Crop Monitoring as an E-agricultural tool in Developing Countries

REPORT ON CGMS WORKSHOP

NOVEMBER 2-4, 2011, HEFEI, CHINA

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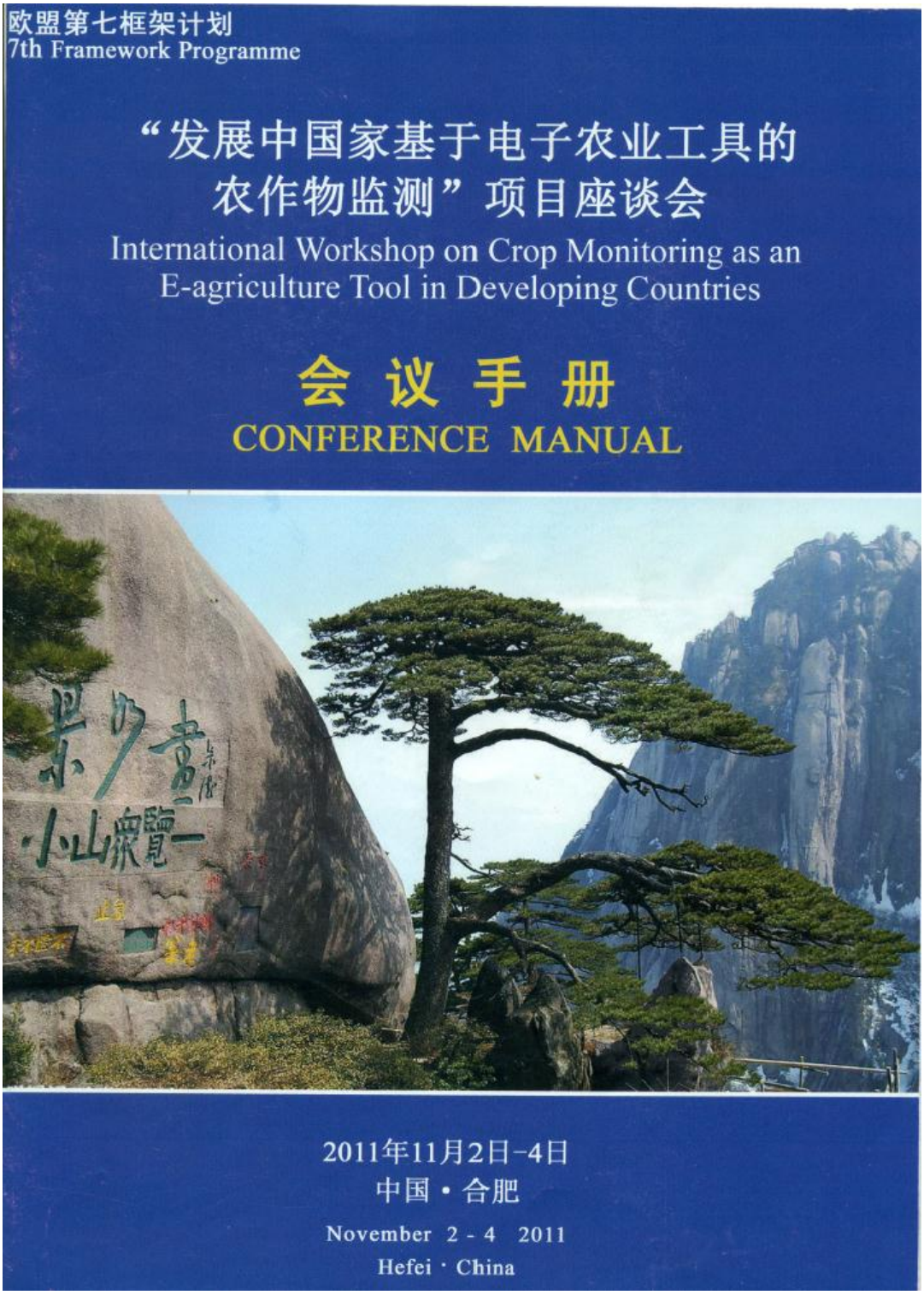

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Contents

1. Acknowledgement

Many thanks to the Prof. Hu Zaisheng, Director of the Anhui Institution For Economic Research, for the invitation and the support and the hospitability. Thanks to Dr. Dong QINGHAN and Dr. Yang QING for the excellent organization of this workshop. Many thanks also to Dr. Allard de Wit and ir. Raymond van der Wijngaart for their presentations and their technical contribution to the E-Agri Project.

2. List of participants and their representatives

Political leaders and experts:

Wu Jingsong: Vice Chairman, Anhui Development and Reform Commission

Frank Greco: First Counsellor, Head of Information Society and Media Section, EU Delegation

Jiang Yan: Assistant to First Counsellor, EU Delegation

Yang Bo: Ph.D, Director, Information Office, The General Office of the People's Government of Anhui Province

Yang Xiaoyang: Director, International Cooperation Office, Science and Technology Department of Anhui Province

Chen Youping: Deputy Director, Anhui Provincial Science & Technology Exchange Center with Foreign Countries

Prof. Dong Qinghan: VITO, Belgium

Prof. Allard de Wit: ALTERRA, Netherlands

Prof. Raymond van der Wijngaart: ALTERRA, Netherlands

Prof. Charles Situma: Ministry of Environment and Mineral Resources, Kenya

Prof. Hicham Marzouki: National Meteorological Direction, Morocco

Prof. Wei Guo: School of Information Science and Technology, University of Science and Technology of China

Teng Fei: Ph.D, Chinese Academy of Agricultural Sciences

- Members from Anhui province:

Prof. Hu Zaisheng: Director, Anhui Institution for Economic Research

Prof. Ma Zhongmo: Deputy Director, Anhui Institution for Economic Research

Jiang Xudong: Associate Prof., Assistant Director, Head of Institute of Geographical Information, Anhui Institution for Economic Research

Wang Xueping: Senior Economist, Head of Institute of Training Department, Anhui Institution for Economic Research

Xu Zhenyu: Associate Prof., Head of Institute of Regional Development and Environment Resource, Anhui Institution for Economic Research

3. Agenda of the workshop

Tuesday, November 1st

Registration

Wednesday, November 2nd

Time: 08:30-18:30

Place: Gui Yuan, No. 1 Meeting Room

Chair: Prof. Ma Zhongmo

Time Slot	Agenda	Speaker
8:30-8:40	Welcome Address	Hu Zaisheng
8:40-9:00	Speech	Wu Jingsong
9:00-9:30	Collaboration in the ICT sector between EU and China; some flagship projects	Frank Greco
9:30-9:50	Presentation of the information development in Anhui	Yang Bo
9:50-10:10	Introduction of ICT project	Wei Guo
10:10-10:30	**Coffee Break(Take a group photo)**	
10:30-11:00	Introduction of E-AGRI project	Dong Qinghan
11:00-11:30	Crop monitoring using agro-meteorological models in Europe	Allard de Wit
11:30-12:00	Crop monitoring in Anhui province	Xu Zhenyu
12:00-14:30	**Dinner(Gui Yuan, Bai Lu Hall)**	Wu Jingsong
14:30-18:30	Social activity (city –tour)	
18:30	**Supper(Liangyuan Revolving Restaurant)**	

Thursday, November 3rd

Time: 08:30-17:50

Place: Gui Yuan, No. 2 Meeting Room

Chair: Prof. Dong Qinghan

Time Slot	Agenda	Speaker
8:30-10:00	Introduction to the WOFOST model: principles, processes, parameters Exercises with the WOFOST Control Centre	Allard de Wit Raymond van der Wijngaart
10:00-10:20	**Coffee Break**	
10:20-11:50	Introduction to the WOFOST model: principles, processes, parameters Exercises with the WOFOST Control Centre	Allard de Wit Raymond van der Wijngaart
12:00-14:30	**Lunch(Daoxianglou Hotel, East Building Restaurant)**	
14:30-16:00	Introduction to the Crop Growth Monitoring System (CGMS) and its database	Allard de Wit Raymond van der Wijngaart
16:00-16:20	**Coffee Break**	
16:20-17:50	Introduction to the Crop Growth Monitoring System (CGMS) and its database	Allard de Wit Raymond van der Wijngaart
18:00	**Dinner(Yintong Hotel)**	

