

SPO v.1-User guidelines

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This program is still not fully user friendly. The program was developed on specific data set and tested on multiple other. It's generic external python plug-in that is expected to work with all crop models available in DSSAT shell. Some of the features are still work in progress and will be improved.

For any additional questions contact the author of the SPO tool!

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More detailed description of the SPO program can be found in following publication:

Generic optimization approach of soil hydraulic parameters for site-specific model applications

Jonas Trenz, Emir Memic, William D. Batchlor, Simone Graeff-Hönniger
Precision Agriculture journal (July 2023, currently under revision)

1. Conceptual framework of SPO

1.1 Soil profile optimization – field scale to site-specific scale - overview

Soil Profile Optimization tool (SPO) can be used for optimizing soil profile-related coefficients available in standard DSSAT soil profiles. In total seven coefficients can be optimized with SPO: entire profile coefficients (SLDR, SLRO, SLPF) and soil-layer coefficients (SLLL, SDUL, SRGF, SSKS). The SPO was designed in a way to use already existing field-specific soil profile setup. Simplified conceptual framework of SPO used for site-specific soil profile analysis is shown in Figure 1. In this example in Figure 1 three phases of optimization are shown: a) field specific soil profile ($n=1$) with field specific yield ($n=3$, referring to three seasons), b) field specific soil profile ($n=1$) and site-specific yield over three years ($n=60$) where for each season 20 site-specific yield measurements are available, and c) site-specific soil profile ($n=20$) and 60 site-specific yield measurements. For site-specific soil profiling three parameters were selected: soil water lower limit, root growth factor and runoff curve, under the assumption that indeed these parameters can be derived based on measured site-specific yield variability and are shown in Figure 2 (Memic et al. 2023).

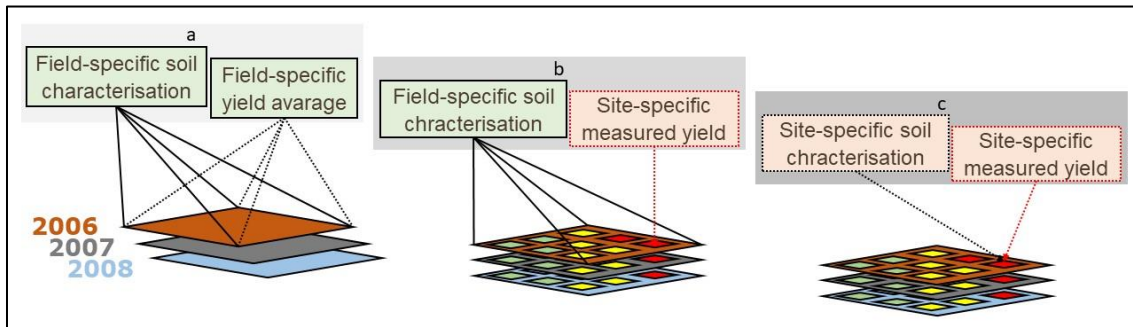


Figure 1 a) field-specific soil profile characterization ($n=1$) and field-specific simulated and measured yield over three years ($n=3$) (Figure 2, left), b) field-specific soil profile characterization ($n=1$) and site-specific simulated and measured yield over three years ($n=60$) (Figure 2, middle) and c) site-specific soil profiles ($n=20$) and site-specific simulated and measured yield over three years ($n=60$) after soil profile optimization (Figure 2, right) .

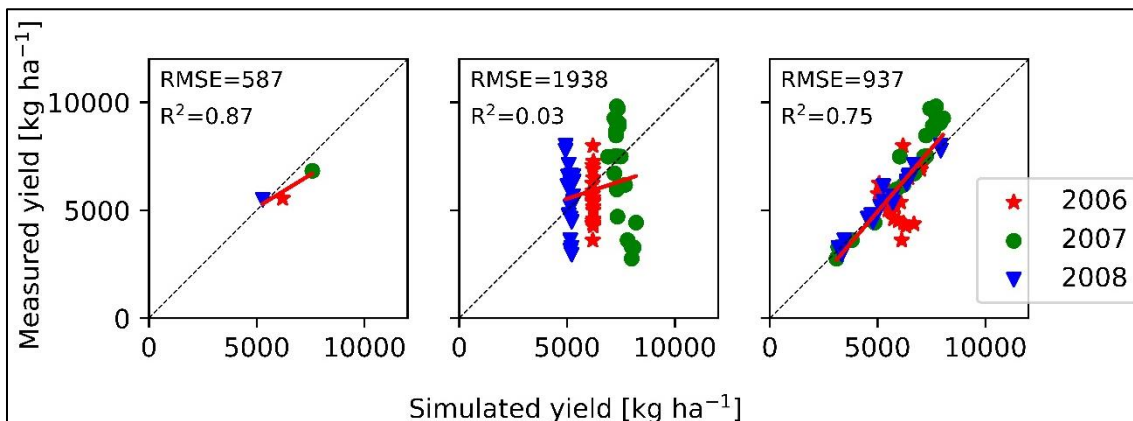


Figure 2 Simulated and measured yield shown in 1:1 graphs for: field-specific soil characterisation and field-specific measured yield (left), field-specific soil characterisation with site-specific measured yield (middle) and site-specific soil characterisation (inverse modelling) with site-specific measured yield (right). (Memic et al. 2023).

1.2 Error minimisation method – time-series measurements over multiple target variables

SPO was based on already published Time-Series cultivar coefficient Estimator (TSE) software tool for DSSAT (Memici et al. 2021). Error minimization method used in TSE was implemented in similar way in SPO. Same error minimisation method was implemented because multiple in-season observations (time-series data) for multiple target variables (grain yield, tops weight, leaf area index, soil water content etc.) can be used in optimisation process simultaneously. This method creates potential of using sensor-based measurements for site-specific soil profile generation in future, by replacing sample cuts with sensor-based measurements. Maximum four target variables simultaneously can be initialized in SPO. Simple example of error minimisation method can be seen in Table 1 for one site-specific unit (one soil profile) with only one target variable grain yield (GWAD). Optimization was conducted with only one soil coefficient in soil profile (SLLL) for this example. The SLLL values 0.7 to 1.2 (min=0.7 and max=1.2) with increment step 0.1 correspond to 30% reduction of the soil layer SLLL value in soil profile (Baseline) as minimum and 1.2 to 20% increase of Baseline as maximum with in between increments 10% (Table 1). This method of creating different soil profile scenarios used in sensitivity analysis was implemented as mathematical multiplier because of programming simplicity (Table 1). In Figure 3a boxplot shows to what degree target variable is sensitive to variation of selected coefficient. The setup shown in Table 1 corresponds to establishment of seven different SLLL scenarios shown as point lines in Figure 3b. The percentual reduction of Baseline SLLL (where SLLL=1.0) is conducted through entire soil profile (all soil layers) with nRMSE being calculated based on available in-season observations. In this simple example nRMSE-GWAD is equal to AVG-nRMSE because only one target variable (GWAD) was analysed and the scenario with the lowest AVG-nRMSE is considered “optimum” (lowest difference between simulated and observed grain yield based on nRMSE). Example of multiple target variable analysis is shown in Table 2 with corresponding target variable boxplots shown in Figure 4a and same SLLL scenario sensitivity analysis shown in Figure 4b. Based on the sensitivity analysis and error minimization it can be seen that target variable selection affects the optimum. For this example grain yield (GWAD), tops weight (CWAD) and harvest index (HIAD) was selected.

