Reducing the risk of compaction

Terranimo® UK

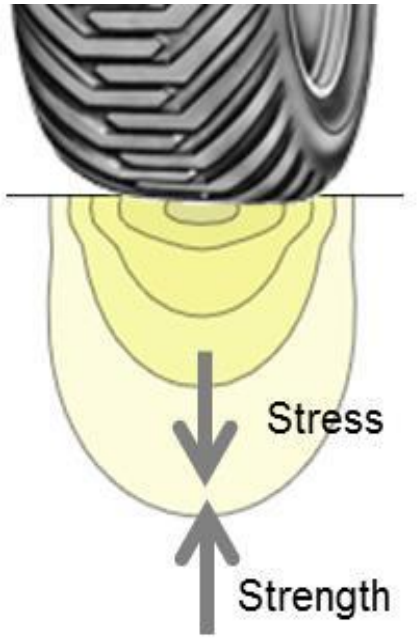
Quick start guide

What is Terranimo?

- A **free** online tool to demonstrate the risk of soil compaction for given:
  - Machinery
  - Tyres/tracks
  - Soil texture, bulk density and organic matter
  - Soil water status

What does Terranimo do?

- Evaluates the severity and depth of any compaction by taking account of the following factors:



Tyre size and inflation pressure
Wheel load
Repeated wheelings

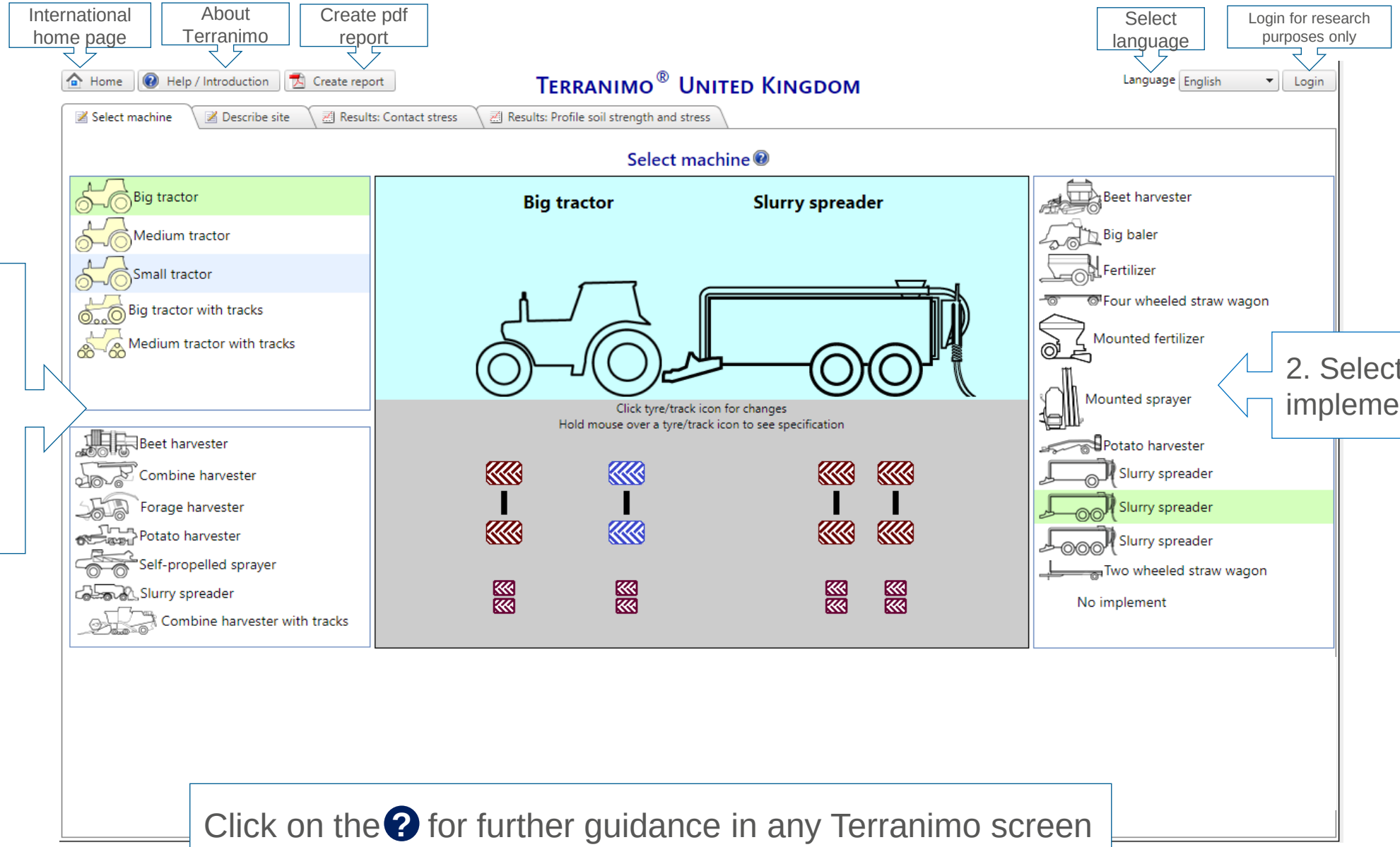
Clay and organic matter content
Bulk density
Soil water potential