Friday, November 4th

Time: 08:30-17:50
Place: Gui Yuan, No. 2 Meeting Room
Chair: Prof. Dong Qinghan

Time Slot	Agenda	Speaker
8:30-10:00	CGMS operations and maintenance, understanding and visualizing CGMS output	Allard de Wit Raymond van der Wijngaart
10:00-10:20	**Coffee Break**	
10:20-11:50	CGMS operations and maintenance, understanding and visualizing CGMS output	Allard de Wit Raymond van der Wijngaart
12:00-14:30	**Lunch(Daoxianglou Hotel, East Building Restaurant)**	
14:30-16:00	Introduction to and exercises with the statistical toolbox for crop yield forecasting	Allard de Wit Raymond van der Wijngaart
16:00-16:20	**Coffee Break**	
16:20-17:50	Introduction to and exercises with the statistical toolbox for crop yield forecasting	Allard de Wit Raymond van der Wijngaart
18:00	**Dinner（Huadu Hotel）**	

Saturday, November 5th

Airport See Off

4. Reports

4.1. Day 1: Wednesday, November 2

Official Speeches:
Wu JingSong, Vice Chairman of Anhui Province Development and Reform Commission

在“发展中国家基于电子农业工具的农作物
监测项目”座谈会上的讲话
省发展和改革委员会副主任 吴劲松
2011年 11月2日

尊敬的各位专家，各位来宾，女士们，先生们:
大家上午好！
今天，欧盟第七框架计划“发展中国家基于电子农业工具的农作物监测国际合作项目”座谈会在安徽合肥召开。我谨代表安徽省发展和改革委员会对各位的到来表示由衷的欢迎！对会议的召开表示热烈的祝贺！
各位专家很多都是第一次来到安徽，我首先简单介绍一下安徽的基本省情和近年来经济社会发展情况。
安徽省总面积为14万平方公里，是中国华东地区的内陆省份，东与长江三角洲相临。现设16个地级市、105个县（市、区）。长江、淮河横贯安徽境内，将全省划分为淮北平原、江淮丘陵和皖南山区三大自然区域。多样的地形地貌、悠久的历史和南北交融的文化造就了安徽独特的自然、人文风光。境内遍布名山秀水，著名的旅游景点有“天下第一奇山”黄山、佛教圣地九华山、道教圣地齐云山、“南天一柱”天柱山，以及被联合国教科文组织列入世界遗产名录的风格独特的皖南古民居群等。安徽是中国史前文明的发祥地之一，人杰地灵，文化底蕴深厚，老庄哲学以及闻名于世的京剧、黄梅戏发源自我省。
安徽不仅有丰富的自然文化资源，悠久的历史，而且区位优势明显，发展潜力较大，近年来经济社会科教等事业发展较快。2010年全省国内生产总值（GDP）12263.4亿元，位居全国第14位，GDP增速居全国第8位。安徽科技整体实力居全国前列，拥有中国科学技术大学、合肥工业大学、安徽大学等大批高等院校，以及以中科院合肥物质研究院为代表的一系列科研院所。省会合肥是目前唯一的国家科技创新型试点城市，是除北京以外全国大科学工程最密集的地区。雄厚的科技实力已经成为我省经济社会发展的重要优势和推动力。
安徽也是农业大省，粮食大省，是全国重要的粮食生产基地。全省共有耕地面积408万公顷，2010年粮食总产量616.1亿斤。目前，在人口增加、耕地减少和全球气候变化背景下，我省乃至世界农业生产的可持续发展都面临着挑战。如何在一个农业大省，切实加强粮食生产能力、预警能力以及粮食安全的保障能力一直是大家所关注的

重要问题。因此，我们迫切希望通过引进国内外农业科技新技术、新成果，特别是农业信息技术成果来解决这些问题。
“发展中国家基于电子农业工具的农作物监测”这个国际合作项目，正是基于这些背景而开展的，项目旨在将欧盟关于电子农业的先进工具CGMS和相应成熟技术引入我省，建立适应我省实际情况的作物生长监测平台。本项目成果将对科学指导我省农业生产，调整农业结构，制定相应农业政策具有重要的现实意义和示范作用。同时，这个项目的开展也将为安徽省发改委及其他政府部门和研究单位今后参与欧盟第七框架计划项目提供一定的借鉴。
作为一个具有重要意义的国际合作项目，省发改委从前期论证到项目立项、项目实施都给予高度重视和大力支持，目前已将此项目申报省科技厅国际合作项目，以期获得我省和国家的进一步支持。承担本项目合作研究任务的安徽省经济研究院具有较强的科研实力和雄厚研究基础，拥有丰富的遥感、地理信息系统以及农业资源的研究、应用经验。我相信，通过各国专家间的通力协作、通过项目科研人员的努力工作，该项目一定能够取得预期研究成果。
最后，祝各位来宾，各位专家在安徽工作交流、生活愉快！预祝座谈会取得圆满成功！预祝“发展中国家基于电子农业工具的农作物监测”国际合作项目取得丰硕成果！

Frank Greco: First Counsellor, head of the Information and Society Media Section, European Union Delegation in Beijing

Vice Chairman Wu Jingsong,
Professor Hu Zaisheng,
Director Yang Bo,
Professor Wei Guo,
Distinguished Guests,
Ladies and Gentlemen,

It gives me great pleasure to speak at this workshop on Crop Monitoring as an E-agriculture tool in developing countries. This is a project supported by the European Union under the Information Society Technologies (IST) Programme managed by DG Information Society of the European Commission. This is appropriate, since the focus of the project is the adaptation of new information and communication technologies (or ICTs) to agriculture. I will talk further about this general topic later on.
On the details of the e-Agri project, I look forward to listen to the distinguished experts present at this workshop. I would like first of all to thank the Development and Reform Commission of Anhui Province for organizing this workshop and salute all Chinese project partners (the Chinese Academy of Agricultural Sciences, Anhui Institute for Economic Research and Jiangsu Academy of Agricultural Science), as well as their European and African counterparts, too many to mention here. You are all vital elements for the successful conclusion of this project.

Let me first recall that, over the years, Europe's cooperation with China has evolved into a strategic partnership based on common interests.
Our overall cooperation has been gradually strengthened to face the joint challenges that confront both, Europe and China, in an ever more globalized world, such as climate change, pollution, energy needs but also the ever-growing global population.
Last week the UN announced that it had reached 7 billion, an increase of 1 billion in just 12 years. Both Europe and China can be justly proud to have overcome famine, although the memories of widespread hunger of the last century are still with many of us.
However, tackling the need to nourish the increasing population is particularly acute in the developing world, and is a priority for these countries' governments. An active partnership with more developed countries is essential in this undertaking and Europe and China are both engaged in supporting the efforts of developing countries to feed their populations.
Whilst in many countries famine is not an issue anymore, the countryside is increasingly confronted by other issues: depopulation, insufficient wages, lack of adequate service provision, a rapidly-ageing population… The European Union already works together with China on all these important challenges.
Helping farmers and the agro-food sector to meet ever-changing market requirements, improving production yields and quality and making agriculture sufficiently profitable to motivate people to remain in the sector are all important goals for policy-makers at all levels. ICT has a key role to play in achieving these goals.
The agricultural sector can be sub-divided into three main "phases":

- Pre-cultivation, including crop and land selection, calendar definition and access to credit;
- Crop cultivation and harvesting, including land preparation, fertilisation, sowing, and water and pest management;
- Post-Harvest, with produce marketing, transportation, packaging and processing.

Each of these steps can benefit from specific ICT solutions, which increase the information available in the process, thus improving decision-making.
For instance, production forecasts and yields can be optimised by the use of Earth observation technology, whilst networking tools and e-commerce can be used to improve access to credit, and to facilitate the operation of the supply chain from the producer to the consumer.
Interest at the highest political level is essential to make progress in this area.
The Chinese government has long considered this issue important, and has been addressing it under its overall national informatisation policy. The recent 12th Five-Year Plan has identified the construction of information infrastructure in rural areas as a priority to improve production and living conditions in these areas.
I would also like to recall the high-level international political commitments already addressing this topic, such as the World Summit on the Information Society (WSIS) of 2003 and 2005 sponsored by the United Nations, which aimed for a global effort to reduce the "digital divide", the increasing gap in ICT know-how between developed and developing nations. WSIS identified e-agriculture as one of the actions lines to be pursued by the members of the United Nations. In this area, two UN agencies, the Food and Agriculture

Organisation (FAO) and the International Telecommunications Union (ITU), have been active with other stakeholders since then.

The G20 group of countries is also increasingly involved in agricultural matters. The first meeting of G20 agriculture ministers took place in July this year and agreed a plan to step up food productivity and create an agricultural market information system that would collect information on stocks, and the supply and demand of crops, providing an early warning system to monitor commodity market information and limiting price volatility. This plan is expected to be endorsed by the leaders of the G20 group later this month in France.

