# AGRICULTURAL DIGITAL TRANSFORMATION

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## DIGITALISATION FOR AGRICULTURE

Digitalisation for agriculture is the use of digital technologies, innovations, and data to transform business models and practices across the agricultural value chain.

Information systems in agriculture, ICT in agriculture, Smart farming, E-agriculture, IoT (Internet of Tractors) and many others similar ideas and approaches can be considered as Digitalisation of agriculture

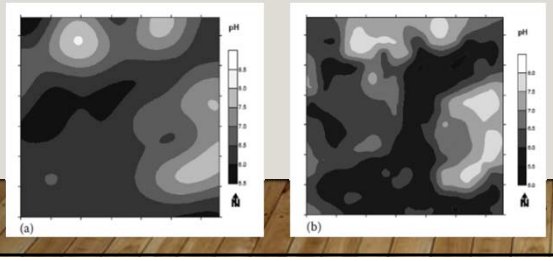
# DIGITALISATION FOR AGRICULTURE

- Agricultural activities are spread in time and space thus very interesting subject for advanced digital techniques,
- The world's first entirely machine-operated crop – a crop sown and tended without a human ever entering the field – was harvested in 2017, (OECD)
- The new technologies, low energy and high precision sensors, networks, embedded computers, big data processing capacities create favorable environment for applying digitalization in every piece of the food chain

# DIGITALISATION FOR AGRICULTURE

Source: Mulla, David, and Raj Khosla. "Historical evolution and recent advances in precision farming." Soil specific farming. CRS Press, Boca Raton, FL. https://www. taylorfrancis. com/books/9781482245349 (accessed 15 Nov. 2018) (2016).

- However the development of precision farming was one of the initial steps in digitalization of agriculture
- Up to 1980's main goal in applying fertilizers was uniform application
- Many researcher worked on intensive soil sampling (grid sampling) and created maps that can be used for "precise fertilizer application"
- Later the approach changed in "precision fertilization based on precision soil sampling."




Melsted sampled soil pH from 1961(left) to 1994 (right) in regular grid (24.3m), and his paper from 1967 is one of the first ever with interpolated maps for soil fertility data

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- Nielsen in 1973 reported soil hydraulic properties using geostatistic
- 1986 Mulla wrote the software that mapped soil fertility samples data into fertilizer recommendation (management zones) – first use of combination of GIS and Geostatistic for precision farming that was beginning of the "FARMING BY SOIL"
- However Pierre Richards is considered as father of "Precision farming" due to his work on promotion of the idea of farming by soil and organizing the first workshop "Soil Specific Crop Management" in 1993, even though the concept was proposed by Schueller (1991,1992)

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This lead toward development of new ideas and technologies that were applied in agricultural practice

- Variable rate fertilizer spreading,
- Site specific farming and management zones,
- Use of GPS in agriculture
- Automated tractor navigation and robots
- Yield mapping
- Variable rate herbicide application
- Variable rate irrigation
- Proximal sensing of soils and crops

## DIGITALISATION FOR AGRICULTURE

The digitalization in agriculture can find many applications in various areas as:

- Advisory and information services (knowledge, decision making…)
- Market linkages (e-commerce for inputs and food)
- Supply chain management (traceability, quality of input, certification…)
- Financial access (saving, credits, crowd farming, insurance….)

## DIGITALISATION FOR AGRICULTURE

The digitalization in agriculture can change the game:

- Embedded computers
- High precision low consumption sensors
- Big data
- Blockchain
- Globalisation

## DIGITALISATION FOR AGRICULTURE

The new big players are entering the game

(Microsoft, Google, Bosch, IBM, Alibaba…)

The big agri-players are still here

(Bayer, Syngenta, Yara, John Deere…..)

