

# Optimizing Agriculture in the Cloud

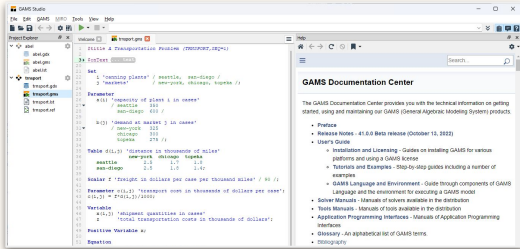
A Real-Life Example of Model Deployment  
with GAMS MIRO

# GAMS Products



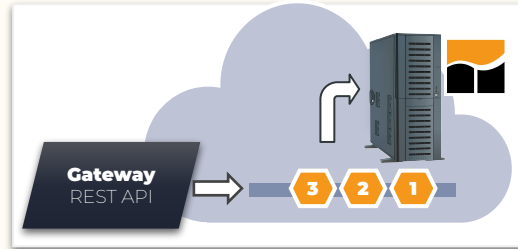
## GAMS - Modeling Platform

- Platform independent algebraic modeling language
- Connected to a wide range of commercial and academic solvers
- APIs for C++, Java, Python, Matlab,...



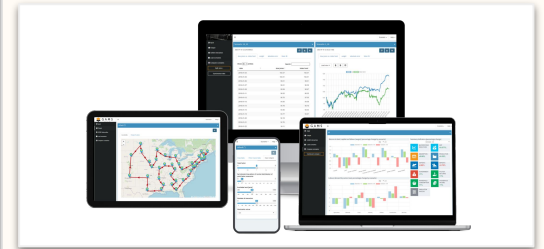
## Engine - Deployment Solution

- Solve GAMS models on centralized or cloud resources
- REST API for user & job management
- Built in GAMS job scheduling



## MIRO - Graphical UI Generator

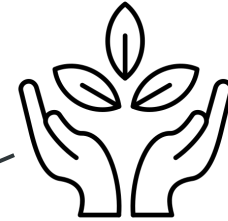
- Transformation of models into interactive web applications
- Rich set graphical output options
- Open source, extendable with custom code