The European Union has also been actively working on e-agriculture, with China as an important partner. For instance, in the last few years, the EU Delegation to China has managed two major projects in this area:

- The EU-China project Crop Growth monitoring and Yield forecasting in the North China Plain, from 2005 to 2007, had a similar focus to and paved the way for the e-Agri project, with the aim to transfer from Europe to China of know-how on the acquisition of agricultural information generated by Earth observation and communication technologies, notably crop monitoring and yield forecasting technology (CGMS). The shared policy goal of this project was to strengthen global monitoring of production and stock levels of agricultural commodities, as well as of food security.
- The EU-China Information Society project (INFSO) from 2004 to 2009 was a major collaborative activity (total budget of over 22 million €) to promote economic and social reform through informatisation in China. One of the main activities of the INFSO project was tackling the urban-rural digital divide and assisting China's rural areas to have adequate access to the on-going information revolution. In this context, the project undertook a study on ICT for rural development in China and in the EU. The study served to exchange experiences and compare the situation in Europe and China, and helped local and central decision-makers to develop practical policies and strategies on how to best use ICT for rural development in China. One of the study's main recommendations was to increase government support to rural and agriculture ICT research.

The e-Agri project fits well within the international policy activities and goals I have mentioned before. It is a useful step in the general introduction of ICTs in agriculture which is being supported by central and local governments across the world. If the project's approach is successful, one could see the benefits of expanding this experience nation-wide in China as well as in other countries. We will follow its progress and results with interest.

The introduction of ICT into agriculture and rural areas is an issue where the benefits are mutual and Europe will be glad to continue working with the Chinese government through expertise and knowledge transfer.

It is my strong wish that e-Agri will become a good example of China and EU working together to tackle common challenges. I wish all present a good and instructive workshop.

Qinghan Dong: Coordinator of E-AGRI project

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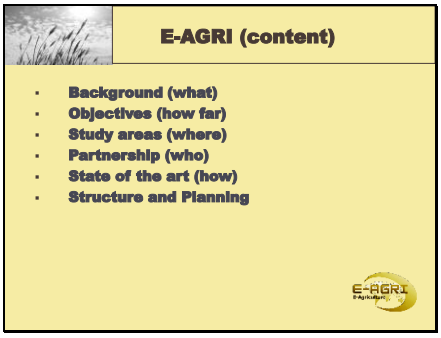
Slide 2



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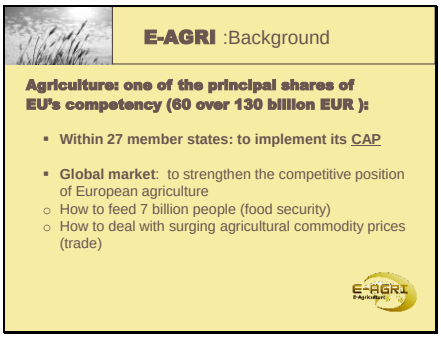

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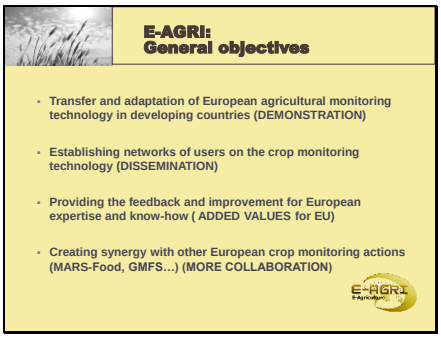

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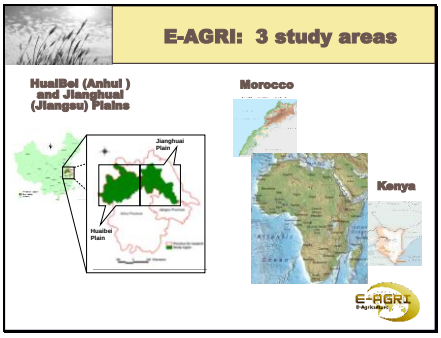

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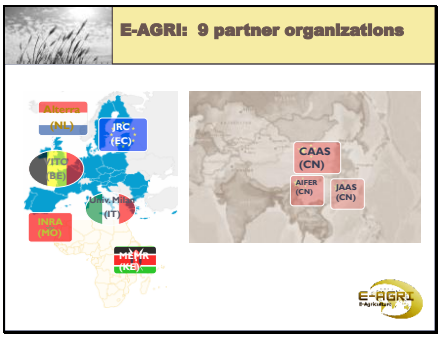

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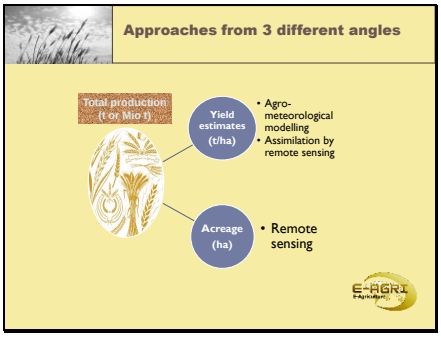

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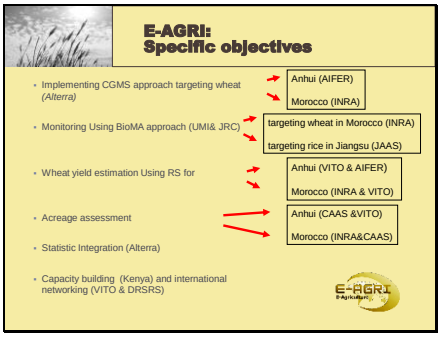

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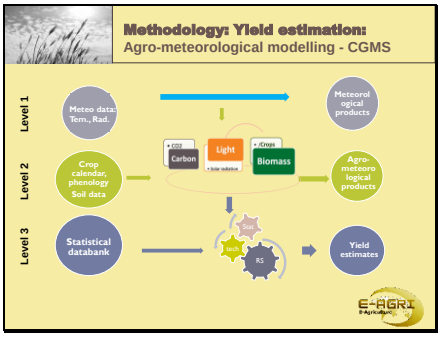

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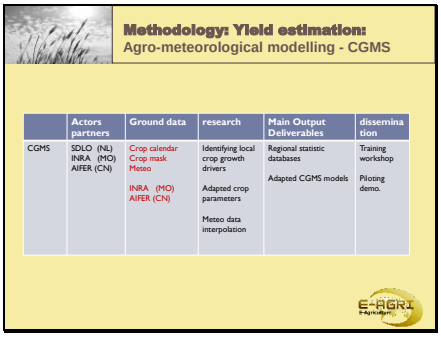

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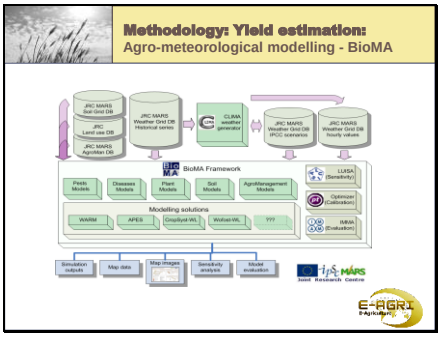

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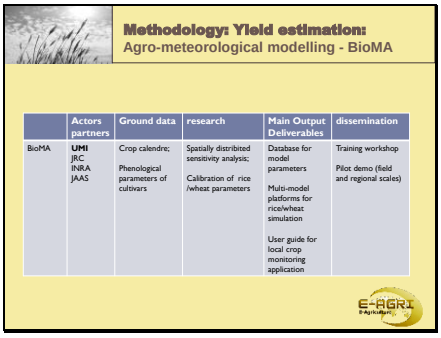

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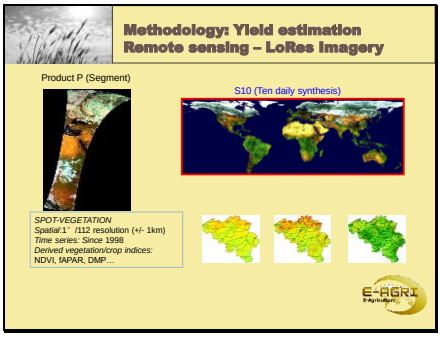

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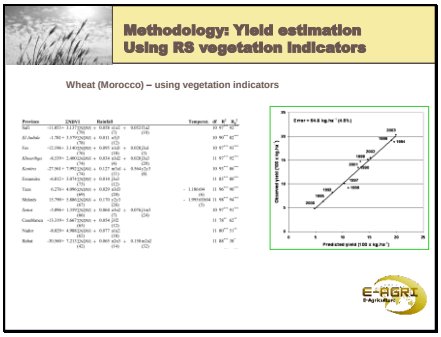