Table 1 SPO SLLL multiplier translation to percentual reduction and resulting nRMSE and AVG-nRMSE for one target variable GWAD (grain yield)

SLLL multiplier	Translates to percent reduction in SPO	nRMSE-GWAD	AVG-nRMSE
0.7	-30%	0.533	0.533
0.8	-20%	0.462	0.462
0.9	-10%	0.349	0.349
1.0	Baseline	0.242	0.242
1.1	+10%	0.095	0.095
1.2	+20%	0.036	0.036

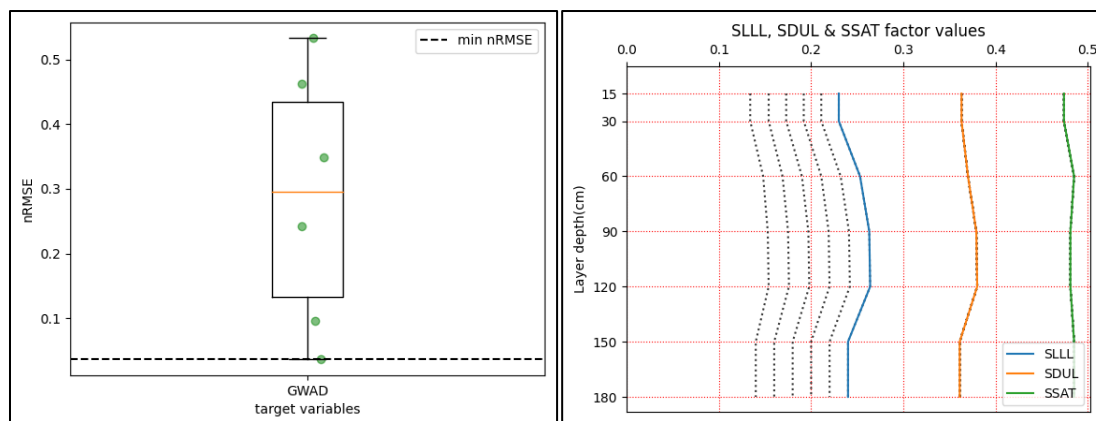


Figure 3 a) boxplot and b) soil-layer based sensitivity analysis of SLLL

Table 2 SPO SLLL sensitivity analysis based on multiple target variables and corresponding multi-target variable AVG-nRMSE

SLLL multiplier	nRMSE-GWAD	nRMSE-CWAD	nRMSE-HIAD	AVG-nRMSE
0.7	0.533	0.204	0.297	0.309
0.8	0.462	0.089	0.367	0.252
0.9	0.349	0.104	0.437	0.249
1.0	0.242	0.257	0.52	0.319
1.1	0.095	0.399	0.553	0.362
1.2	0.036	0.54	0.623	0.435

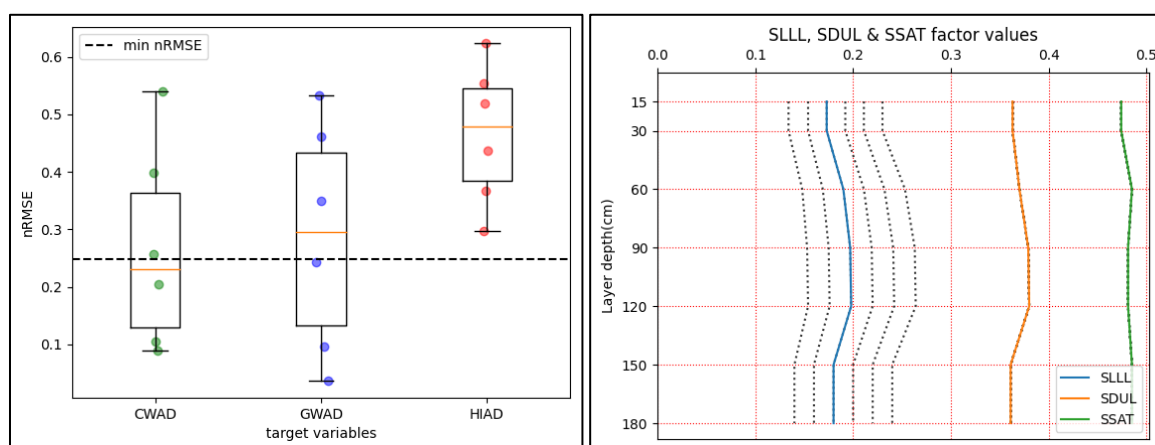


Figure 4 a) boxplot and b) soil profile SLLL over multiple depths

In Figure 5a normalised RMSE of target variable GWAD can be seen during the SLLL coefficient modification. SLLL coefficient optimisation based on multiple target variables (CWAD, GWAD, HIAD) can be seen in Figure 5b. The dotted line indicates lowest AVG-nRMSE in these two different sensitivity analyses. The more target variables are available the more difficult it gets to select “optimum” based on certain statistical or mathematical criteria. For this reason already tested nRMSE method was implemented in SPO.