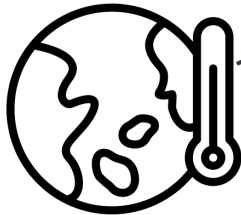
# Challenges in Agriculture



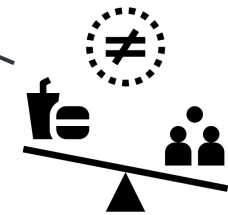
Loss of biodiversity



Scarcity of resources

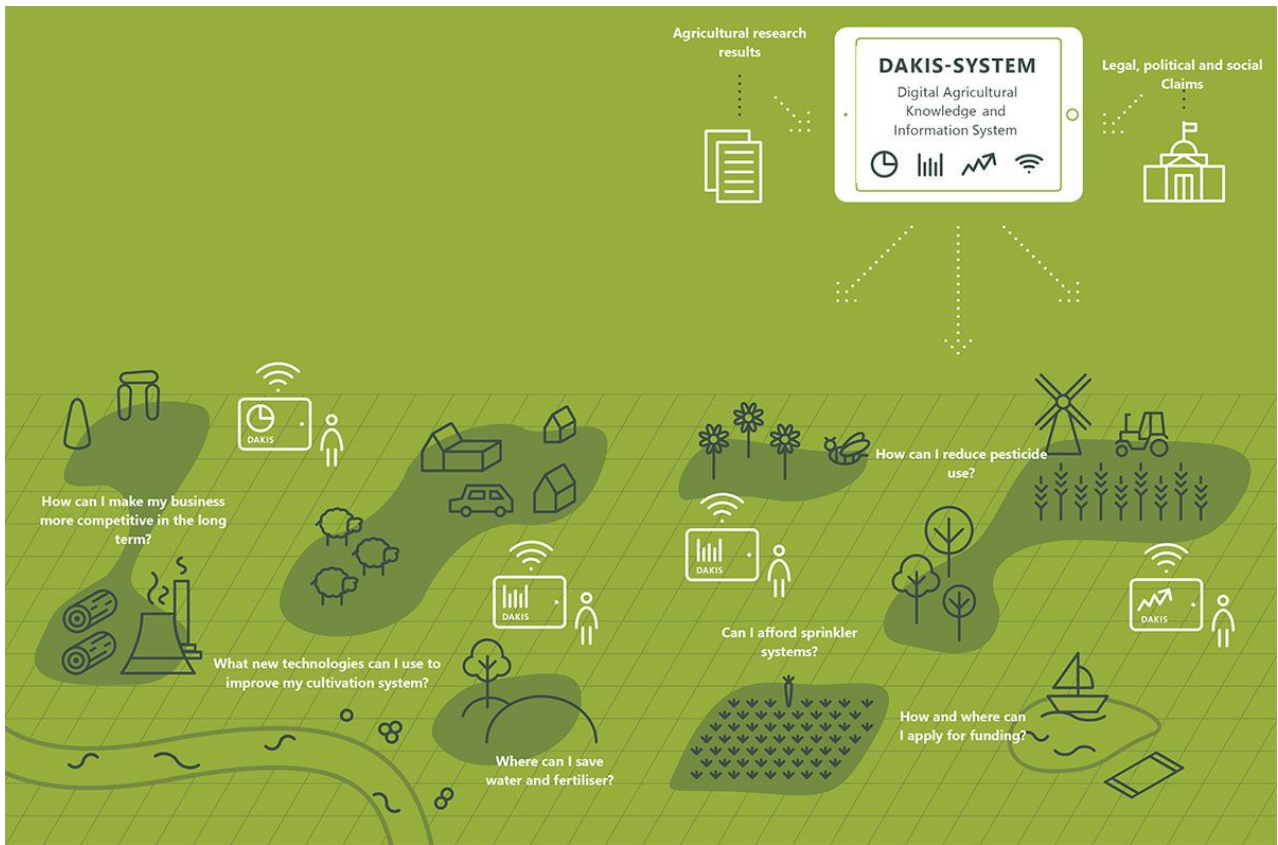


Climate change



Increasing demand  
for food

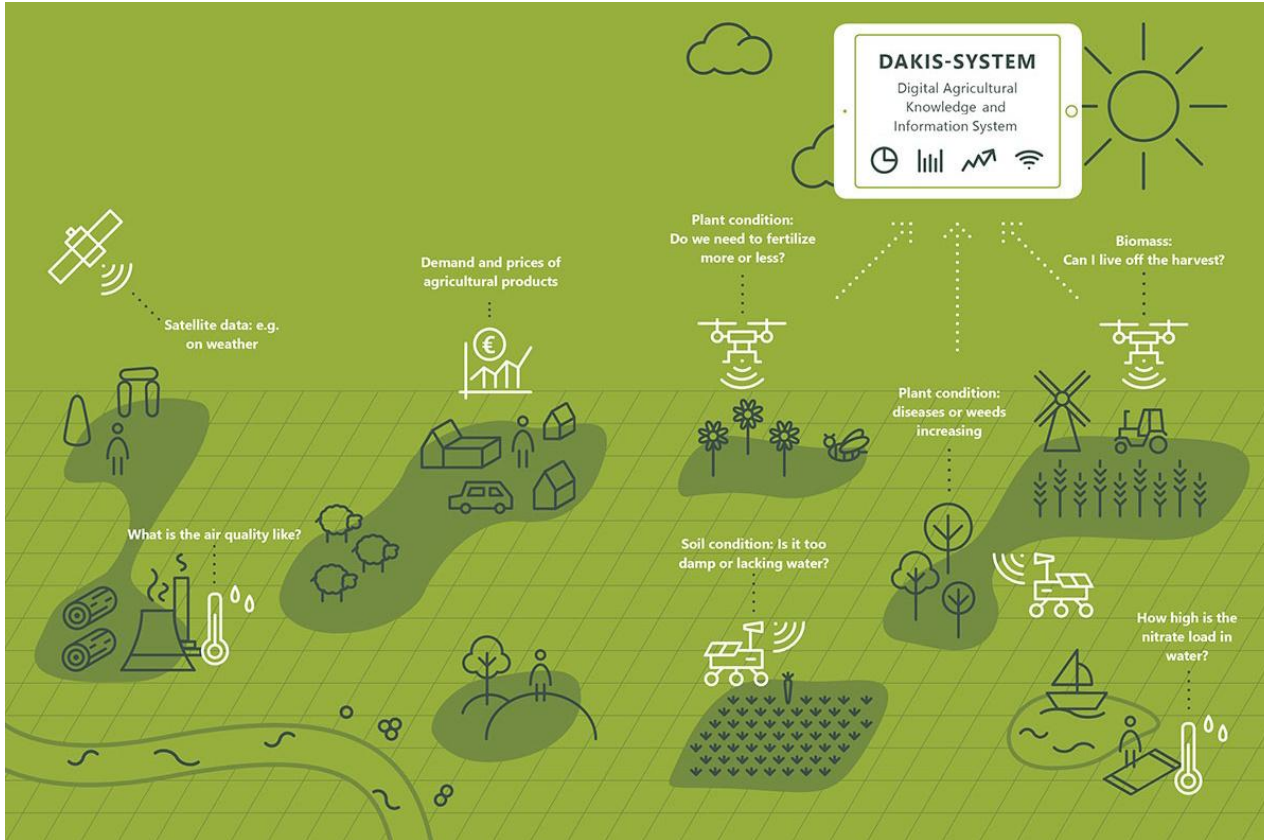
# DAKIS System



## Project partner

- Leibniz Centre for Agricultural Landscape Research (ZALF)
- University of Bonn
- Forschungszentrum Jülich
- IHP - Innovations for High Performance Microelectronics
- German Research Center for Artificial Intelligence