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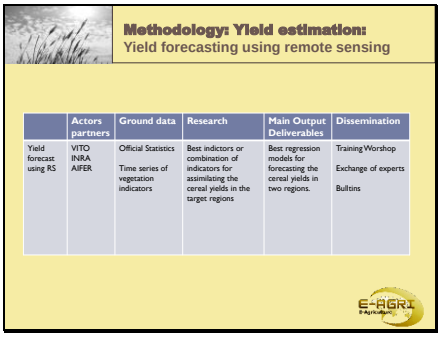

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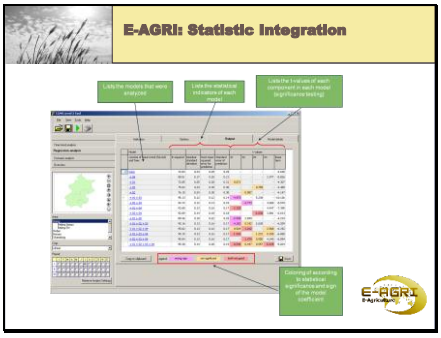

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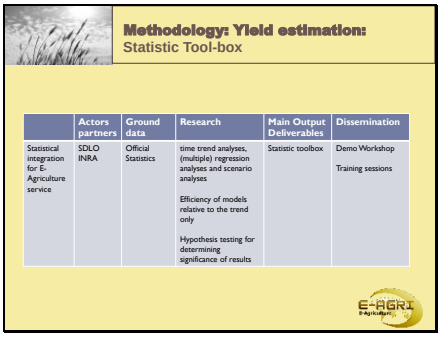

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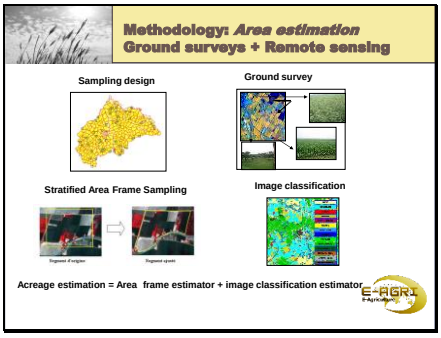

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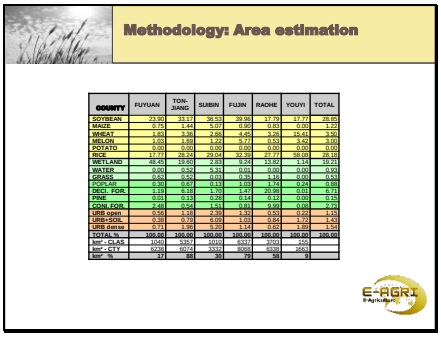

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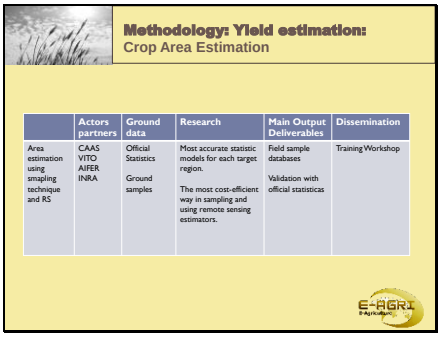
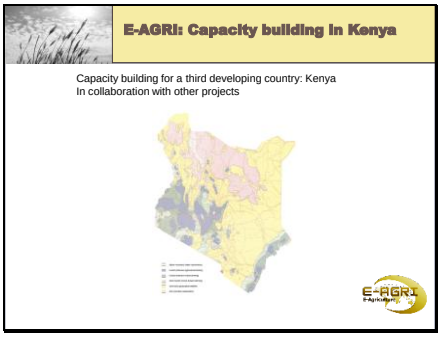


Slide 21



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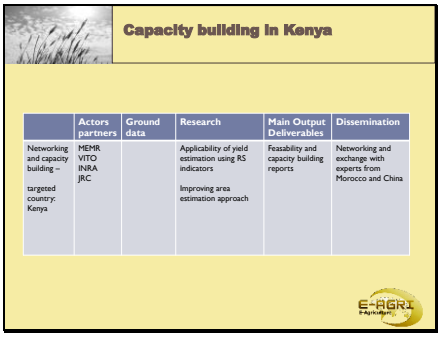

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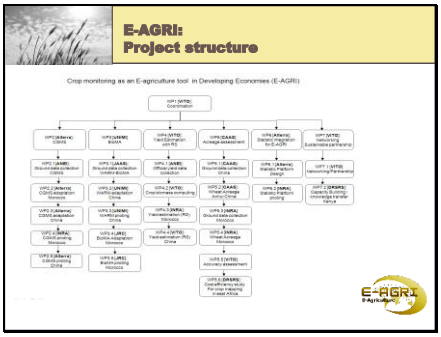

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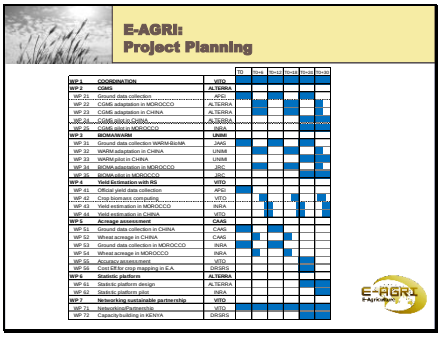
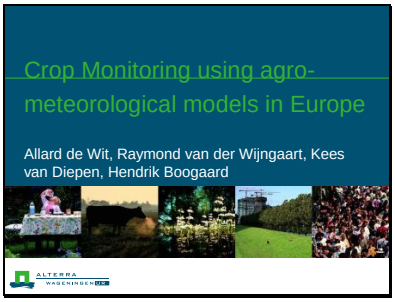


Slide 25

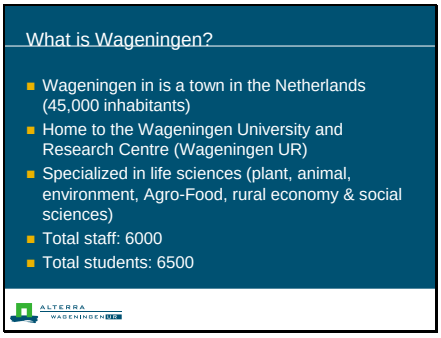
Allard de Wit: Crop monitoring using agro-meteorological Models in Europe

Slide 1



Slide 2

Slide 3



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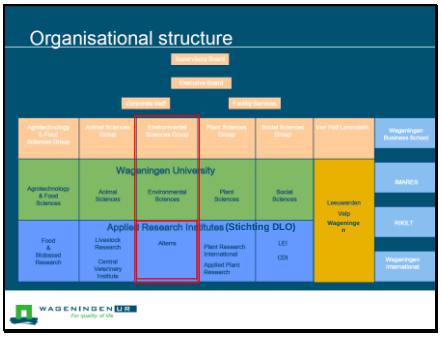

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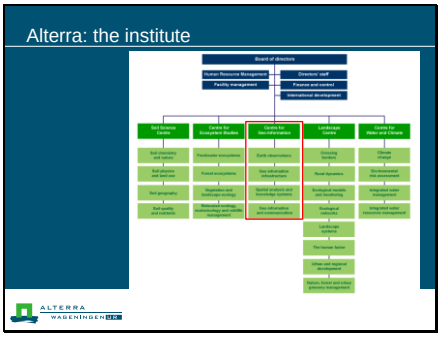

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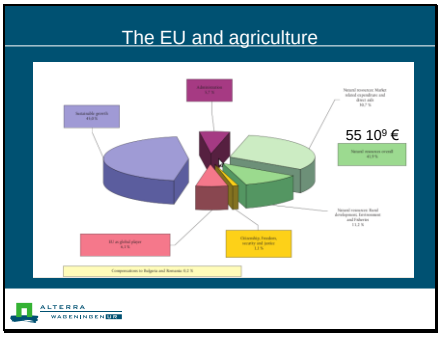

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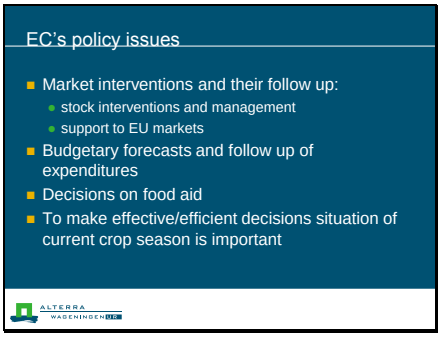

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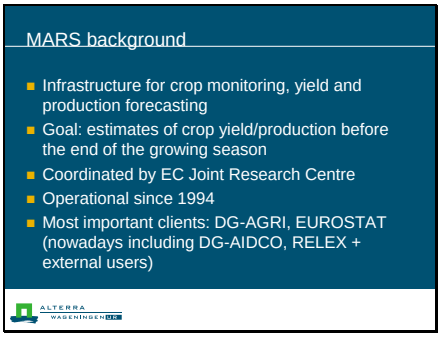