## DIGITALISATION FOR AGRICULTURE

# ARE WE READY?????

# NATIONAL CIRCUMSTANCES IN AGRICULTURAL SECTOR 2018 (AGRICULTURAL LAND USE)

| | 2018 | | | | | | |
|---|---|---|---|---|---|---|---|
| | Agricultural area | Cultivated land | Arable land and gardens | Orchards | Vineyards | Meadows | Pastures |
| REPUBLIC OF MACEDONIA | 1 264 139 | 518 740 | 418 140 | 16 827 | 24 088 | 59 685 | 744 66 |

Source: State statistical office

# NATIONAL CIRCUMSTANCES IN AGRICULTURAL SECTOR 2018 (EDUCATION OF THE FARM HOLDERS)

| | 2013 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | No education | Incomplete primary education | Primary education | Secondary education (agricult.) | Secondary education (other) | Higher vocational education (agricult.) | Higher vocational education (other) | University level education (agricult.) | University level education (other) | Master's degree and Doctorate (agricultural sciences) | Master's degree and Doctorate (other) |
| Republic of Macedonia | 6 656 | 17 950 | 60 055 | 5 350 | 66 363 | 596 | 4 757 | 1 201 | 7 223 | 202 | 227 |

Source: State statistical office

170 580 farmers (only 4% with education in agriculture, 50 % primary education and lower)

## NATIONAL CIRCUMSTANCES IN AGRICULTURAL SECTOR 2018 (EDUCATION OF THE FARM HOLDERS)

- Average farm size: about 2 ha
- Average plot size: 0,2 – 0,3 ha (each farm dispersed on 7 to 10 parcels in average)
- 170 580 farmers (only 4% with education in agriculture, 50 % primary education and lower)
- They manage 50% of the land and 70% of the water use in the country and use very dangerous chemicals

IS THIS SUSTAINABLE??????

## NATIONAL CIRCUMSTANCES IN AGRICULTURAL SECTOR 2018 (EDUCATION OF THE FARM HOLDERS)

**OUR AGRICULTURE NEED DIGITALISATION**

## COMPARISON OF THE AVERAGE FARM SIZE

- Average farm size:

| USA | Canada | EU - 28 | Czech Republik | Macedonia |
|---|---|---|---|---|
| 180 ha | 315 ha | 16.1 ha | 133 ha | 2 ha |

**CAN WE JUST TRANSFER KNOW-HOW FROM OTHER COUNTRIES???**

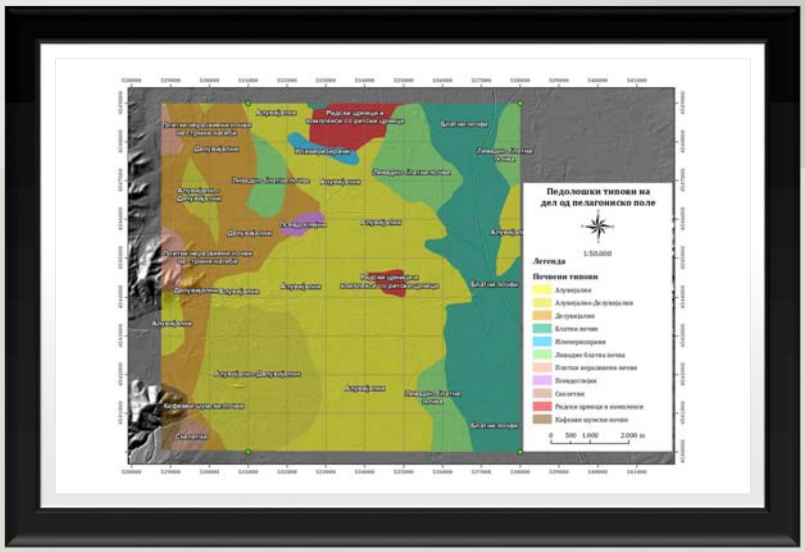
## STEPS TOWARD DIGITALISATION CASE 1: FARMERS SUPPORT SYSTEM FOR IRRIGATION IN PELAGONIA

- Project supported by IPA cross border cooperation with Greece in 2011 (Interactive Farmers Support System for Efficient Water Use Management-RULAND )
- Existing irrigation scheme, covering about 15 000 ha
- The project developed databases for soil properties important for irrigation (Bulk density, field capacity, wilting point, soil water retention functions, infiltration)
- One experimental site established with meteorological station and soil moisture sensors
- The irrigation recommendation was derived by model based on evapotranspiration, crop water requirement and soil moisture balance