- Osnabrück University of Applied Sciences (HNEE)
- Leibniz Institute for Agricultural Engineering and Bioeconomy
- Fraunhofer Institute for Systems and Innovation Research ISI
- European University Viadrina

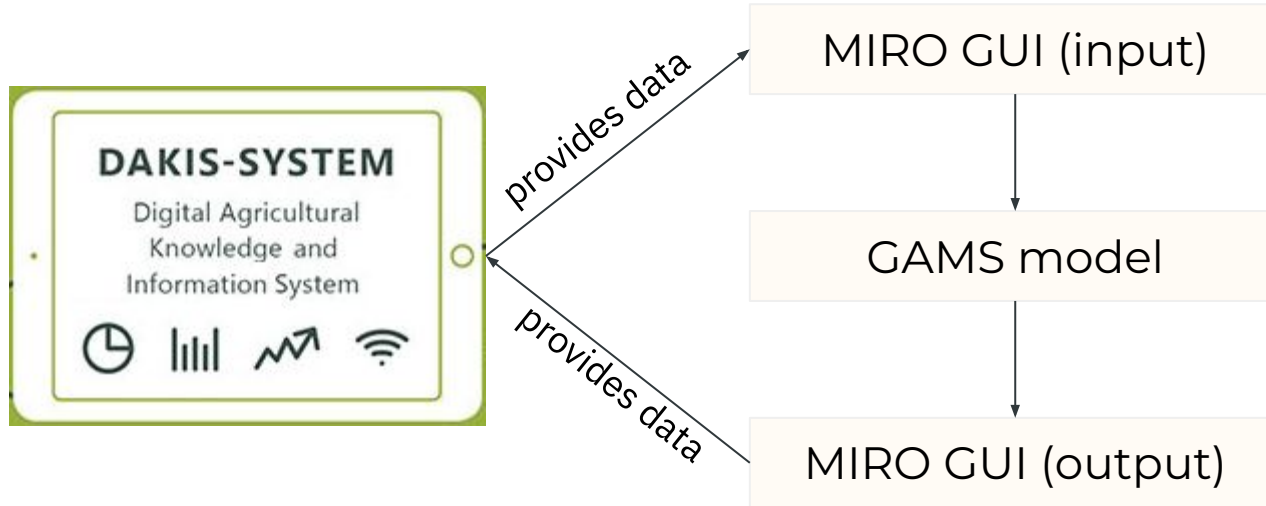
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# GAMS contribution to DAKIS



# Optimisation software requirements



- GUI

- Rich data visualization, performance, user experience, interactivity
- Online service with user management
- Platform independent
- Mobile usage