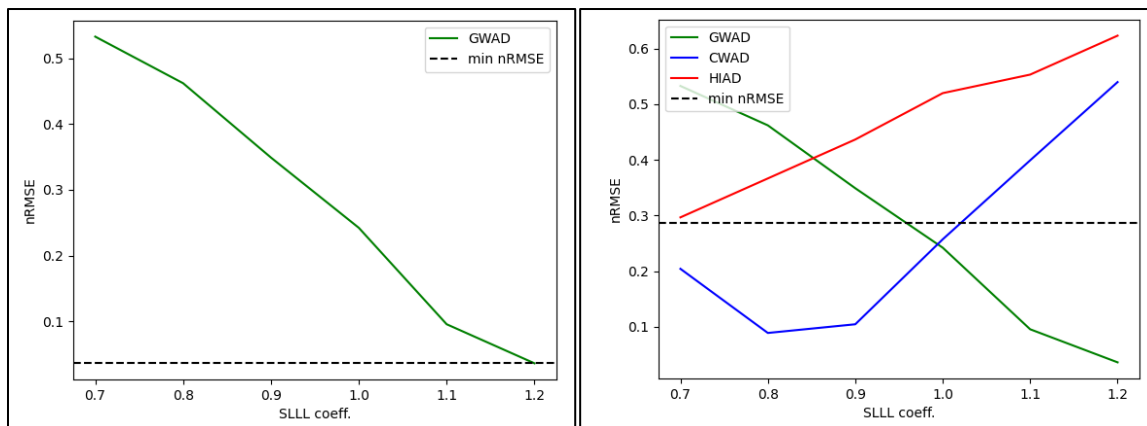


Figure 5

1.3 General SPO program settings overview

The “SPO_v1.7zip” must be unzipped and copied to the Tools directory: “C:\DSSAT48\Tools” (depending on the DSSAT version “C:\DSSAT**\Tools”).

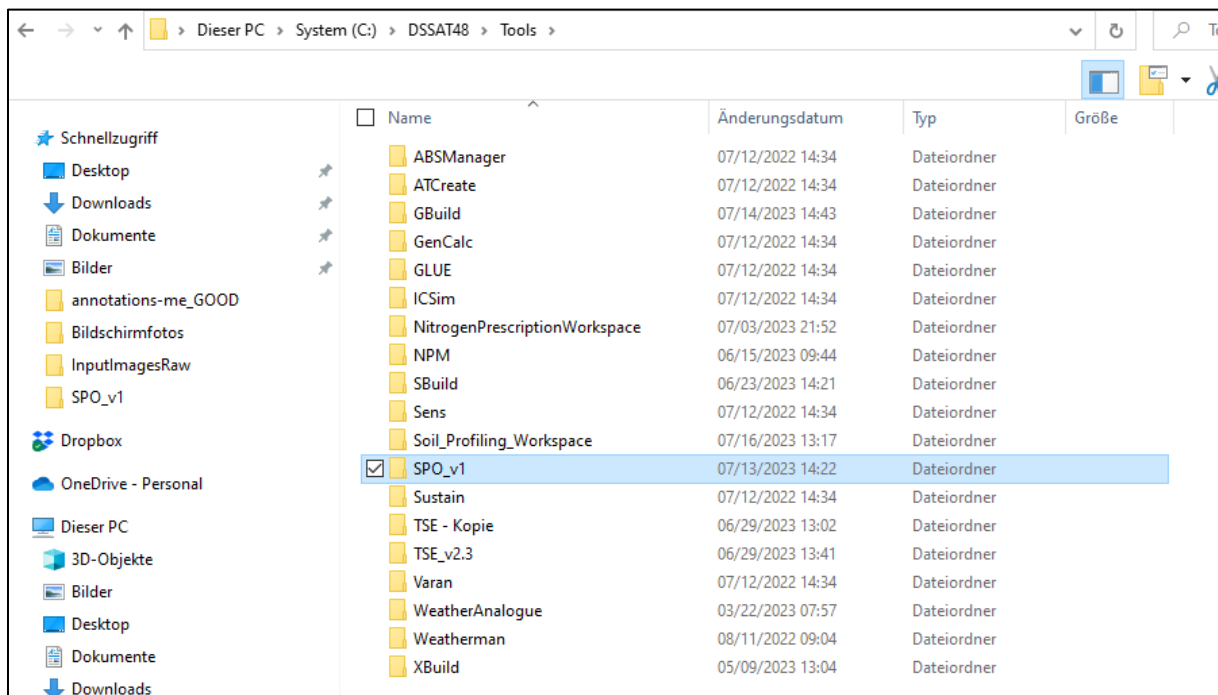


Figure 6

In the folder “SPO_v1” “C:\DSSAT48\Tools\SPO_v1” (Figure 6) “SPO_v1.exe” windows runnable must be executed as “Administrator” (Figure 7).

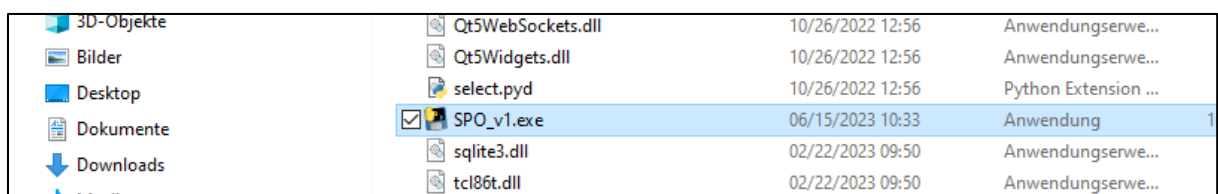


Figure 7

VERY IMPORTANT:

- I. In order to use SPO a user has to have their soil profiles in **SOIL.SOL** input file in **native DSSAT Soil directory**.
- II.
- III. **PlantGro.OUT** (or other time-series) crop model outputs are coupled to those in **File-T** time-series in-season observations.
- IV. If sub-model (e.g. WHAPS) is initialized in the File-X, the optimizer might NOT work! (in File-X in *SIMULATION CONTROLS in GENERAL line, column SMODEL **do NOT initialize sub-models such as WHAPS, IXIM etc.!**). This does SPO program.
- V. For multi-TRT optimizations only target variables simultaneously available in all **File-T/s** (for corresponding **File-X/s** Treatment/s) are accessible for optimization.
- VI. **File-T** observations: **All in-season observations available including 0 are used!**
Only “-99” values are ignored by SPO.
- VII. The program is matching DOY from **File-T** with those in the **PlantGro.OUT**. If the user setup in File-X reporting frequency for example every fifth day and exact observation DOY is not present in the PlantGro.OUT as it is written in the File-T, the program will NOT be able to match them for comparing simulated with observed.

The SPO program is creating additional directory “Soil_Profiling_Workspace” (C:\DSSAT48\Tools\Soil_Profiling_Workspace) Figure 8 and modifying the SOIL.SOL in that directory after which is DSSAT crop model executed.