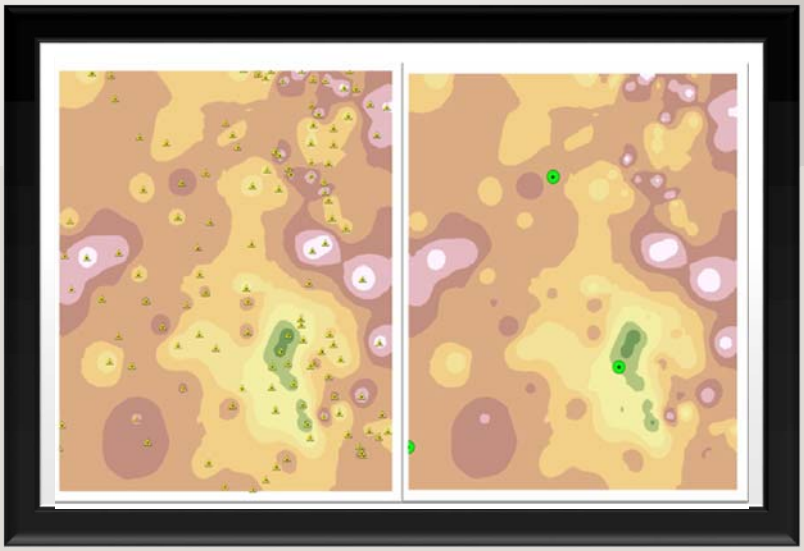
## STEPS TOWARD DIGITALISATION
## CASE 1: FARMERS SUPPORT SYSTEM FOR IRRIGATION IN PELAGONIA

- Farmers were welcomed to install soil moisture sensors on their fields and to correct the recommendation based on the sensor readings (personalization)
- Farmers were able to enter soil data in the system for more accurate recommendation
- Information delivered by web site

SOIL MAP – PELAGONIA (ONLY NAME AND BASIC SOIL PROPERTIES)



## SOIL MAP – PELAGONIA SOIL WATER PROPERTIES, SAMPLING, INTERPOLATEION AND VALIDATION



The Automated Weather Station was based on Campbell Scientific data logger and Vaisala sensors




Soil moisture measurement was based on Irrometer granular matrix sensor Watermark SS 200

## STEPS TOWARD DIGITALISATION
## CASE 1: FARMERS SUPPORT SYSTEM FOR IRRIGATION IN PELAGONIA

RESULTS:

- The system failed, never more than 100 farmers registered
- The sustainability was unsecure
- Two years ago, the system was completely closed, equipment was moved, and experimental site do not exist any more

## STEPS TOWARD DIGITALISATION
## CASE II: PRESPA REGION

- Project: Restoration of Prespa Lake Ecosystem -Support to the Introduction of Sustainable Farming Practices in the Prespa Lake Watershed (UNDP 2013-15))
- The project developed the system for recommending in irrigation and in crop protection
- The approach was to install number of automated weather stations (seven) and the stations were considered as representative for the locality were installed
- The irrigation component was based on model for estimating the evapotranspiration, crop water requirement and irrigation water requirement (weather and soil data)/ Moreover farmers were equipet with soil moisture data logger and trained in using soil moisture data for correction in the recommendation derived by the system
- The crop protection component was based on model for assessing the infection risk of one fungial disease Apple Scrab