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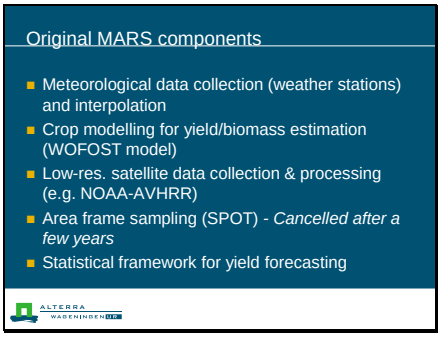

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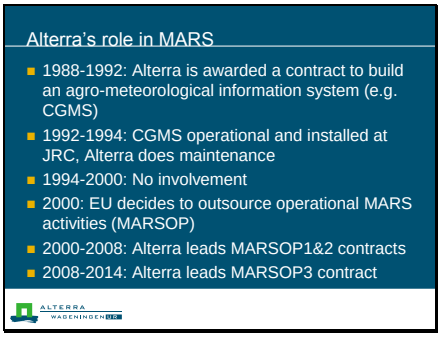

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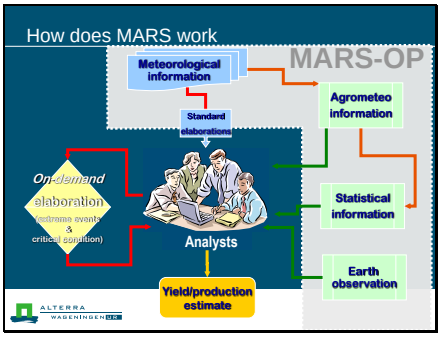

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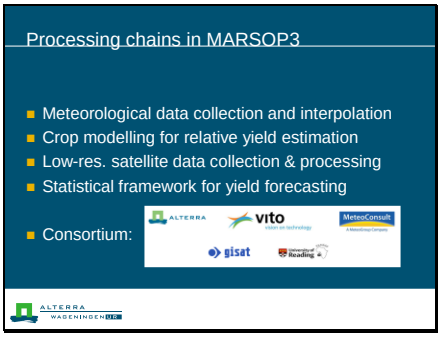

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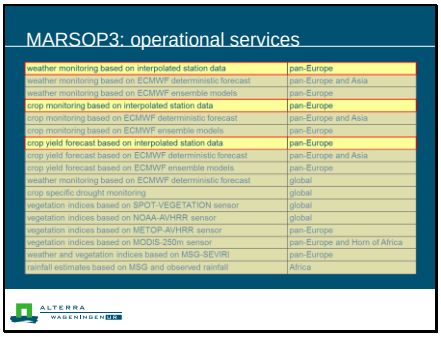

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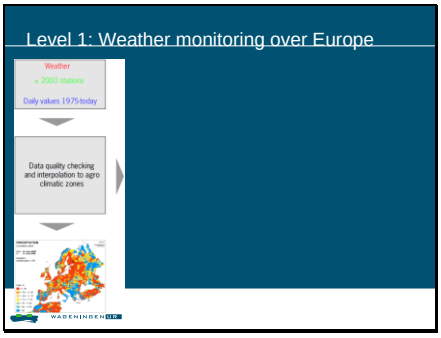

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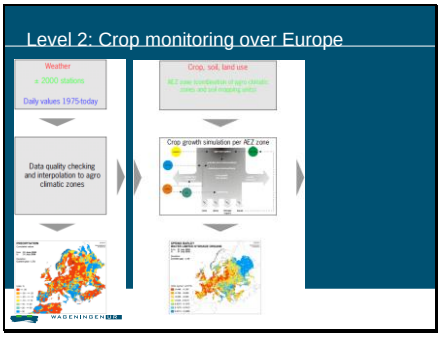

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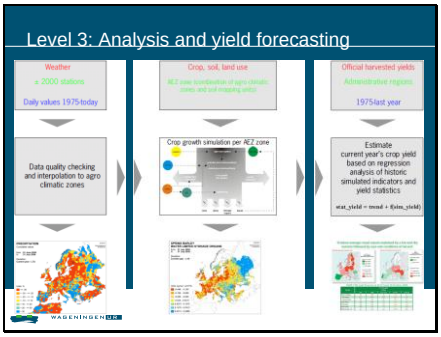

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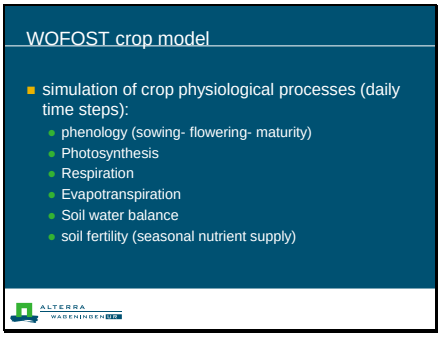

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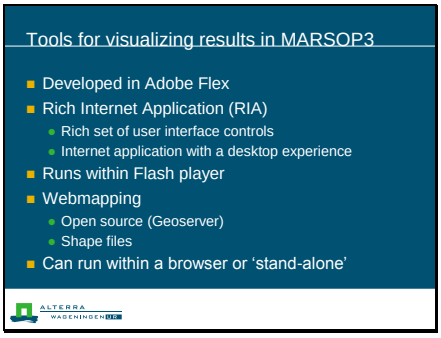

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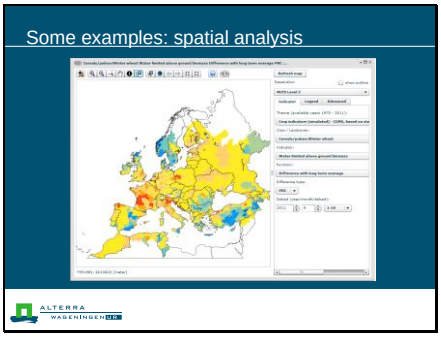

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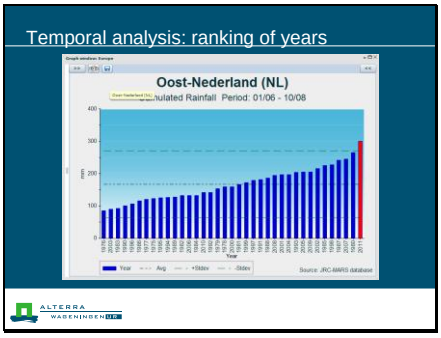

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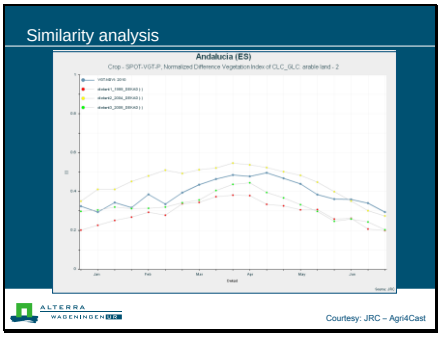


Slide 23

Slide 24

4.2. Day 2: Thursday, November 3

4.2.1. Wofost

The main objectives of this day are to learn the principals of the WOFOST model, how it can be implemented, how to configure different parameters and to practice some examples of use.

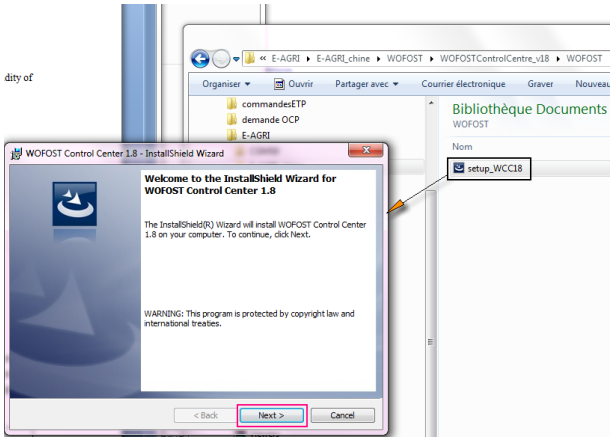
There is an inter-annual of yield variability of crops over regions and countries of the world. That's because the field is depending on multiple parameters: weather, meteorological data's, simulated yield data. All this parameters are used as predictors for the regional crop yield model (CGMS).

a) Installation of WOFOST

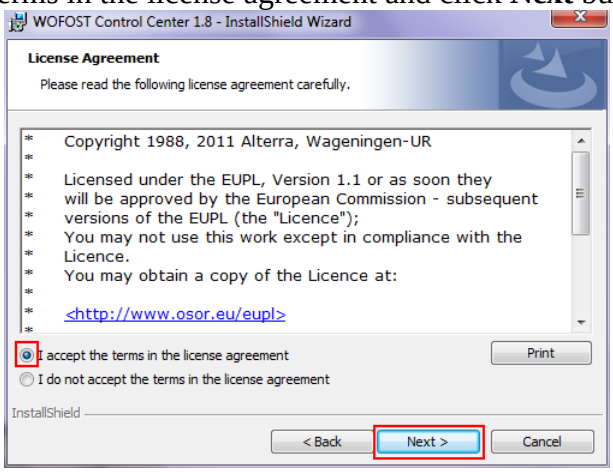
First, the WOFOST software should be downloaded from the web site: www.wofost.wur.nl . In this dedicated web site, we can also find the manuals and different slide presentations

to learn more about how to implement WOFOST correctly. There is also a wiki page for this software: http://wofost.wikispaces.com , where we can find FAQ pages, the FORTRAN source codes, the hard ware requirements and much other useful information.
How to install it?