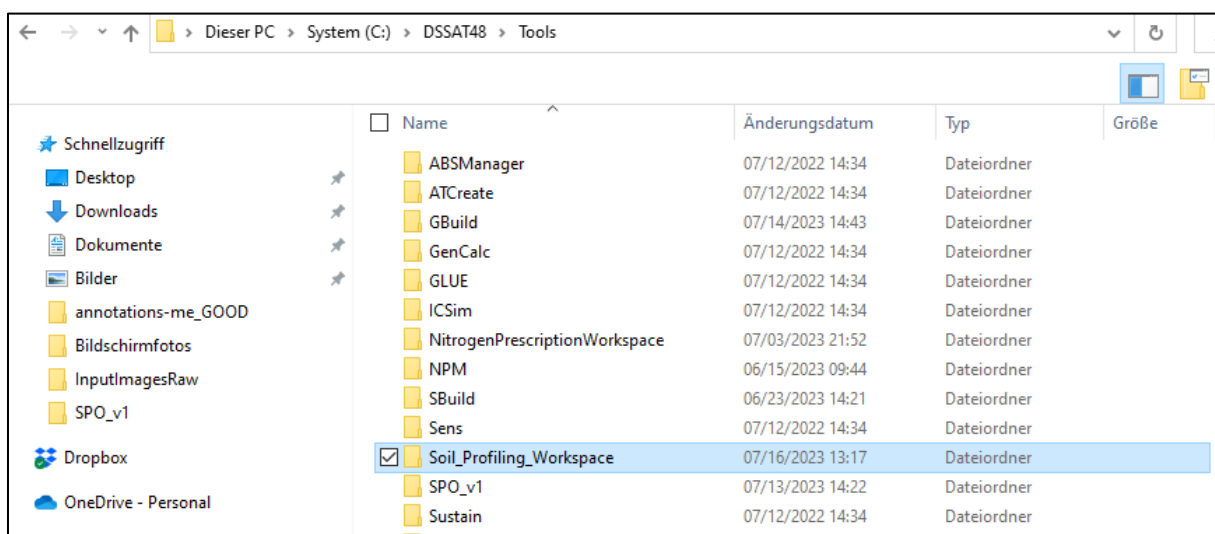


Figure 8

1.4 SPO program run

The **SPO** program **does NOT modify original DSSAT files in their native directories**. The program creates copies in “Soil_Profiling_Workspace” and do the sensitivity analysis by modifying targeted files in that directory.

After selecting desired files for optimization and setting up sensitivity analysis scenarios all modifications on soil profile are conducted in “Soil_Profiling_Workspace” in SOIL.SOL. Every time **Run the Model** push button is clicked the SPO will copy SOIL.SOL from “C:\DSSAT48\Soil” directory to Soil_Profiling_Workspace” and start optimization from beginning even if user did not exit SPO interface in the meantime.

After the model is executed the SPO algorithm creates backup of original SOIL.SOL soil profiles and modifies targeted soil profile isolated in SOIL.SOL in Soil_Profiling_Workspace. After soil profile optimization is conducted and before exiting SPO interface a user can open SOIL.SOL from Soil_Profiling_Workspace in text editor and **MANUALLY** copy soil profile to the “C:\DSSAT48\Soil” SOIL.SOL.

If user is using a target variable for optimizing specific parameters in soil profile that is insensitive to the variations of the coefficient, they will not result in different values of nRMSE, and it will result in having multiple soil profiles in SOIL.SOL in Soil_Profiling_Workspace. This can be used as an indicator to check if it makes any sense to use such target variable for optimizing soil profile coefficient. In Soil_Profile_Workspace more systemic overview of target variable sensitivity to coefficient/s variations can be checked in BoxPlot figures.

SPO program running through section flow:

- 1. List and select crop model**
- 2. Load File-X list to the list widget in interface**
- 3. File-X selection**
- 4. File-X treatment (TRT) selection**
- 5. Original DSSAT files setup test run**
- 6. Target variable selection and initialization**
- 7. Soil profile coefficient selection and coefficient min/max/increment range setup**
- 8. Checking the setup of SPO and potentially initialization of Figure generators**

SPO v.1

1. C:\DSSAT48

Change Dir

List crop models

2.

Load FileX/s

3. FileX exp. info and soil ID

4. FileX - (TRT) and soil ID

5. Check DSSAT files setup

Check DSSAT files!

☐ Include jittered Obs

Graph dist. and box p.

☒ PlantGro.OUT
☐ Other

6. Target variables selection

Initialize

7. Soil Profile Optimisation -> SOIL.SOL

Coeff.	Min	Max	Inc
<input type="checkbox"/> SLDR	0.6	1	0.2
<input type="checkbox"/> SLRO	50	100	25
<input type="checkbox"/> SLPF	0.8	1	0.01

(%) reduction of available parameter values:

	Min	Max	Inc
<input type="checkbox"/> SLLL	0.9	1.1	0.02
<input type="checkbox"/> SDUL	0.7	1.3	0.02
<input type="checkbox"/> SRGF	0.9	1.1	0.05
<input type="checkbox"/> SSKS	0.9	1.1	0.2

8. ☐ Activate Fig generator

Check setup

☐ Param uncertainty graph

Run the Model

Plot scenarios

Multi year

GBuild

Exit

Figure 3 Interface

2. Crop model selection and initialization

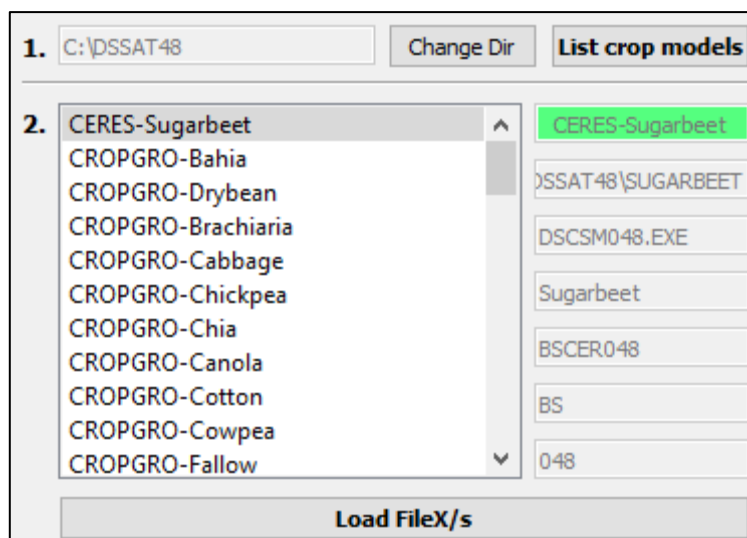


Figure 4 After SPO windows runnable is executed and "List crop models" button pressed all crop models available in DSSAT shell are offered for selection in section 2.