- Allows comparisons to inform decisions

How to access Terranimo

- Go to: terranimo.uk
- Select 'Terranimo United Kingdom'

Select machine and implement

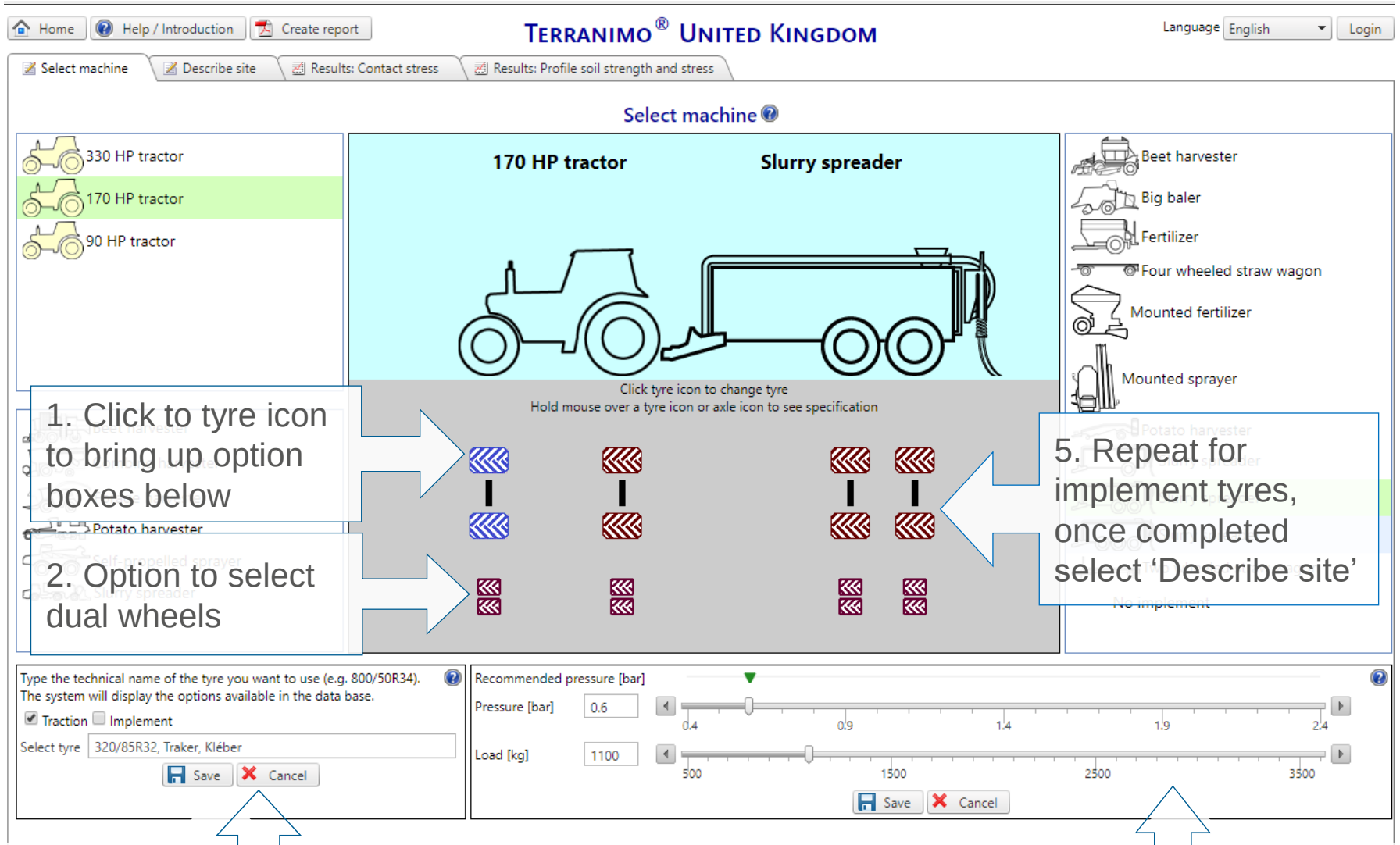


1. Select machine, Traditional and self-propelled potato harvesters

2. Select implement

Click on the ? for further guidance in any Terranimo screen

Select traction: tyres or tracks



3. Select tyres and click 'Save'.
There are many options to choose from (e.g. 85 options for 480 width tyres).

4. Set tyre pressures (or use default for that tyre), adjust the load per tyre, and click 'Save'.

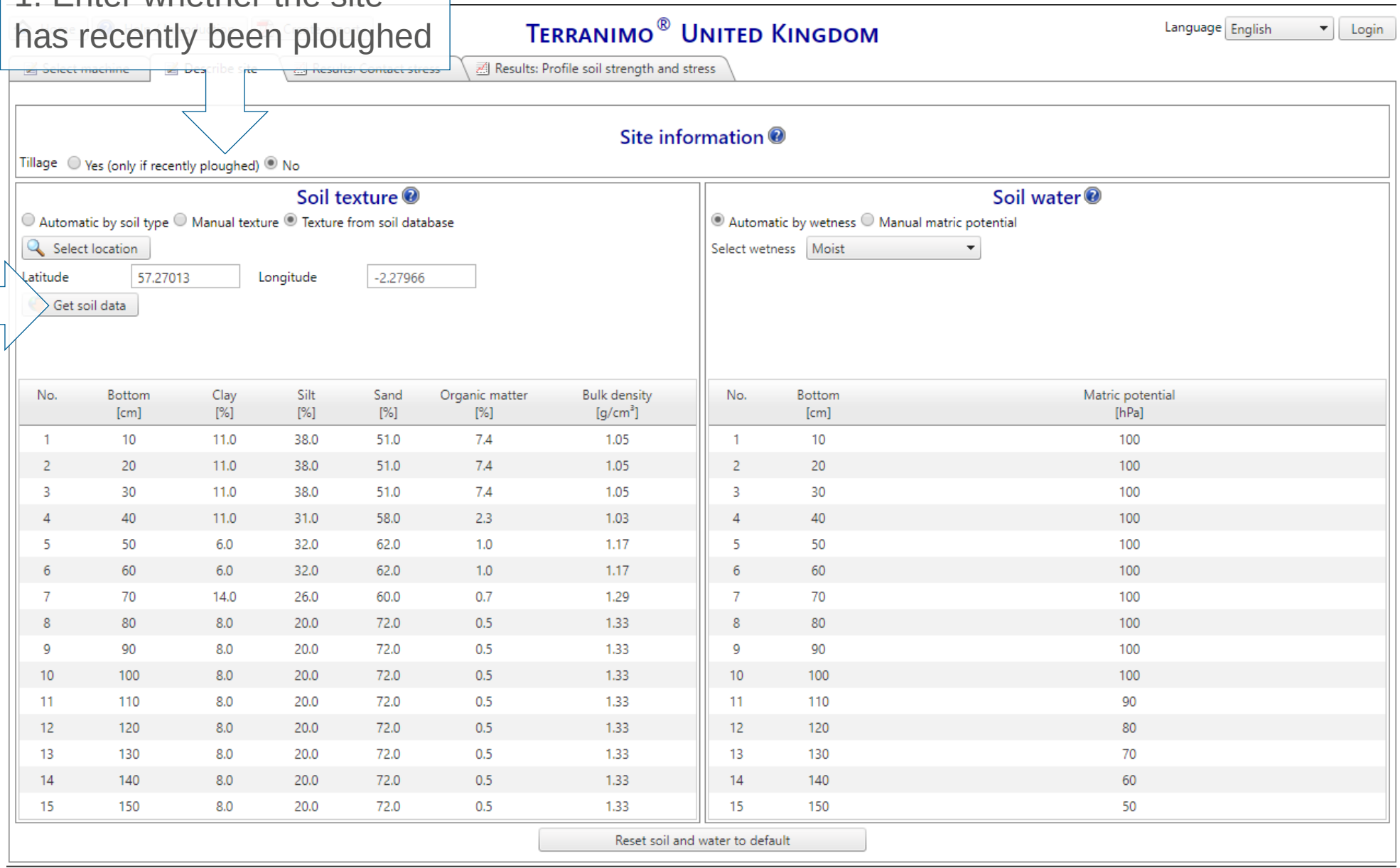
Describe site: Soil texture

1. Enter whether the site has recently been ploughed

2. Soil texture, organic matter and bulk density* can be entered in three ways:

i. Automatic, by county (shown here)
ii. Manual, e.g. for 3 layers
iii. By map, click on 'Select location', choose location on map by dropping a pin, save coordinates, then click 'Get soil data'
iv. Enter lat' and long' coordinates and click 'Get soil data'

*NB soil texture, organic matter and bulk density are only visually displayed for locations in Scotland. For England and Wales data, only the layer names are displayed. However the data is still included in the calculation.