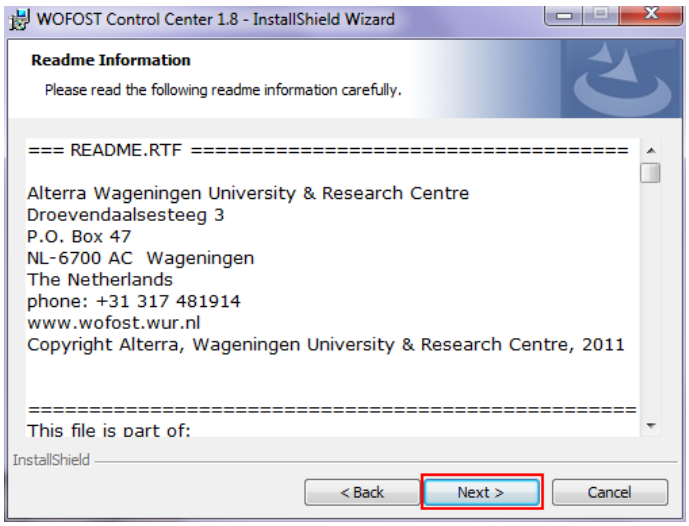
- **1:** to start the installation, we just lunch the **setup8WCC18.exe**, and click on **Next** button.



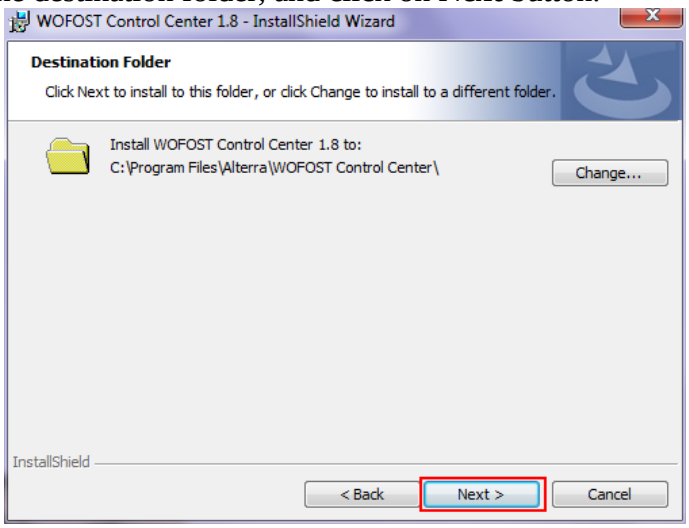
- **2:** Accept the terms in the license agreement and click **Next** button.



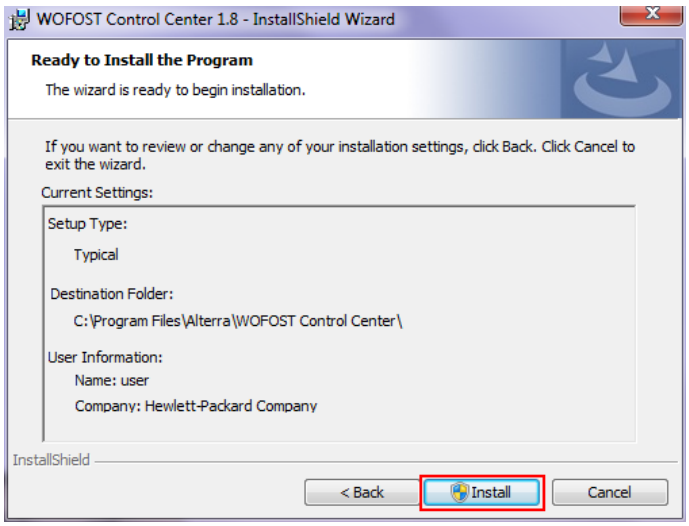
- **3:** After reading the readme information's, click on **Next** button.



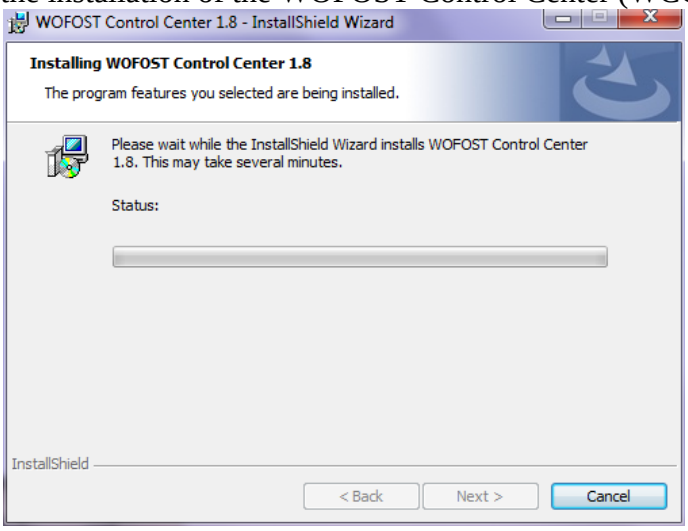
- **4:** Specify the destination folder, and click on **Next** button.



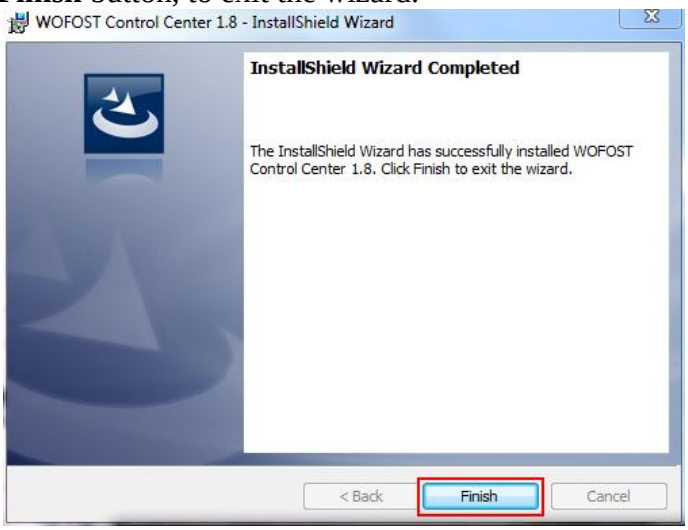
- **5:** click on **Install** button.



- **6:** Just wait the installation of the WOFOST Control Center (WCC) v1.8.

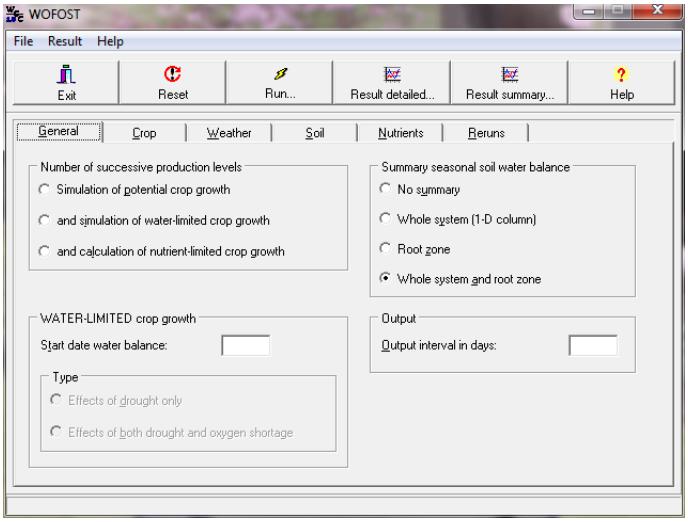


- **7:** Click on **Finish** button, to exit the wizard.