# Optimisation software requirements



- Computing power
  - Centralized compute resources
  - Solver performance

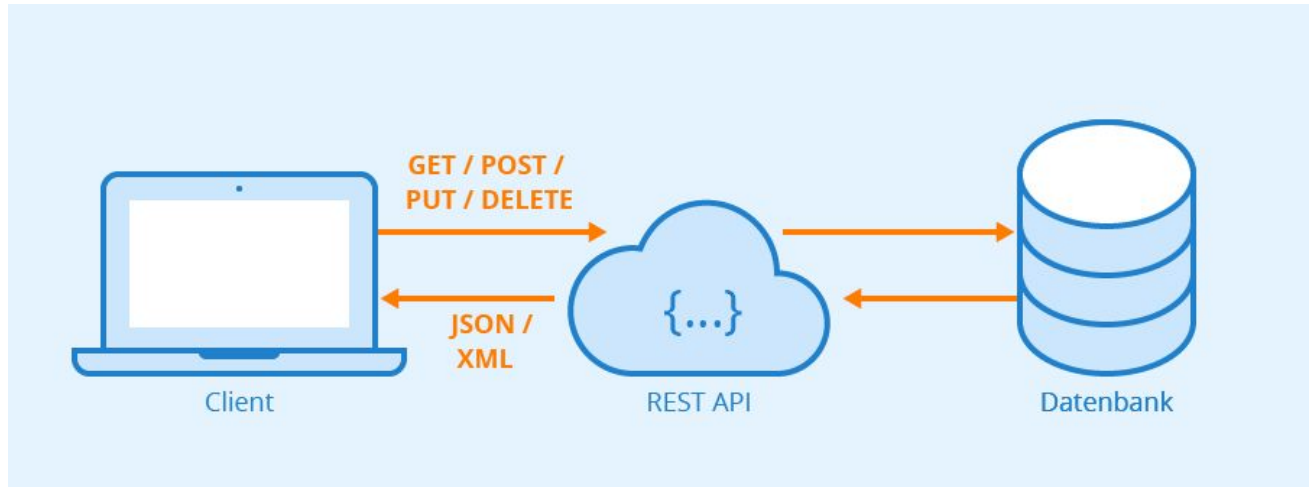






# Optimisation software requirements

- Development & Deployment
  - Integration into IT infrastructure / Interfaces to other software
  - Flexible software



# GAMS MIRO



## Configuration vs coding

- A few model annotations make GAMS model MIRO ready

The screenshot displays the GAMS MIRO web interface. On the left is a dark sidebar with navigation options: Input, Output, GAMS interaction, Load scenarios, and Compare scenarios. Below these are buttons for 'Load data' and 'Solve model'. The main content area is titled 'default' and contains input fields for 'capacity of plant i in cases', 'demand at market j in cases', and 'distance in thousand'. Below these fields is a table with the following data:

	canning plants	capacity of plant i in cases
1	seattle	350.00
2	san-diego	600.00



# Model Annotations

```
Set
  i 'canning plants' / seattle, san-diego /
  j 'markets' / new-york, chicago, topeka /;
```

\$onExternalInput

**Parameter**

```
a(i) 'capacity of plant i in cases'
  / seattle 350
  san-diego 600 /

b(j) 'demand at market j in cases'
  / new-york 325
  chicago 300
  topeka 275 /;
```

**Table** d(i,j) 'distance in thousands of miles'

```
          new-york  chicago  topeka
seattle   2.5       1.7     1.8
san-diego 2.5       1.8     1.4;
```

**Scalar** f 'freight in dollars per case per thousand miles'

\$offExternalInput

```
Parameter c(i,j) 'transport cost in thousands of dollars'
c(i,j) = f*d(i,j)/1000;
```

\$onExternalOutput

**Variable**

```
x(i,j) 'shipment quantities in cases'
z       'total transportation costs in thousands of dollars'
```

\$offExternalOutput

The screenshot shows the GAMS MISO interface. On the left is a dark sidebar with navigation options: Input, Output, GAMS interaction, Load scenarios, and Compare scenarios. Below these are two buttons: 'Load data' and 'Solve model'. The main area is titled 'default' and contains three input fields: 'capacity of plant i in cases', 'demand at market j in cases', and 'distance in thousands of miles'. Below the fields is a table with the following data:

	canning plants	capacity of plant i in cases
1	seattle	350.00
2	san-diego	600.00

# GAMS MIRO

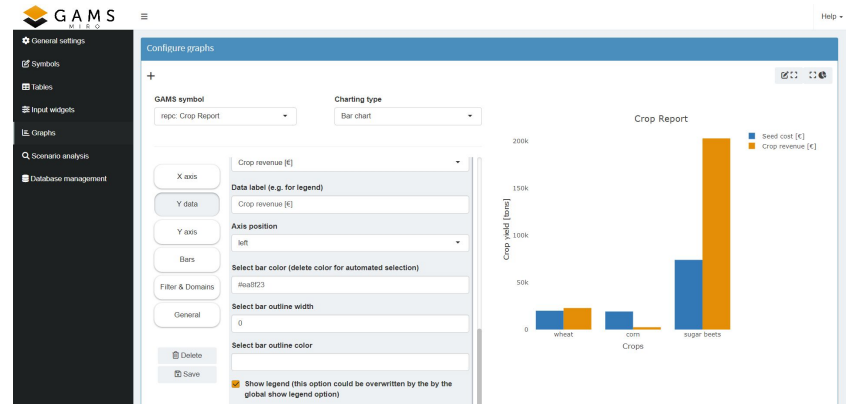
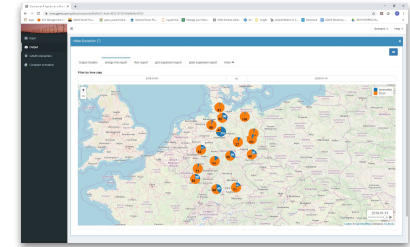
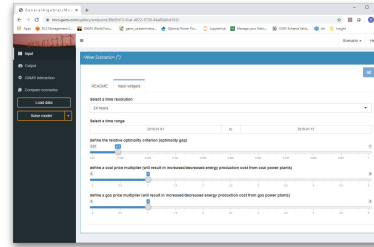


## Configuration vs coding

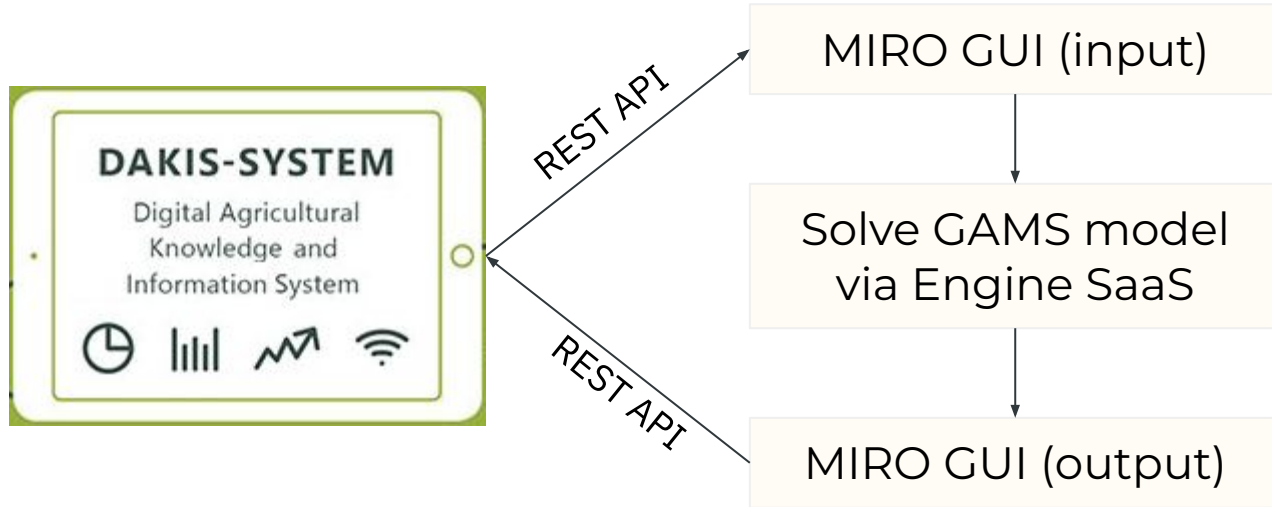
- A few model annotations make GAMS model MIRO ready
- Widgets and graphs can be configured, but do not need to be programmed

## Benefits

- Very quick results



# GAMS contribution to DAKIS



# Custom Code Implementation



Model Setup | Closure | Numeraire Check | Technical Setup

Modules: Policy Instruments

Local Content Requirement (LCR) Module

Price Preference Module

Willingness to Pay Module

Other Modules

Intermediate Input Nesting Module

Capital Accumulation

Elasticities

Armington Elasticities: GTAP

Export Elasticities: GTAP

Production Substitution Elasticities first nest: GTAP

Production Substitution Elasticities second nest: GTAP

Dashboard | Crop Comparison Deterministic vs. Stochastic | Financial Report by Scenario | Crop Report

PROFIT 111.749€

REVENUE 226.261€

COST 114.512€

LANDUSE 100%

Profit by Scenario

Crop Planted [acres]

Setting	Value
Yield Factor	1
Available Land [acre]	500
Number of Scenarios	500
Yield Factor Standard Deviation	NA

Crop Report

Yield / Planted / Seed Cost | Sales / Purchases

Crop Yield [tons]

Crop Planted [acres]

Seed Cost [€]