TERRANIMO® UNITED KINGDOM

Language English Login

Results: Profile soil strength and stress

Site information

Tillage: Yes (only if recently ploughed) No

Soil texture

Automatic by soil type Manual texture Texture from soil database

Select location

Latitude 57.27013 Longitude -2.27966

Get soil data

No.	Bottom [cm]	Clay [%]	Silt [%]	Sand [%]	Organic matter [%]	Bulk density [g/cm³]
1	10	11.0	38.0	51.0	7.4	1.05
2	20	11.0	38.0	51.0	7.4	1.05
3	30	11.0	38.0	51.0	7.4	1.05
4	40	11.0	31.0	58.0	2.3	1.03
5	50	6.0	32.0	62.0	1.0	1.17
6	60	6.0	32.0	62.0	1.0	1.17
7	70	14.0	26.0	60.0	0.7	1.29
8	80	8.0	20.0	72.0	0.5	1.33
9	90	8.0	20.0	72.0	0.5	1.33
10	100	8.0	20.0	72.0	0.5	1.33
11	110	8.0	20.0	72.0	0.5	1.33
12	120	8.0	20.0	72.0	0.5	1.33
13	130	8.0	20.0	72.0	0.5	1.33
14	140	8.0	20.0	72.0	0.5	1.33
15	150	8.0	20.0	72.0	0.5	1.33

Soil water

Automatic by wetness Manual matric potential

Select wetness Moist

No.	Bottom [cm]	Matric potential [hPa]
1	10	100
2	20	100
3	30	100
4	40	100
5	50	100
6	60	100
7	70	100
8	80	100
9	90	100
10	100	100
11	110	90
12	120	80
13	130	70
14	140	60
15	150	50

Reset soil and water to default

Describe site: Soil water status

Home | Help / Introduction | Create report

TERRANIMO® UNITED KINGDOM

Language English | Login

Select machine | Describe site | Results: Contact stress | Results: Profile soil strength and stress

Site information

Tillage: Yes (only if recently ploughed) / No

Soil texture

Automatic by soil type / Manual texture / Texture from soil database

Select location

Latitude 57.27013 Longitude -2.27966

Get soil data

No.	Bottom [cm]	Clay [%]	Silt [%]	Sand [%]	Organic matter [%]	Bulk density [g/cm³]
1	10	11.0	38.0	51.0	7.4	1.05
2	20	11.0	38.0	51.0	7.4	1.05
3	30	11.0	38.0	51.0	7.4	1.05
4	40	11.0	31.0	58.0	2.3	1.03
5	50	6.0	32.0	62.0	1.0	1.17
6	60	6.0	32.0	62.0	1.0	1.17
7	70	14.0	26.0	60.0	0.7	1.29
8	80	8.0	20.0	72.0	0.5	1.33
9	90	8.0	20.0	72.0	0.5	1.33
10	100	8.0	20.0	72.0	0.5	1.33
11	110	8.0	20.0	72.0	0.5	1.33
12	120	8.0	20.0	72.0	0.5	1.33
13	130	8.0	20.0	72.0	0.5	1.33
14	140	8.0	20.0	72.0	0.5	1.33
15	150	8.0	20.0	72.0	0.5	1.33

Soil water

Automatic by wetness / Manual matric potential

Select wetness: Moist

No.	Bottom [cm]	Matric potential [hPa]
1	10	100
2	20	100
3	30	100
4	40	100
5	50	100
6	60	100
7	70	100
8	80	100
9	90	100
10	100	100
11	110	90
12	120	80
13	130	70
14	140	60
15	150	50