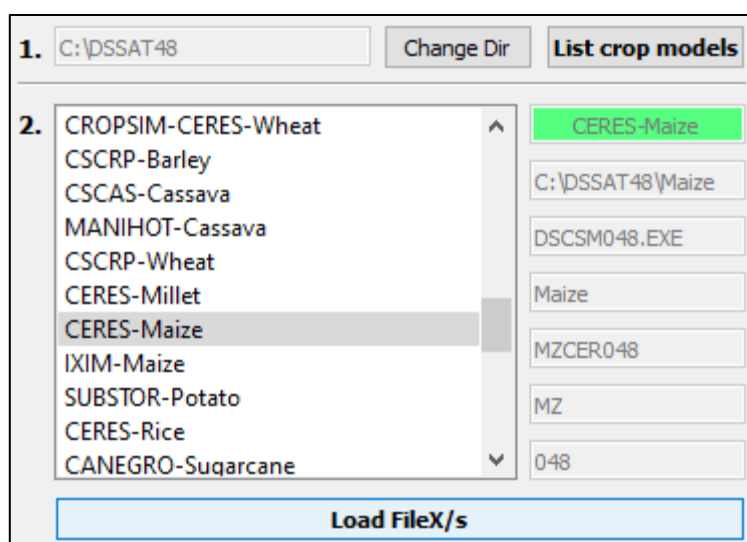


Figure 5 After desired crop growth model is selected in section 2 and "Load FileX/s" button pressed all available experiment files are loaded into list widget window in Section 3.

3. Experiment files initialization

3. FileX exp. info and soil ID	4. FileX - (TRT) and soil ID
GAGR0201.MZX ----> GAGR0201MZ 2002 ENVIOTRON	IHRI0605.MZX -- 1 Grid 1 UHIRF05001 --
GHWA0401.MZX ----> GHWA0401MZ ON-STATION NXP	IHRI0605.MZX -- 3 Grid 3 UHIRF05003 --
IBWA8301.MZX ----> IBWA8301MZ N X VAR WAPIO,	IHRI0605.MZX -- 6 Grid 6 UHIRF05006 --
IHRI0601.MZX ----> IHRI0601MZ IHINGERHOF FIEL	IHRI0605.MZX -- 11 Grid 11 UHIRF05011 --
IHRI0602.MZX ----> IHRI0601MZ IHINGERHOF FIEL	IHRI0605.MZX -- 12 Grid 12 UHIRF05012 --
IHRI0603.MZX ----> IHRI0601MZ IHINGERHOF FIEL	IHRI0605.MZX -- 13 Grid 13 UHIRF05013 --
IHRI0605.MZX ----> IHRI0601MZ IHINGERHOF FIEL	IHRI0605.MZX -- 16 Grid 16 UHIRF05016 --
IHRI0606.MZX ----> IHRI0601MZ IHINGERHOF FIEL	IHRI0605.MZX -- 22 Grid 22 UHIRF05022 --
IHRI0607.MZX ----> IHRI0607MZ IHRI_FIELD_SPEC	IHRI0605.MZX -- 31 Grid 31 UHIRF05031 --
IHRI0608.MZX ----> IHRI0601MZ IHINGERHOF FIEL	IHRI0605.MZX -- 32 Grid 32 UHIRF05032 --
IHRI0609.MZX ----> IHRI0601MZ IHINGERHOF FIEL	IHRI0605.MZX -- 39 Grid 39 UHIRF05039 --
IHRI0701.MZX ----> IHRI0701MZ IHINGERHOF FIEL	IHRI0605.MZX -- 42 Grid 42 UHIRF05042 --
IHRI0702.MZX ----> IHRI0701MZ IHINGERHOF FIEL	IHRI0605.MZX -- 45 Grid 45 UHIRF05045 --
IHRI0703.MZX ----> IHRI0701MZ IHINGERHOF FIEL	IHRI0605.MZX -- 46 Grid 46 UHIRF05046 --
IHRI0705.MZX ----> IHRI0701MZ IHINGERHOF FIEL	IHRI0605.MZX -- 50 Grid 50 UHIRF05050 --
IHRI0706.MZX ----> IHRI0701MZ IHINGERHOF FIEL	IHRI0605.MZX -- 55 Grid 55 UHIRF05055 --
IHRI0707.MZX ----> IHRI0707MZ IHRI0701MZ_FIEL	IHRI0605.MZX -- 59 Grid 59 UHIRF05059 --
IHRI0708.MZX ----> IHRI0701MZ IHINGERHOF FIEL	IHRI0605.MZX -- 62 Grid 62 UHIRF05062 --
IHRI0709.MZX ----> IHRI0701MZ IHINGERHOF FIEL	IHRI0605.MZX -- 69 Grid 69 UHIRF05069 --
IHRI0801.MZX ----> IHRI0801MZ IHINGERHOF FIEL	IHRI0605.MZX -- 72 Grid 72 UHIRF05072 --
IHRI0802.MZX ----> IHRI0801MZ IHINGERHOF FIEL	
IHRI0803.MZX ----> IHRI0801MZ IHINGERHOF FIEL	
IHRI0805.MZX ----> IHRI0801MZ IHINGERHOF FIEL	
IHRI0806.MZX ----> IHRI0806MZ IHINGERHOF FIEL	
IHRI0807.MZX ----> IHRI0807MZ IHRI0801_FIELD	

Figure 6 In this figure we can see two different list widgets shown as section 3 and 4. Section 4 shows experiment files (File X/s). When FileX is clicked on in section 3 and available treatments (TRT/s) in FileX/s are shown in section 4, for selection. FileX treatments correspond to the site-specific units analyzed with DSSAT crop growth models. Selected active treatments from section 4 are shown in text browser windows in section 7 (Figure 7)