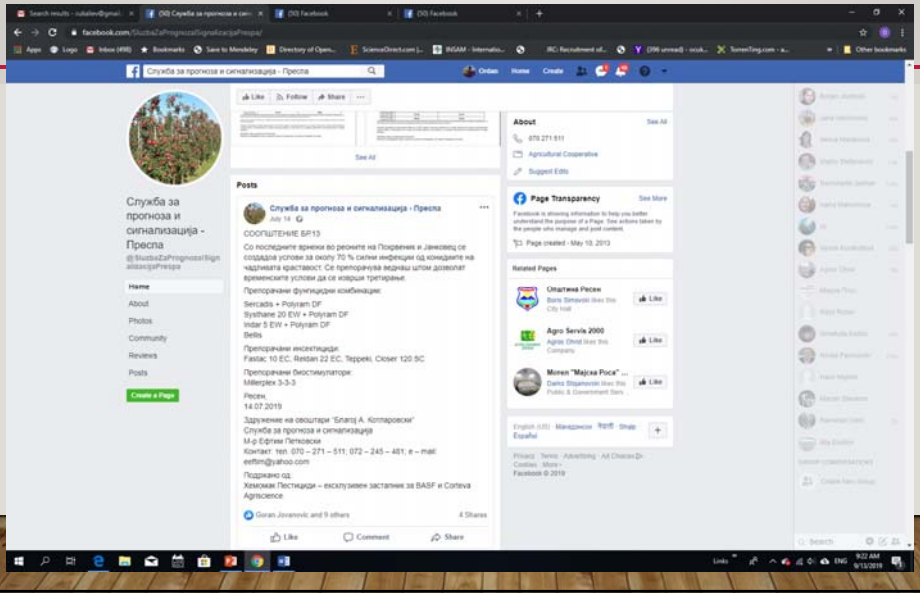
## STEPS TOWARD DIGITALISATION CASE II: PRESPA REGION

## STEPS TOWARD DIGITALISATION CASE 1: PRESPA REGION

RESULTS:

- The 70 farmers participated in the testing period.
- The average irrigation water saving was more than 60%
- Number of sprayings decreased from average 10-15 to 5-7 (50% reduction)
- The system raised big interest among the farmers
- The irrigation component is not operational in present, but spraying component is active and upgraded

## STEPS TOWARD DIGITALISATION
## CASE II: PRESPA REGION – FACEBOOK INFORMATION




## STEPS TOWARD DIGITALISATION
## CASE II: PRESPA REGION – REASONS FOR SUCCESS

- Area is small – less than 5000ha
- There is only one crop from importance – apple
- Survey for establishing the base situation and farmers expectation was conducted
- More than 10 years of precious presence of the same team in the region
- Economic power of the farmers and cost of their production (wheat grower with 2 ha will get about 1200 Eur annually (3t/ha with price of 0,20 eur/kg). Apple growers will get minimum of 10000 EUR from same area (yield of 20 t/ha and 0,25 EUR/kg).

## STEPS TOWARD DIGITALISATION
## CASE II: PRESPA REGION – (WHY CROP PROTECTION IS SUCCESFULL STORY, AND IRRIGATION NOT)

- Cost induced
- Each application of pesticides is about 100 euro per hectare
- Reducing 5 applications during the season per hectare is 500 EUR
- Irrigation cost is associated with pumping cost. (about 200kw of electricity annualy)
- Saving is about 120 kw, or maksimum of 12 euro assuming industrial electricity prices.

## STEPS TOWARD DIGITALISATION
## CASE III: STRUMICA RIVER CATCHMENT

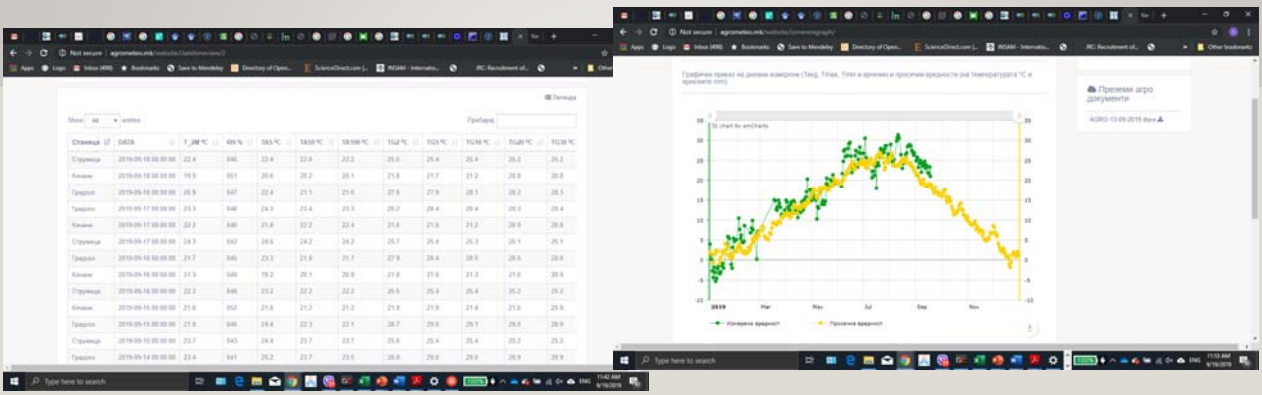
- Project: Technical Assistance for Introduction of Sustainable Farming Practices in the Strumica River Basin (UNDP 2015-now))
- The project is developing the system for recommending in irrigation and in crop protection
- The idea was to replicate Prespa story
- The irrigation scheduling system is not centralized, but individual equipment is installed on each participating farm