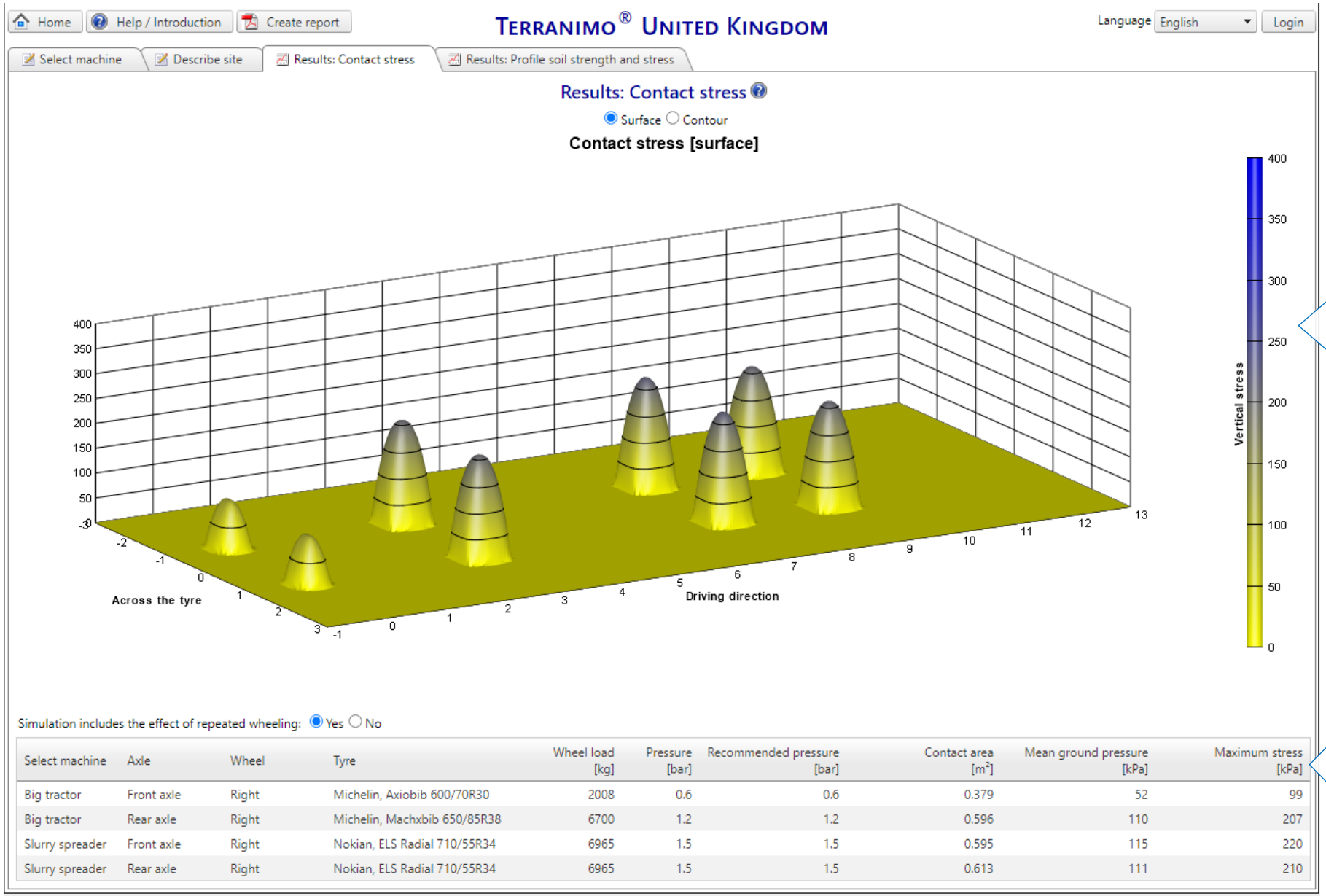
Reset soil and water to default

Two ways to enter:

i. Automatic, select option dry, moist or wet

ii. Manual, enter own estimates/measurements for matric use and soil water content e.g. suction measurements from tensiometer

Results: Contact Stress - Surface



Select machine	Axle	Wheel	Tyre	Wheel load [kg]	Pressure [bar]	Recommended pressure [bar]	Contact area [m²]	Mean ground pressure [kPa]	Maximum stress [kPa]
Big tractor	Front axle	Right	Michelin, Axiobib 600/70R30	2008	0.6	0.6	0.379	52	99
Big tractor	Rear axle	Right	Michelin, Machxbib 650/85R38	6700	1.2	1.2	0.596	110	207
Slurry spreader	Front axle	Right	Nokian, ELS Radial 710/55R34	6965	1.5	1.5	0.595	115	220
Slurry spreader	Rear axle	Right	Nokian, ELS Radial 710/55R34	6965	1.5	1.5	0.613	111	210