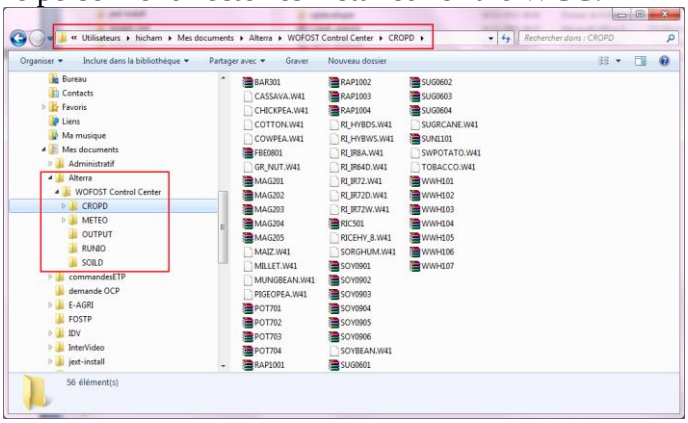


- **8:** A quick launch of WCC should be on Desktop.

- **9:** This is the main page of WCC.



- **10:** This is the personnel directories installed for the WCC:

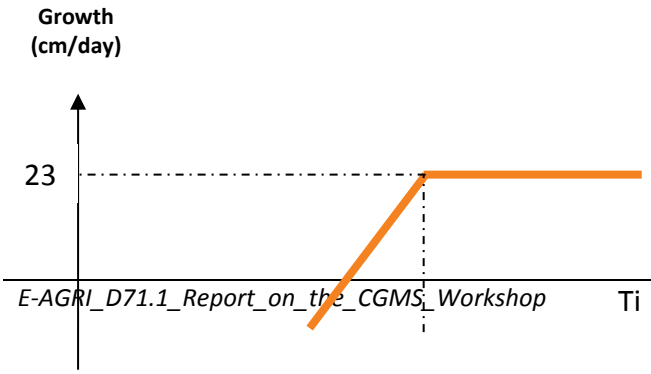


b) What is WOFOST?

WOFOST is a semi-deterministic crop simulation model. It can be run's in daily time steps. We can use single value parameters types for a specified point or tabular one's for regional scale. To manage the crop phonology evolution, WOFOST use the DVS parameter: the value zero is for the emergence step, the other values (1, 2, and 3) are used for others (maturity…etc).

c) The growth

The following graph shows the growth evolution (cm/j) per day depending of the sum of temperature of crops:



Sum of temperature

30

d) Light interception

The light interaction depends on three parameters: the first one is the solar radiation (Direct/diffuse...), the second is the LAI parameter (Leaf Area Index). The last one is the CO2 assimilation. WOFOST can manage the Leaf Area Dynamics, by using two parameters:

- The senescence which depend on the heat sum (SPAN), the PERDL or water stress, and KDIFTB (LAI>LAIcritic, LAIcritic=3.2/KDLF~5.5).
- LSUM, which is the $\sum_{class=1}^{n}$ biomass $*$ SLA

e) Transpiration

The crop's transpiration depends on the reference evapo-transpiration, the LAI and the humidity of soils.

f) Soil fertility

The soil fertility is not yet implemented in CGMS model.

g) CGMS limitations

The limitations of CGMS are:

- It's inherent to simulation techniques
- The chosen generalization
- The chosen system boundaries
- The limited knowledge of crop response relations.
- The observation data's are needed for a quick configuration of CGMS-WOFOST.

h) Trainings

All the trainings are described in the file named "WOFOST_Training_Anhui.pdf"

i) The first simulation

The WOFOST software can be installed just by executing the file already downloaded from the web site: www.wofost.wur.nl . Then we can launch the WCC (WOFOST Control Center) by double clicking on the quick link named "wcc" in the desktop. Then, the control center appears.

But before we can start our first simulation, we should make an ODBC connection to the mdb database used by the WCC, by following these few steps:

- First go to the **Control Panel**:

- Then go to **Administration tools**, then to **ODBC Data Sources**:

- Click on Add button:

- Select **Driver do Microsoft Access (*.mdb)**, then click on **Finish** button:
- Then **Select** button, to choice the mdb database for WCC:
- Now select where this mdb database is located:

In our case:

- Then tape a name for this ODBC connection:
- Finally, click on **OK** button, to finish this installation:

Following is first simulation that we tested:

steps	Menu	To do
1	General	
2	Crop: winter wheat	
3	Weather	
4	Soil parameterization	
5	Reruns	
6	Running WOFOST CC	
7	Result detailed	

The reruns can be used to calculate the sum of temperature that a crop needs to arrive in certain phonology step. For example, if we use the reruns (900, 950, 1000, 1050…) and run the WOFOST, then we can use the graph menu to select the DVS one. Then if we know the exact date (Julian day) corresponding to those phonological steps, then we can visually determines that 900°C is the sum of temperature that correspond to the maturity step, and that 950°C is the emergency's one.

j) Configuration files

To configure the WOFOST, we just edit the file DIRECT located in: "C:\Programme Files\Alterra\WOFOST Control Centres\".

Then, we can copy the file: "C:\Documents\Alterra\WCC\WWH.102N.CAB" in "C:\ Programme Files\Alterra\WOFOST Control Centres\CROPD\". Then we can modifie this file by using a text editor:

- The line started by "Line:" can be changed into "Line: name = test Sim". This is the name of this test simulation that will appear on the WOFOST application.
- The lines defining "∑T" can also be changed to specify the SUM1 and SUM2 constants. For our example, TSUM1=900 and TSUM2=950.
- To run WOFOST with the new parameters, first we should delete all the RERUNS, and then, we can select the CROP "test Sim". In the end, we can launch the WOFOST application by clicking on the RUN button.

4.2.2. CGMS

CGMS is the implementation of WOFOST for a hall region. First, we started this presentation by looking at the development (growth) for a crop, by using the fint formula:

$$D = 1 - e^{(-0.6*LAI)}$$

CGMS manage three levels:

a) **Weather mapping:** for all climatologically parameters (Tmax, Tmin…etc).
b) **Crop simulation:** for crop, soil and the land use. All this parameters can be visualized in maps.
c) **Yield forecasting:** for official harvested yields and other statistical tools. The result can also be visualized in maps.
d) **CGMS mdb Database:**

In CGMS, we transform the point model (WOFOST) into a regional one. The files are changed into tables in the CGMS database. It's a relational database containing:

- Base and derived tables and views.
- Different domains to control and manage extreme values for example.
- All table constraints.
- Other database specifications: Primary keys, procedures, indices for faster access to data.

CGMS can use also an oracle database. Sql Developper can also be used to access to the oracle DB data's. Many other tools were developed for the CGMS:

- Cgms.exe for a quick launch of CGMS.
- Supiconstant.exe to make forecast of yield crops.
- CgmsStatTool.exe to make statistics on yields estimation.
- Scripts, procedures and packages…etc

To visualize the CGMS outputs, we can use ArcGis/FME/OGIS or Custom Build Viewer.

4.2.3. Weather monitoring

The first level of CGMS is to monitor climatologically weather data's. We can also evaluate abnormal or alarming situations climatologically. Other useful thing in CGMS is to manage drought, extreme temperatures, and extreme rainfall during flooding or harvest.

This weather data will serve later as input for the crop simulations, after a quality testing and checking of course before any later use. Other important functionality of CGMS is the generation of a complete spatial and temporal coverage for a hall region. It's also possible to make interpolation of the climatologically data's to the grid, and also, to make downscaling easily.

a) Observed weather data:

To run CGMS, we need this daily data's: Precipitation, Temperature (maximal and minimal), Radiation or sunshine, cloud cover, Vapor pressure or humidity (maximal and minimal), Wind speed and Snows.

For this observed data's, CGMS will calculate new weather data's such as:

- The radiation at the surface of the ground, by using one of the three formulas (Angstrom, Supit, or Hargreaves). The Supit method uses sunshine, Tmax, Tmin, Longitude and Latitude.
- The evaporation of water at the surface (EO) and the evaporation of wet bare soil (ESO);
- The evapo-transpiration by using Penman Montith methode for the daily ETO, or other one if the data are not complete.

b) Weather monitoring:

Initially, we use ECMWF forecasts and analyses data's that we downscaled to generate climate data's in the CGMS grid. Then, we can use GIS tools for visualization of this new data's.

The ms access database contains 25x25 km grid, with administrative regions and pseudo stations. The tables that are used for managing the observed data's are:

- GRID: CGMS uses Albert projection for gridded observed data's.
- WEATHER_STATION
- METDATA

These last three tables are important to run CGMS.