Load FileX/s

3. FileX exp. info and soil ID

IBWA8301.MZX ----> IBWA830

IHRI0601.MZX ----> IHRI0601N

IHRI0602.MZX ----> IHRI0601N

IHRI0603.MZX ----> IHRI0601N

IHRI0605.MZX ----> IHRI0601N

IHRI0606.MZX ----> IHRI0601N

IHRI0607.MZX ----> IHRI0607N

IHRI0608.MZX ----> IHRI0601N

IHRI0609.MZX ----> IHRI0601N

IHRI0701.MZX ----> IHRI0701N

IHRI0702.MZX ----> IHRI0701N

IHRI0703.MZX ----> IHRI0701N

IHRI0705.MZX ----> IHRI0701N

IHRI0706.MZX ----> IHRI0701N

IHRI0707.MZX ----> IHRI0707N

IHRI0708.MZX ----> IHRI0701N

IHRI0709.MZX ----> IHRI0701N

IHRI0801.MZX ----> IHRI0801N

IHRI0802.MZX ----> IHRI0801N

IHRI0803.MZX ----> IHRI0801N

IHRI0805.MZX ----> IHRI0801N

IHRI0806.MZX ----> IHRI0806N

IHRI0807.MZX ----> IHRI0807N

IHRI0808.MZX ----> IHRI0808N

4. FileX - (TRT) and soil ID

IHRI0605.MZX -- 1 Gr

IHRI0605.MZX -- 3 Gr

IHRI0605.MZX -- 6 Gr

IHRI0605.MZX -- 11 Gr

IHRI0605.MZX -- 12 Gr

IHRI0605.MZX -- 13 Gr

IHRI0605.MZX -- 16 Gr

IHRI0605.MZX -- 22 Gr

IHRI0605.MZX -- 31 Gr

IHRI0605.MZX -- 32 Gr

IHRI0605.MZX -- 39 Gr

IHRI0605.MZX -- 42 Gr

IHRI0605.MZX -- 45 Gr

IHRI0605.MZX -- 46 Gr

IHRI0605.MZX -- 50 Gr

IHRI0605.MZX -- 55 Gr

IHRI0605.MZX -- 59 Gr

IHRI0605.MZX -- 62 Gr

IHRI0605.MZX -- 69 Gr

IHRI0605.MZX -- 72 Gr

SSKS 0.9 1.1 0.2

IHRI0605.MZX UHIRF05001 1 (1)

IHRI0705.MZX UHIRF05001 1 (1)

IHRI0805.MZX UHIRF05001 1 (1)

IHRI0605.MZX UHIRF05001 1 (1)

IHRI0705.MZX UHIRF05001 1 (1)

IHRI0805.MZX UHIRF05001 1 (1)

IHRI0605.MZX UHIRF05003 3 (3)

IHRI0705.MZX UHIRF05003 3 (3)

IHRI0805.MZX UHIRF05003 3 (3)

IHRI0605.MZX UHIRF05001 1 (1)

IHRI0705.MZX UHIRF05001 1 (1)

IHRI0805.MZX UHIRF05001 1 (1)

IHRI0605.MZX UHIRF05003 3 (3)

IHRI0705.MZX UHIRF05003 3 (3)

IHRI0805.MZX UHIRF05003 3 (3)

IHRI0605.MZX UHIRF05006 6 (6)

IHRI0705.MZX UHIRF05006 6 (6)

IHRI0805.MZX UHIRF05006 6 (6)

8. ☐ Activate Fig generator ☐ Param uncertainty graph

Figure 7

4. Experiment file and soil profile setup

5. Check DSSAT files setup

< >

IHRI0605.MZX UHIRF05001 1 (1)

☐ Include jittered Obs

Figure 8 After site-specific units (TRT/s) are selected in section 4 it is shown in section 7 text browser window for multiple years that have same soil profiling. The UHIRF05001 is soil identifier used for labeling soil profile in SOIL.SOL file. Since it is the same for all three years in this case, this soil profile can be optimized based on three years of crop model maize parametrization and weather data (to

investigate seasonality factor with respect to specific soil profile characterization).

Once Check DSSAT files! push button is pressed the DSSAT crop model is executed in order to check if all files are runnable. If the files are runnable and usable for soil profile optimization, they are shown in text browser windows in section 8 (Figure 9).

Load FileX/s

3. FileX exp. info and soil ID

IBWA8301.MZX ----> IBWA8301.MZX
IHRI0601.MZX ----> IHRI0601.MZX
IHRI0602.MZX ----> IHRI0601.MZX
IHRI0603.MZX ----> IHRI0601.MZX
IHRI0605.MZX ----> IHRI0601.MZX
IHRI0606.MZX ----> IHRI0601.MZX
IHRI0607.MZX ----> IHRI0607.MZX
IHRI0608.MZX ----> IHRI0601.MZX
IHRI0609.MZX ----> IHRI0601.MZX
IHRI0701.MZX ----> IHRI0701.MZX
IHRI0702.MZX ----> IHRI0701.MZX
IHRI0703.MZX ----> IHRI0701.MZX
IHRI0705.MZX ----> IHRI0701.MZX
IHRI0706.MZX ----> IHRI0701.MZX
IHRI0707.MZX ----> IHRI0707.MZX
IHRI0708.MZX ----> IHRI0701.MZX
IHRI0709.MZX ----> IHRI0701.MZX
IHRI0801.MZX ----> IHRI0801.MZX
IHRI0802.MZX ----> IHRI0801.MZX
IHRI0803.MZX ----> IHRI0801.MZX
IHRI0805.MZX ----> IHRI0801.MZX
IHRI0806.MZX ----> IHRI0806.MZX
IHRI0807.MZX ----> IHRI0807.MZX
IHRI0808.MZX ----> IHRI0806.MZX
IHRI0809.MZX ----> IHRI0801.MZX
IUAF9901.MZX ----> IUAF9901.MZX
IUAF9902.MZX ----> IUAF9902.MZX
IUAF9903.MZX ----> IUAF9903.MZX
OBER2201.MZX ----> OBER2201.MZX
OBER2202.MZX ----> OBER2202.MZX
OBER2203.MZX ----> OBER2203.MZX
OBER2207.MZX ----> OBER2207.MZX

4. FileX - (TRT) and soil ID

IHRI0605.MZX -- 1 Gr
IHRI0605.MZX -- 3 Gr
IHRI0605.MZX -- 6 Gr
IHRI0605.MZX -- 11 Gr
IHRI0605.MZX -- 12 Gr
IHRI0605.MZX -- 13 Gr
IHRI0605.MZX -- 16 Gr
IHRI0605.MZX -- 22 Gr
IHRI0605.MZX -- 31 Gr
IHRI0605.MZX -- 32 Gr
IHRI0605.MZX -- 39 Gr
IHRI0605.MZX -- 42 Gr
IHRI0605.MZX -- 45 Gr
IHRI0605.MZX -- 46 Gr
IHRI0605.MZX -- 50 Gr
IHRI0605.MZX -- 55 Gr
IHRI0605.MZX -- 59 Gr
IHRI0605.MZX -- 62 Gr
IHRI0605.MZX -- 69 Gr
IHRI0605.MZX -- 72 Gr