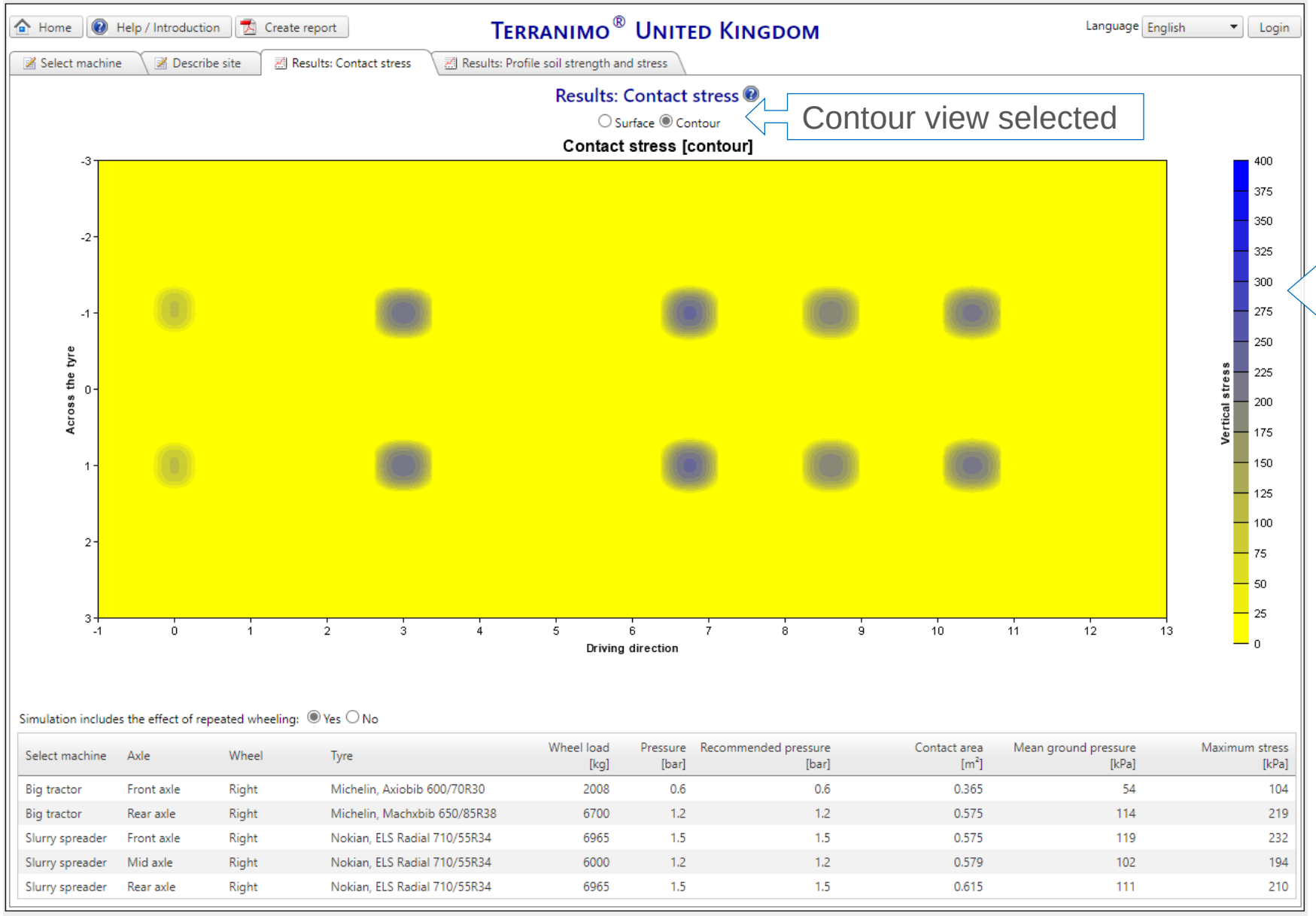
The chart shows stresses in the contact area for all tyres on the selected machinery