## Custom R Code Implementations for

- Renderers
- Input Widgets
- Scenario Analysis
- Data Connectors (Im-/Export)

# Current Status - Input



Scenario ▾ Help ▾



Input

Output

GAMS interaction

Load scenarios

Compare scenarios

Load data

Solve model

default (\*)

MODAM Settings Detailed prices Detailed Yields Detailed costs ESS

Years, Farmlid, static data % costs % prices % other

Select a time range

From

2023

To

2023

Change Maximization Weight

Weight of Water Erosion Index Minimization

0.03

Weight of Gross Margin Maximization

0

Weight of Nitrate Leaching Index Minimization

0.03

Weight of Habitat Quality Index Maximization

0.04

Farm(s) to use

Farm ID	Use
4064003	<input checked="" type="checkbox"/>
4067003	<input checked="" type="checkbox"/>



Input

Output

GAMS interaction

Load scenarios

Compare scenarios

Load data

Solve model

default (\*)

MODAM Settings Detailed prices Detailed Yields Detailed costs ESS

Crop prices (Euros/t) Animal prices / (Euros/head) and (Euros/t) BP prices

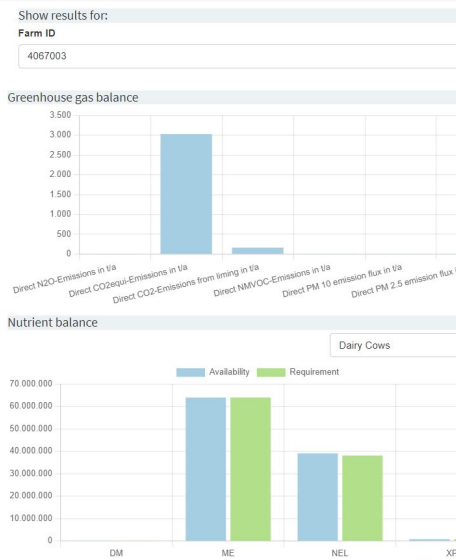
	Farm identifier dynamic set	Production activities	Products	Crop product prices (Euros/t)
1	4064003	KARi	WARE	79.81
2	4064003	KARs	WARE	144.01
3	4064003	LUP	GRAI	246.55
4	4064003	SGEb	GRAI	166.56
5	4064003	SGEf	GRAI	180.90
6	4064003	TRI	GRAI	179.93
7	4064003	WGE	GRAI	180.90
8	4064003	WRA	GRAI	422.30
9	4064003	WRO	GRAI	174.77
10	4064003	WWE	GRAI	209.27
11	4067003	KARi	WARE	79.81
12	4067003	KARs	WARE	144.01
13	4067003			
14	4067003			
15	4067003			

Test run with unverified data

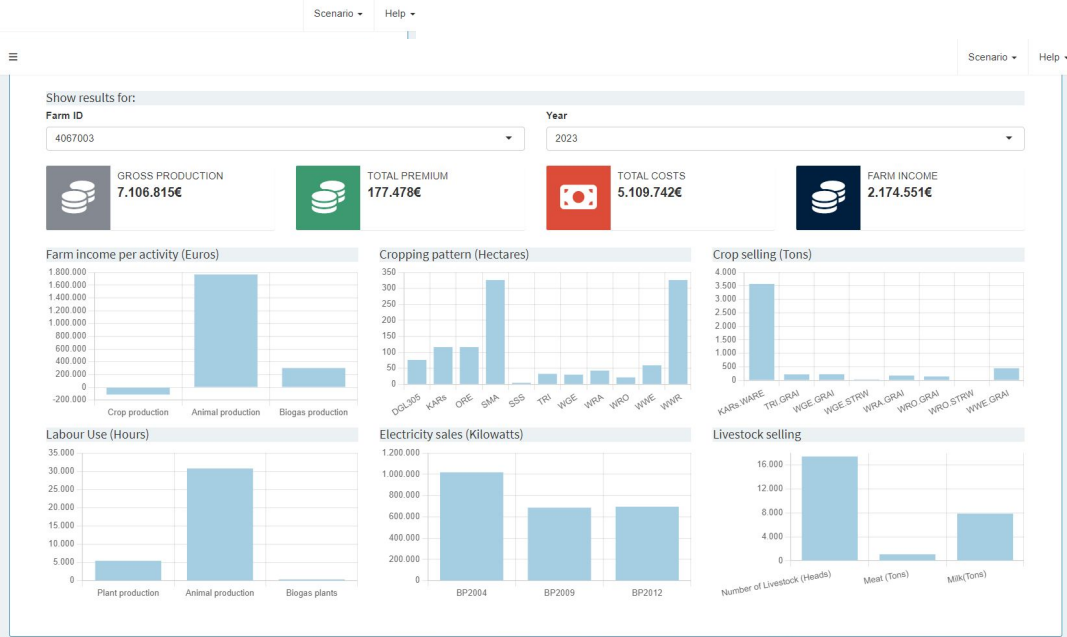
# Current Status - Output



- Input
- Output
- GAMS interaction
- Load scenarios
- Compare scenarios



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Test run with unverified data