GWAD

HIAD

G#AD

GN%M

CNAD

CNAD

GNAD

Grain wt kg/ha

Harvest index

Grain no #/m2

Grain N%/mature

Crop N kg/ha

CROP N kg/ha

Grain N kg/ha

SSKS

0.9

1.1

0.2

IHRI0605.MZX UHIRF05001 1 (1)
IHRI0705.MZX UHIRF05001 1 (1)
IHRI0805.MZX UHIRF05001 1 (1)

IHRI0605.MZX UHIRF05001 1 (1)
IHRI0705.MZX UHIRF05001 1 (1)
IHRI0805.MZX UHIRF05001 1 (1)
IHRI0605.MZX UHIRF05003 3 (3)
IHRI0705.MZX UHIRF05003 3 (3)
IHRI0805.MZX UHIRF05003 3 (3)

IHRI0605.MZX UHIRF05001 1 (1)
IHRI0705.MZX UHIRF05001 1 (1)
IHRI0805.MZX UHIRF05001 1 (1)
IHRI0605.MZX UHIRF05003 3 (3)
IHRI0705.MZX UHIRF05003 3 (3)
IHRI0805.MZX UHIRF05003 3 (3)

IHRI0605.MZX UHIRF05001 1 (1)
IHRI0705.MZX UHIRF05001 1 (1)
IHRI0805.MZX UHIRF05001 1 (1)
IHRI0605.MZX UHIRF05003 3 (3)
IHRI0705.MZX UHIRF05003 3 (3)
IHRI0805.MZX UHIRF05003 3 (3)

8. ☐ Activate Fig genrator

Check setup

☐ Param uncertainty graph

Run the Model

-- IHRI0605.MZX UHIRF05001 1 (1) --
-- IHRI0705.MZX UHIRF05001 1 (1) --
-- IHRI0805.MZX UHIRF05001 1 (1) --
-- IHRI0605.MZX UHIRF05003 3 (3) --
-- IHRI0705.MZX UHIRF05003 3 (3) --
-- IHRI0805.MZX UHIRF05003 3 (3) --
-- IHRI0605.MZX UHIRF05006 6 (6) --
-- IHRI0705.MZX UHIRF05006 6 (6) --
-- IHRI0805.MZX UHIRF05006 6 (6) --

Figure 9

5. Site-specific yield variability check (optional for site-specific yield optimization)

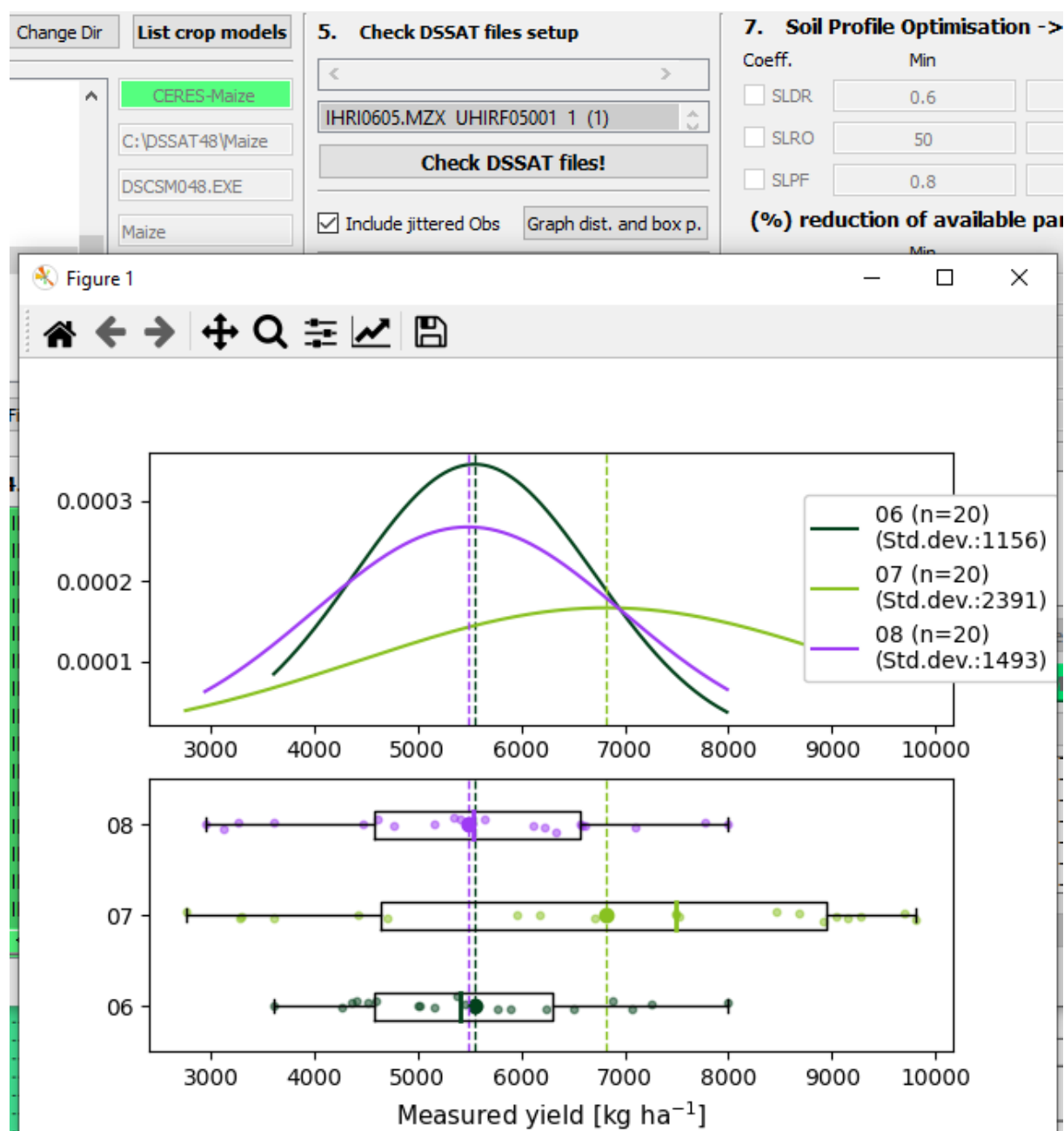


Figure 10 It is possible to investigate distribution of the individual target variables with standard deviation and corresponding boxplots.

6. Target variable selection and initialization

☒ PlantGro.OUT ☐ Other PlantGro.OUT ▾

6. Target variables selection

CWAD	Tops wt kg/ha
GWAD	Grain wt kg/ha
HIAD	Harvest index
G#AD	Grain no #/m2
GN%M	Grain N%,mature
CNAD	Crop N kg/ha
CNAD	CROP N kg/ha
GNAD	Grain N kg/ha

Initialize

GWAD Grain wt kg/ha

-99 -99

-99 -99

-99 -99

Figure 11 In this section of the SPO a user can select multiple target variables for optimization based on either on DSSAT PlantGro.OUT or some other DSSAT time-series output file (if “other” checkbox is initialized).

