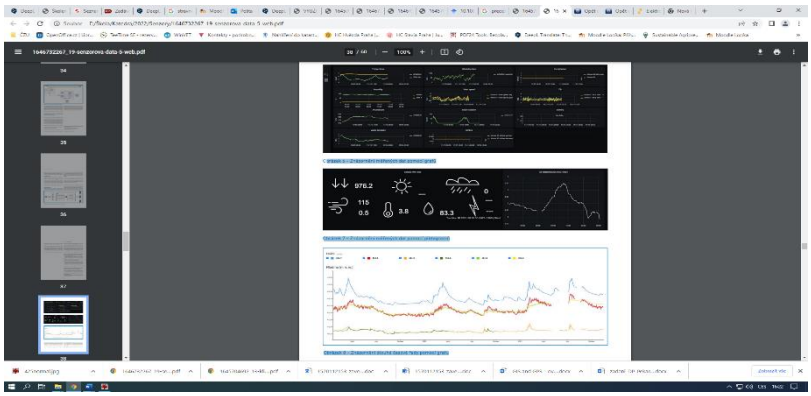

Figure 3: Data visualization - pictograms. Source (3)

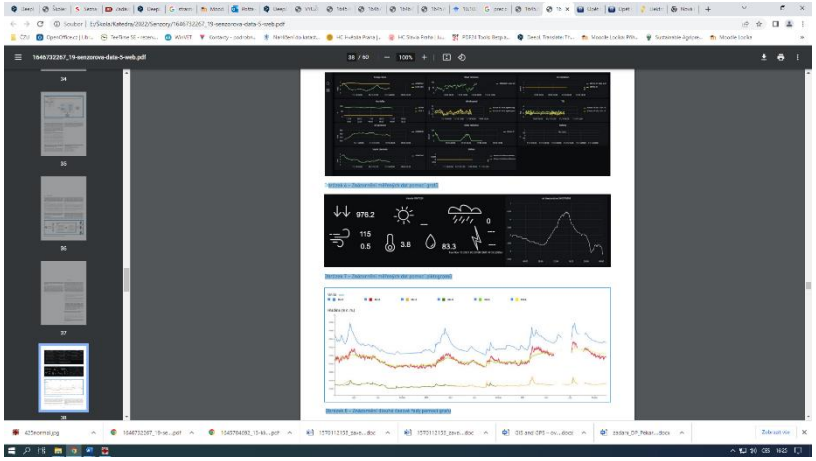

Figure 4: Data visualization - time series Source (3)

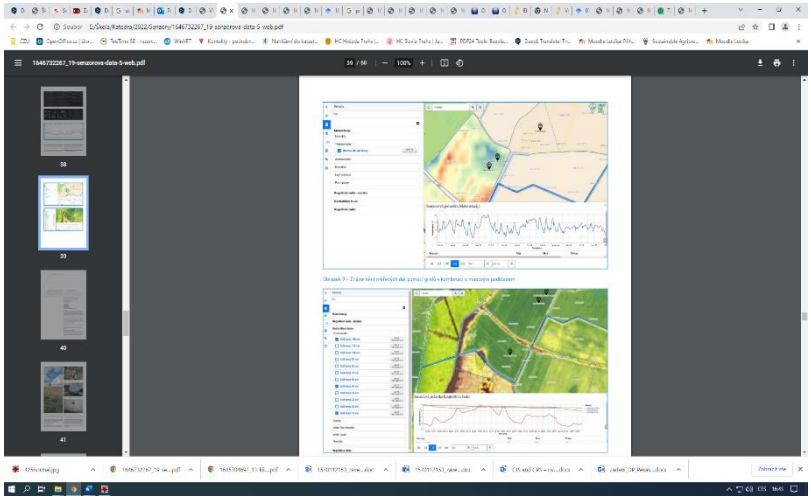

Figure 5: Data visualization - combination of map base and graph. Source (3)