# Current Status - Output



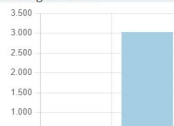
- Input
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Show results for:

Farm ID

4067003

Greenhouse gas balance



- Input
- Output
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- Load scenarios
- Compare scenarios

Show results for:

Farm ID

4067003

Year

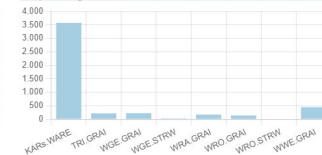
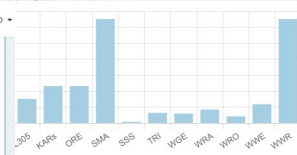
2023



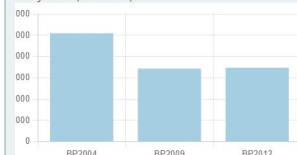
Farm income per activity (Euros)

Cropping pattern (Hectares)

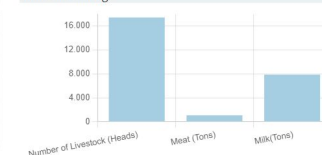
Crop selling (Tons)



Electricity sales (Kilowatts)



Livestock selling



- Input
- Output
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Show results for:

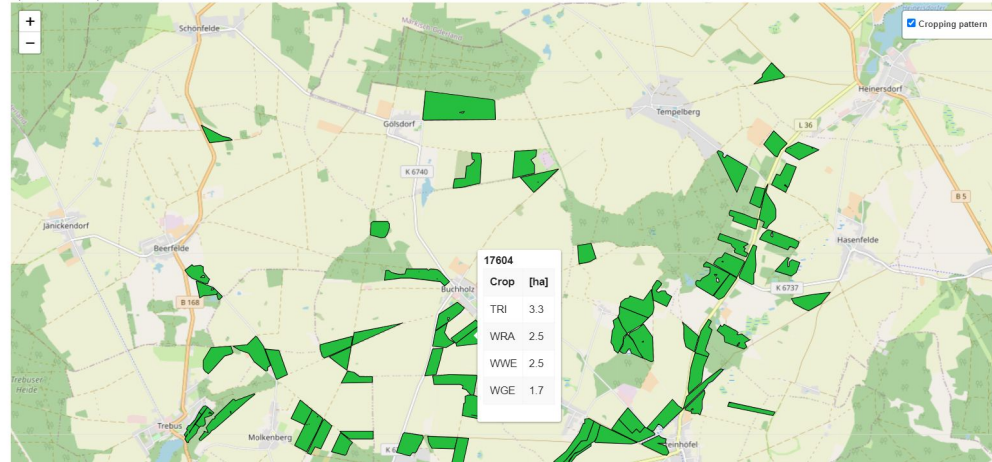
Farm ID

4067003

Year

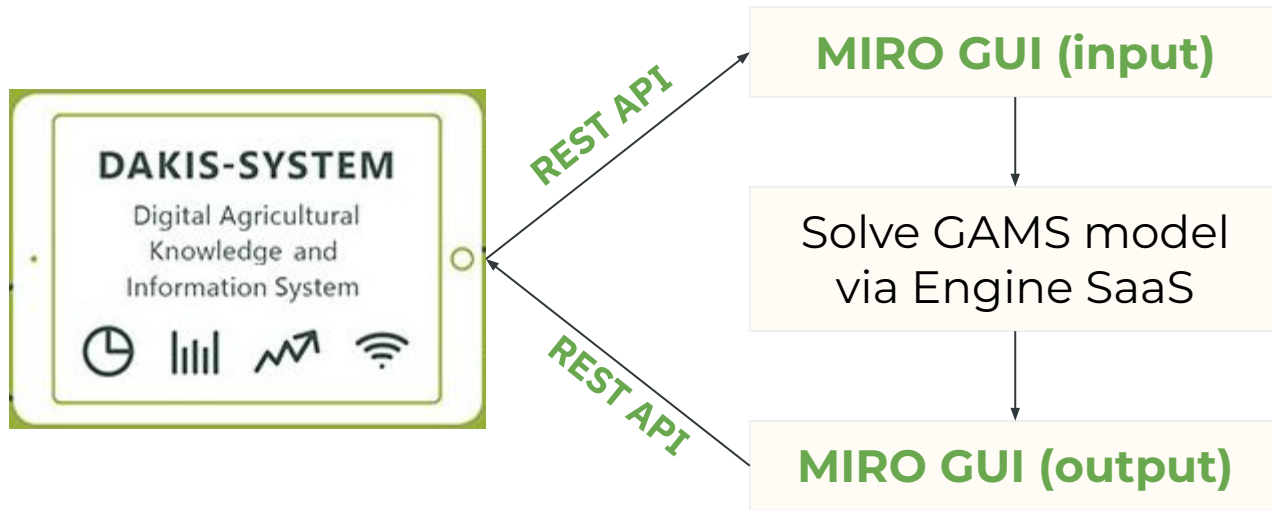
2023

Optimal Cultivation plan



Test run with unverified data

# GAMS contribution to DAKIS



**ENGINE**

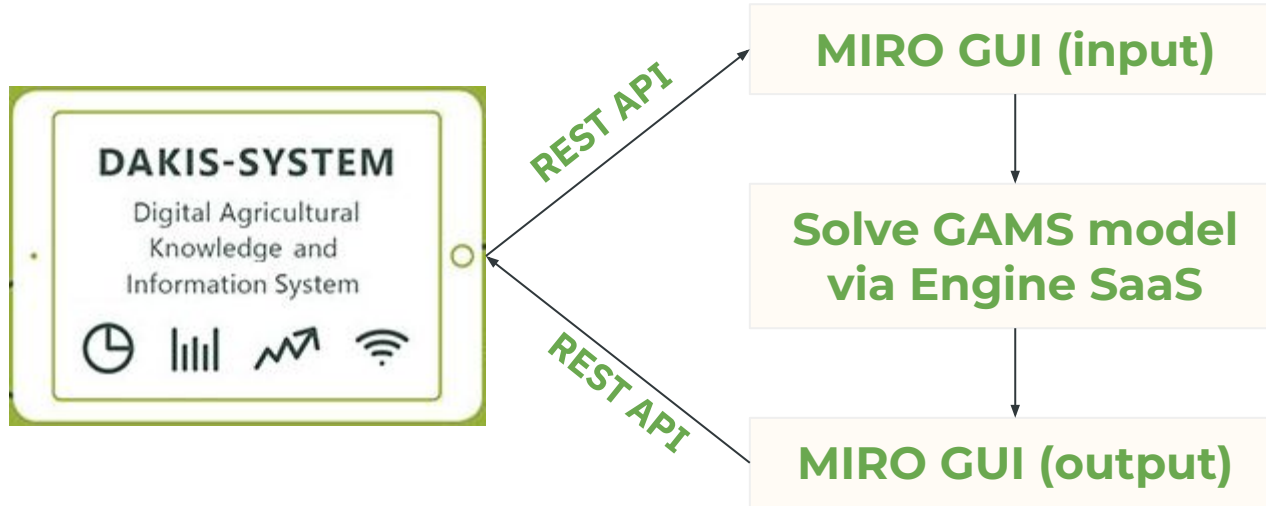
Engine -  
Deployment Solution

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- REST API for user & job management
- Built in GAMS job scheduling

Gateway REST API

1 2 3

# GAMS contribution to DAKIS



# Requirements - Summary



- GUI
  - Rich data visualization, interactivity

# Requirements - Summary



- GUI
  - Rich data visualization, interactivity ✓



# Requirements - Summary

- GUI
  - Rich data visualization, interactivity ✓
  - Online service with user management ✓
  - Platform independent ✓
  - Mobile usage ✓



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- GUI
  - Rich data visualization, interactivity ✓
  - Online service with user management ✓
  - Platform independent ✓
  - Mobile usage ✓
- Computing power
  - Centralized compute resources ✓
  - Solver performance ✓



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- Computing power
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  - Solver performance ✓
- Development & Deployment
  - Integration into IT infrastructure / Interfaces to other software (✓)
  - Flexible software (✓)



# Contact Us

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MODEL – SOLVE – DEPLOY