7. Soil profile parameters selection and setup

7. Soil Profile Optimisation -> SOIL.SOL

Coeff.	Min	Max	Inc
<input type="checkbox"/> SLDR	0.6	1	0.2
<input type="checkbox"/> SLRO	50	100	25
<input type="checkbox"/> SLPF	0.8	1	0.01
(%) reduction of available parameter values:			
	Min	Max	Inc
<input checked="" type="checkbox"/> SLLL	0.7	1.2	0.05
<input type="checkbox"/> SDUL	0.7	1.3	0.02
<input checked="" type="checkbox"/> SRGF	0.7	1.3	0.05
<input type="checkbox"/> SSKS	0.9	1.1	0.2

Figure 12 In section 7 (“(%) reduction of available parameter values:”) of SPO interface a user can initialize specific soil profile coefficients for conducting sensitivity analysis. At the moment coefficient initialization is conducted based on multiplier approach where each multiplier setup based on coefficient min/max and increment step creates various soil profile scenarios. Every multiplier translates to percentual values as shown in Table 3.

Table 3 Conversion of multipliers to percentual values

SLLL	Translates to percent reduction in SPO
0.7	-30%
0.8	-20%
0.9	-10%
1.0	Baseline
1.1	+10%
1.2	+20%

8. SPO run

countLine:7firstTrt1
lineCountStop in file-T:None
countLine:7firstTrt1
lineCountStop in file-T:None
countLine:6firstTrt1
lineCountStop in file-T:None
countLine:7firstTrt1
lineCountStop in file-T:None
countLine:7firstTrt1
lineCountStop in file-T:None
countLine:7firstTrt1
lineCountStop in file-T:None

8. ☐ Activate Fig generator ☐ Param uncertainty graph

Run the Model

IHRI0705	mean:6824.4	Std.Dev.:2391.3	median:
7488.5			
IHRI0805	mean:5485.0	Std.Dev.:1493.6	median:
5532.0			
IHRI0605	mean:5548.6	Std.Dev.:1156.8	median:
5417.0			
IHRI0705	mean:6824.4	Std.Dev.:2391.3	median:
7488.5			
IHRI0805	mean:5485.0	Std.Dev.:1493.6	median:
5532.0			

Plot scenarios Multi year GBuild Exit

Figure 13 In section 8 a user can activate the figure option of creating figures showing coefficient-based scenarios (Figure 12) or boxplots as a form of parameter sensitivity analysis (Figure 13).

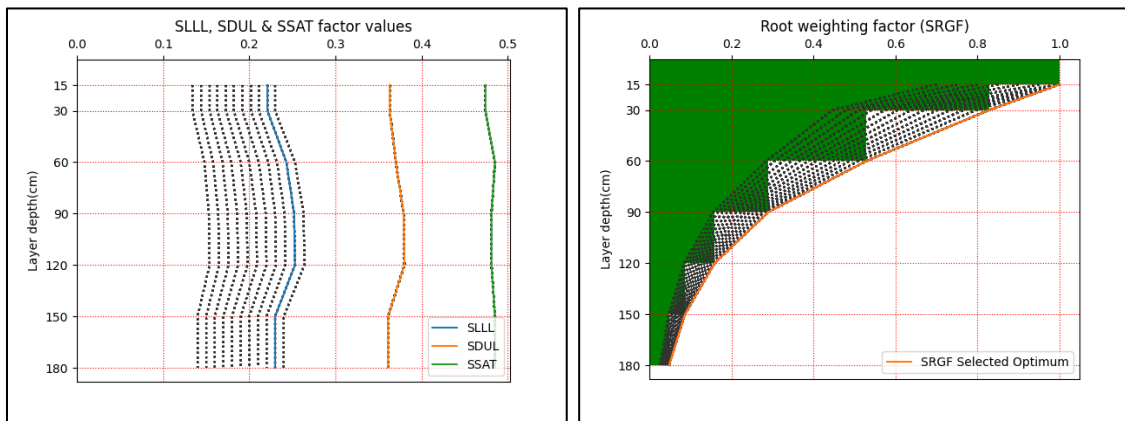


Figure 14 Coefficient based soil profile scenarios: SLL (left) and SRGF (right)

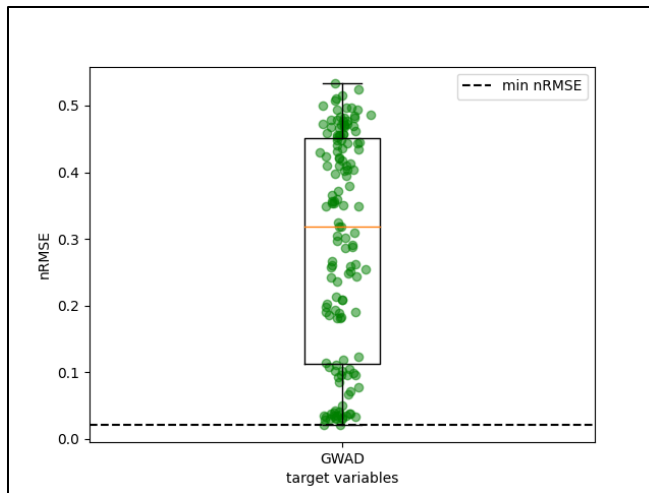


Figure 15

9. Appendix

References

Memic E., Trenz J., Heshmati S., Graeff H. (2023). Evaluation of crop model-based marginal net return maximizing nitrogen application rates on site-specific level in maize. 23 Proceedings of the European Conference on Precision Agriculture, Bologna, Italy, 2 July 2023.

Memic E., Graeff, S., Boote, K. J., Hensel O., Hoogenboom G. (2021). Cultivar coefficient estimator for the cropping system model based on time-series data-a case study for soybean. In Transactions of the ASABE, (Transactions of the ASABE 2021, doi: 10.13031/trans.14432).

Interface:

The SPO_v1 user interface was created in Qt Designer 5
(<https://doc.qt.io/qtcreator/index.html>)

Programming language:

The SPO_v1 algorithm was written in python 3.7
Python Software Foundation. Python Language Reference, version 3.7. Available at <http://www.python.org>

Windows runnable:

SPO_v1 was compiled into windows runnable with Pyinstaller
(<https://www.pyinstaller.org/>)

TSE_v2.2 algorithm and interface development/setup by Emir Memic.