Simulation of repeated wheeling can be selected

Key figures for stresses in the contact area are given for each tyre

- Contact area
- Mean ground pressure
- Maximum stress

Results: Contact Stress - Contour

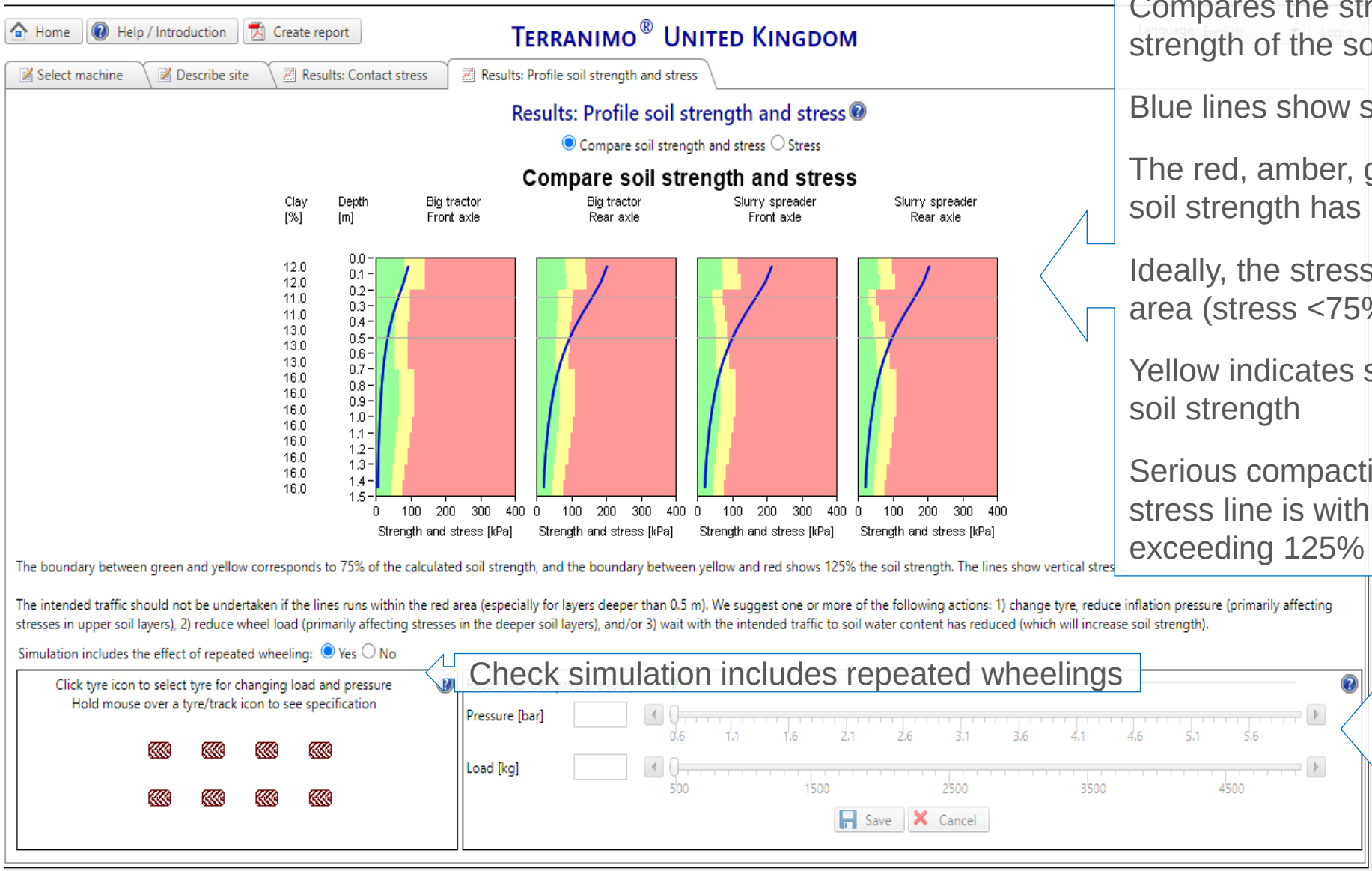


Contour view selected

As with the surface view, the chart shows stresses in the contact area for all tyres on the selected machinery in 2D

Select machine	Axle	Wheel	Tyre	Wheel load [kg]	Pressure [bar]	Recommended pressure [bar]	Contact area [m²]	Mean ground pressure [kPa]	Maximum stress [kPa]
Big tractor	Front axle	Right	Michelin, Axiobib 600/70R30	2008	0.6	0.6	0.365	54	104
Big tractor	Rear axle	Right	Michelin, Machxbib 650/85R38	6700	1.2	1.2	0.575	114	219
Slurry spreader	Front axle	Right	Nokian, ELS Radial 710/55R34	6965	1.5	1.5	0.575	119	232