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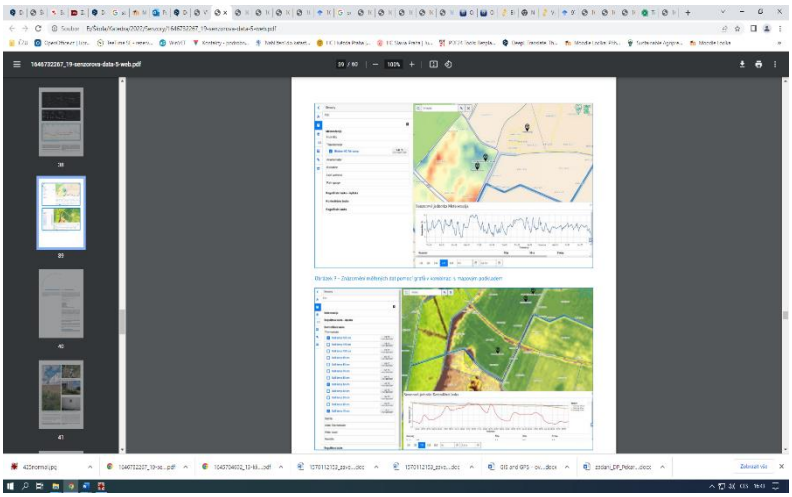

Figure 6: Data visualization - combination of a map base (remote sensing of the earth) and a graph Source (3)

Images and videos are also very popular tools of visualization - interpretation in mobile devices, which are also used for this purpose. A good example is the placement of these multimedia objects in the environment of social networks.

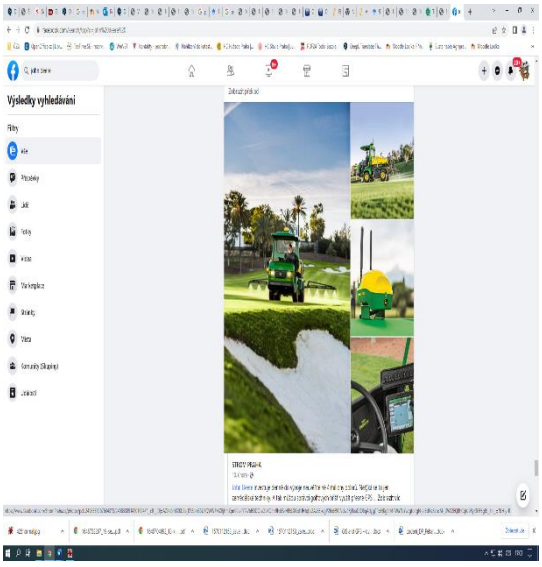


Figure 7: Data visualization - photos, video. Source (4)

## Links to relevant topics

1) MICHELS, Marius, et al. Smartphone adoption and use in agriculture: empirical evidence from Germany. Precision Agriculture, 2020, 21.2: 403-425., adapted from doc. Mgr. Jitka Kumhálové, Ph.D. ČZU v Praze

2) ŠUSTA, Václav. Precision farming made better again It will make it easier for you and your wallet. Http://www.newholland-biso.eu [online]. 30.3.2017, 2017 [cited 2022-08-30]. Available from: http://www.newholland-biso.eu/vsechny-clanky/opet-dokonalejsi-system-precizniho-zemedelstvi/

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3) Kepka, M., Musil, M., & Charvat, K. (2021). USE OF SENSORS IN AGRICULTURE. Pilsen, Pilsen, Czech Republic. Retrieved from https://www.ctpz.cz/publikace/vyuziti-senzoru-v-zemedelstvi-1070

4) Https://www.facebook.com/search/top?q=john%20deere [online]. 2022. John Deere, 2022 [cited 2022-08-30]. Available from: https://www.facebook.com/search/top?q=john%20deere

**Key words**

*mobile phones*

*smartphones*

*wireless sensors*

*decision making processes*

*„smart" systems*

*visualization*

*graph*

*chart or map*

*graphical visualization*

*linear lists of items*

*2-D/planar/geospatial*

*3-D/volume*

*temporal*

*multidimensional*

*tree/hierarchical*

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