- SYSCON
- SUPIT_REFERENCE_STATIONS
- CROP
- CROP_GROUP
- STAT_GROUP
- STAT_CROP
- NUTS

c) Similarity score:

There are three groups of similarities: RAIN, TEMP and REST. To calculate scores, CGMS use's the average functionality by calculating for each grid point:

- The distance is calculated using weighting average with only four nearest observations.
- The distance to the coast.
- If there is any difference or same uniform region (EMU).
- Distance between grid and center of gravity of stations.

d) Output tables of CGMS:

- GRID_WEATHER
- STATIONS_PER_GRID
- STATIONS_PER_GRID_CURRENTYEAR
- LONG_TERM_AVERAGE_GRID_WEATHER
- SUPIT_REFERENCE_STATIONS

All these last five tables are very important, and contain constants that should be specified for Morocco.

- CGMS_SYSLOG
- SUPIT_CONSTANTS: contains all constants used, not only by SUPIT method, but by the entire system.
- CALCULATED_WEATHER: to calculate even statistical means or the 360 records per station.
- REFERENCE_WEATHER
- WEATHER_DATA_AVAILABILITY

4.3. Day 3: Friday, November 4

4.3.1. CGMS system for crop simulations

The GRID_WEATHER table is the most important table that contains observation data's from the table METDATA, and also the weather calculated from observations (radiation, ETO…etc) available in CALCULATED_WEATHER.

a) Input data:

The weather data observation's are of course important, and should be available at the database. Then, we need crop parameter files to be correctly modified and upgraded. The third input data is the soil map files that should also be carefully implemented in the different tables of the CGMS database. We need also to configure administrative regions and special schematization.

b) Crop parameters:

These parameters are described in different CGMS database tables:

- CROP_PARAMETER_VALUE: where the different crops are described and where to go if we would like to add a new variety of crops.
- PARAMETER_DESCRIPTION: to describe the crop growth.
- VARIETY_PARAMETER_VALUE: here we can specify crop varieties. For example, the parameters TSUM1 and TSUM3 are specified in this table for the winter wheat.
- CROP_CALENDAR: this table is dedicated to specify the crop calendars. Also, we can identify, in this table, which crop is growing in which cell zone.
- CROP_GROUP: here we can specify the suitability of soil and spatial/temporal variations.

c) Soil map:

Soil characteristics	Spatial distribution or STU's
• SOIL_TYPOLOGIE_UNIT (STU): where we can define soil parameterizations. • ROOTING_DEPTH • SOIL_PHYSICAL_GROUP • SUITABILITY: to define the suitable STU per CROP_GROUP. • SITE: this table is dedicated to define infiltration of soil.	• SOIL_MAPPING_UNIT (SMU): to define the geographic regions mapping. • SOIL_ASSOCIATION_COMPOSITION: to determine which STU is included in which SMU.

d) Administrative regions:

In CGMS, regions are hierarchically structured, by using Nuts and different levels (country, city, province…). This is important for the aggregation of crop yields in AGGREGATION_AREA table.

e) Spatial schematization:

WOFOST combine spatially the weather, the soil and the crop by using a unique intersection between SMU (grid table, soil map) and EMU.

For example, for the grid number (GRID_NO) 69163, we can see in SIMULATION_UNIT table that this number exist in the field GRID, and correspond to 5 values in the field STU_NO, which means that WOFOST has been running 5 times for that grid. Now, in the table ELEMENTARY_MAPPING_UNIT, we can find these SMU_NO values. The soil map table SOIL_ASSOCIATION_COMPOSITION contains also these SMU_NO's and STU_NO's. That's simply how we can associate spatially weather, soil and crop.

f) Output table:

The output tables for CGMS are:

- INITIAL_SOIL_WATER
- CROP_YIELD
- GRID_YIELD
- NUTS_YIELD: for level 1(region), 2 and 3(country).

4.3.2. Conclusions and actions

Anhui test site: set-up the system

Meteorological data must become available:

- Locations of meteo stations and attributes:
  - Only data from 3 stations within Anhui province (up to 10 when surrounding area <250 km is taken into account) can deliver data (freely available over internet).
- List of meteo variables needed:
  - TMAX
  - TMIN
  - RAIN
  - WIND
  - VAPOUR PRESSURE
  - SUNSHINE (optional)
  - CLOUD COVER (optional)
  - MEASURED RADIATION (optional)
- List of available meteo variables:
  - To be checked by AIFER
- Archive of daily meteo data (2000-2011, preferably 1990-2010):
  - Possibly archive data can be retrieved from the national meteorological office. Disadvantage: 10 daily aggregates and no near real time (NRT) deliveries. This involves extra work: disaggregation from 10-daily to daily weather.
  - If the availability of observed weather data is delayed, alternative ECMWF data could be used during set-up (later to be replaced by observed weather). JRC will be asked to grant the use of downscaled ECMWF reanalyses product for ANHUI grid cells (+/- 240). This is a very limited amount of the JRC ECMWF archive.
- Regular updates of the meteo data (daily or 10-daily):
  - It will be unlikely that daily data will be come available in NRT during the project. At least with a 3 month delay.

Crop experimental data that must become available

- Observations of sowing date and phenology:
  - Dong Qinghan will contact CAAS (Chen Zhongxin) to request crop experimental data (phenology) from test sites in Anhui province.
  - Needed amount: 15 combinations of year / stations (for calibration: 3 stations, 5 years; for validation 2 stations, 5 years)
  - this seems feasible for Anhui province.
- Observations of yield, LAI, total biomass
  - Official statistical data of yield en total biomass are available.

Basic GIS data to be used:

- Soil map and attributes

    - Needed parameters: soil depth (rootable depth), porosity, field capacity and wilting point.
    - Possibly 1:500K map is available. Only available attribute is soil type according to Chinese classification. This would require a manual conversion to American classification. Within Anhui province only a limited number of soil types are present. This might be feasible.
    - Fall-back solution = FAO 1:5M
- Map of regions of Anhui
    - Available
- Crop mask showing locations of crop types
    - Only a general crop mask for cereals is available.
    - There is little difference between crop specific masks within Anhui province, therefor the general crop mask will do.
- Regional statistics of crop yield and area

Crop calendar

    - Available

Setup a database system

- Access (well-tested, limited to 2Gb)
    - Available and good option during setup because of
    - Because area is limited (+/- 240 25x25km grid cells)
    - Because no station weather, only 10 years of ECMWF grid weather.
- ORACLE (well-tested but expensive & complicated)
    - Option when database is growing
    - Needed when extra data become available
    - Needed when system runs in operational mode (oracle packages and procedures).
- MySQL (free, easy, but not yet well-tested: can be done in e-AGRI)
    - A number of scripts, oracle packages and procedures would need to be converted or rewritten.

Anhui test site: EC deliverables

Anhui usability report: Inventory of usability of CGMS for Anhui:

1. Inventory of available data sources and their suitability for applying CGMS
    - See above
2. Inventory of factors explaining regional yield variability in Anhui: irrigation, fertilizer, disease, lodging (hard wind)
    - Allard de Wit will create a list of factors to be ranked by partners.
3. Inventory of technical constraints, e.g. is ORACLE available/usable for AIFER to work with
    - With implemented in Oracle: No constraints.

Moroccan test site: set-up the system

Meteorological data must become available:

- Classical interpolation approach OR AURELHY approach (only 10-daily temp, rain): Classical CMGS interpolation
- Archive of weather data (1990-2010): Available
- Daily or 10-daily updates of weather data: Daily updates available

Crop experimental data must become available

- Observations of sowing date and phenology: Available
- Observations of yield, LAI, total biomass: Available

Basic GIS data to be used:

- Soil map and attributes: : Available EU 1:1M; possibly local soil map?
- Administrative regions of Morocco: Available
- Crop mask showing locations of crop types: Available
- Regional statistics of crop yield and area: Available

Crop calendar of Morocco

- One national calendar available.
- What about using GWSI method of finding season start and season duration, calibrated on national calendar? For example maize: FAO start = dekad 5. GWSI start =

Dekad	number of grid cells
5	9
6	5
7	108
8	16
9	11

Not so good in this case but with local calibration it could be improved. This example is based on a global 'calibration'

Setup a database system

- ORACLE (well-tested but expensive & complicated)
  - Available

Moroccan test site: EC deliverables

Morocco usability report: Inventory of usability of CGMS for Morocco:

1. Inventory of available data sources and their suitability for applying CGMS
2. Inventory of factors explaining regional yield variability in Morocco: irrigation, fertilizer, disease, heat damage
3. Inventory of technical constraints, e.g. is ORACLE available/usable for INRA to work with