Slurry spreader	Mid axle	Right	Nokian, ELS Radial 710/55R34	6000	1.2	1.2	0.579	102	194
Slurry spreader	Rear axle	Right	Nokian, ELS Radial 710/55R34	6965	1.5	1.5	0.615	111	210

Results: Profile soil strength and stress



Compares the stress from the wheels with the strength of the soil

Blue lines show stress under tyres vs depth

The red, amber, green zones indicate whether soil strength has been exceeded

Ideally, the stress line should be within the green area (stress <75% of soil strength)

Yellow indicates stresses between 75 and 125% soil strength

Serious compaction may be expected in case the stress line is within the red zone (stress stresses exceeding 125% the soil strength)

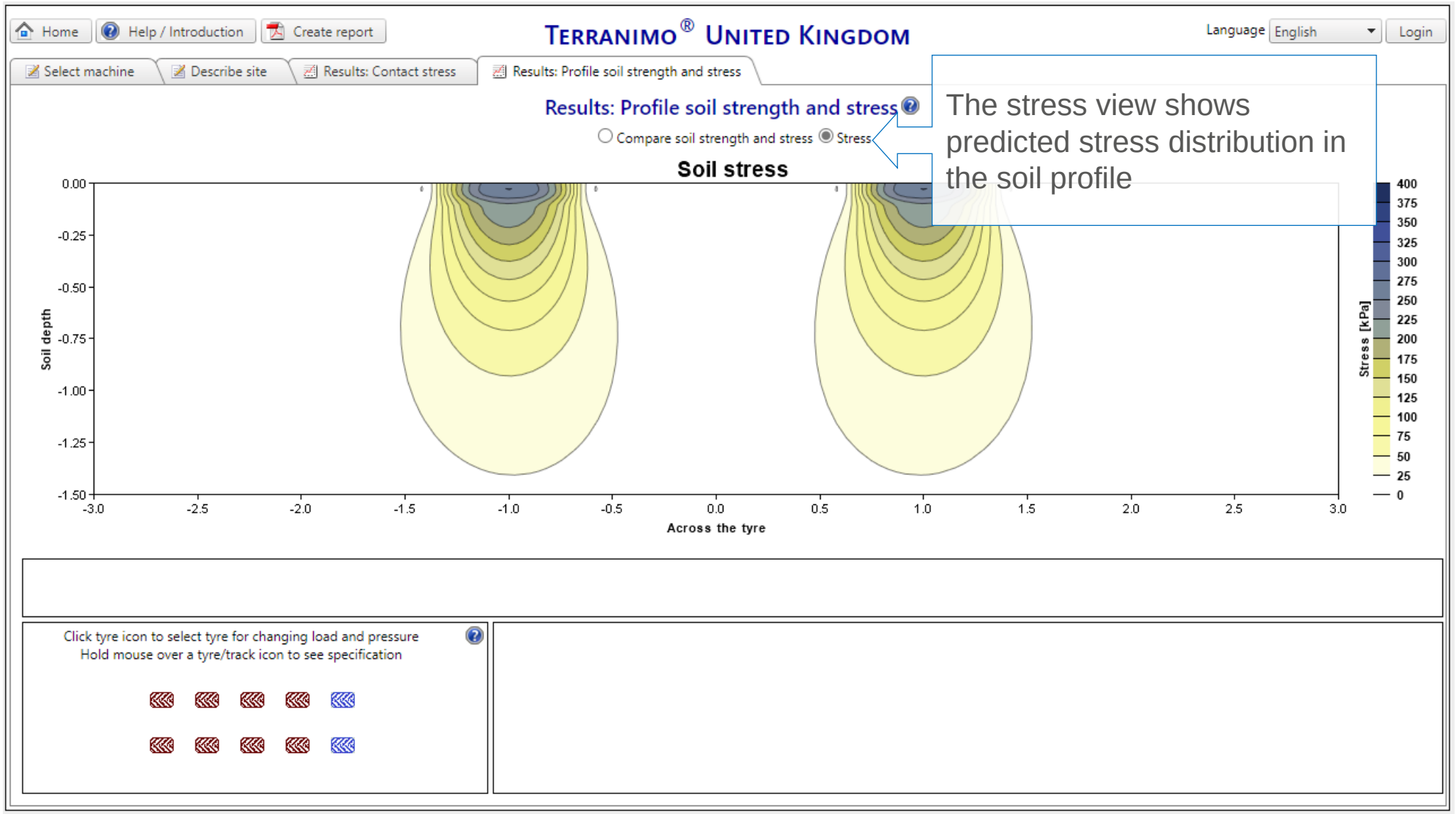
Check simulation includes repeated wheelings