## STEPS TOWARD DIGITALISATION
## CASE III: STRUMICA RIVER CATCHMENT

RESULTS

- Results are hardly visible
- Much bigger area
- Huge number of farmers, different crops, varieties, hybrids, systems of production
- No previous presence in the region (everything is new for the farmers and they are much more interested in basic topics than in digitalization)

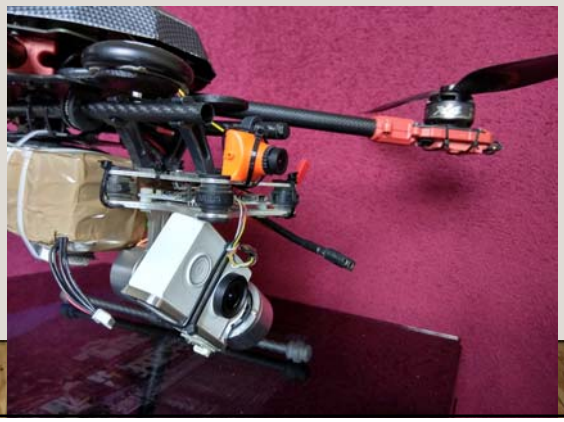
## STEPS TOWARD DIGITALISATION
## CASE IV: FAO SUPPORT DEVELOPED WWW.AGRIMETEO.MK



## STEPS TOWARD DIGITALISATION
## CASE IV: FAO SUPPORT DEVELOPED WWW.AGRIMETEO.MK

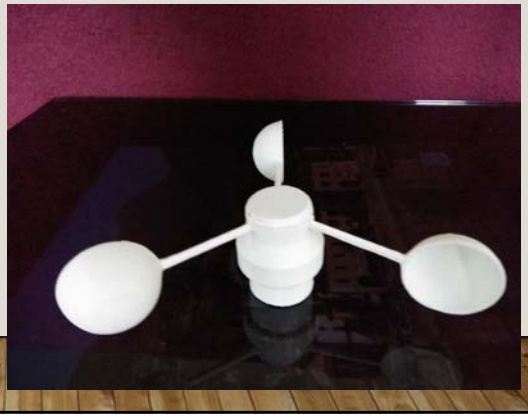

## STEPS TOWARD DIGITALISATION
## CASE V: NON-PROJECT ACTIVITIES

DEVELOPMENT OF THE LOW-COST EQUIPMENT AFFORDABLE FOR SMALL FARMERS: UAV (DRONE with NDVI camera)



## STEPS TOWARD DIGITALISATION
## CASE IV: NON-PROJECT ACTIVITIES

DEVELOPMENT OF THE LOW-COST EQUIPMENT AFFORDABLE FOR SMALL FARMERS: UAV (AWS with temperature, relative humidity, wind speed and rain gauge sensors)



## NEW DEVELOPMENT AT FASF - SKOPJE

- Sensor networks
- LORAWAN
- We still hope that low cost equipment that will be produced locally will increase level of digitalization among small farmers.
- One integrated solution packed in the envelop farmer will like
- The higher-level automation is required for the activities farmers do not like to use (irrigation)

## WHAT NEXT

I am looking forward for

INTERNET OF CROPS

# THANK YOU FOR YOUR ATTENTION

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