Can locally modify wheel loads and tyre inflation pressures here

Click tyre icon first

NB they won't be included in the report

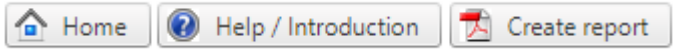
Results: Profile soil strength and stress



The stress view shows predicted stress distribution in the soil profile

Reports

1. Select ‘create report’



2. Example pages from a report

Report from simulation with Terranimo

Date: 14 September 2021

Terranimo version: 3.0, United Kingdom

Selected machinery

Big tractor with Slurry spreader

Table 1. Loading characteristics for all wheels of the machine system.

Axle	Manufacturer	Tyre category	Tyre dimension	Track-/Wheelload [kg]	Pressure [bar]	Recommended pressure [bar]
Front axle	Michelin	Traction	600/70R30	2008	0.6	0.6
Rear axle	Michelin	Traction	650/85R38	6700	1.2	1.2
Front axle	Nokian	Implement	710/55R34	6965	1.5	1.5
Mid axle	Nokian	Implement	710/55R34	6000	1.2	1.2
Rear axle	Nokian	Implement	710/55R34	6965	1.5	1.5

See a sketch of the machinery in Appendix 1.

Soil and soil water

You have simulated for a soil with 11.0 % clay content (topsoil, average 0-20 cm) and 100 hPa matric potential in the topsoil. Detailed data for soil texture and soil matric potential are found as tables in Appendix 2.

You have simulated for a soil, which has not been recently tilled.

The simulation does not include the effect of repeated wheeling.

The tyre-soil contact area

Table 2. Key figures for the stress distribution in the tyre-soil contact area.

Axle	Contact area [m²]	Mean ground pressure [kPa]	Max. stress in contact area [kPa]
Front axle	0.365	54	104
Rear axle	0.575	114	219
Front axle	0.578	118	230
Mid axle	0.564	104	202
Rear axle	0.578	118	230

A graph showing the contact area stress distribution for all tyres is displayed in Appendix 3.

Report from simulation with Terranimo

Soil profile stress

The vertical stress right below the center of each tyre is tabulated below. For most tyres and inflation pressures, these data will indicate the highest stresses affecting the soil profile,- at least for soil depths deeper than ~0.3 m.

Table 3. Vertical soil stress (kPa) in a line under the center of the tyre for all tyres on the machinery.

Axle	Soil layer [cm]														
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Front axle	99	84	67	52	40	32	25	20	17	14	12	10	9	8	7
Rear axle	214	195	167	137	111	90	73	60	50	42	36	31	27	23	22
Front axle	224	204	174	143	116	94	76	63	52	44	38	32	28	25	23
Mid axle	197	179	152	125	101	82	67	55	46	38	33	28	24	21	20
Rear axle	224	204	174	143	116	94	76	63	52	44	38	32	28	25	23

Soil profile strength and stress

Soil compaction will take place if stress exceeds soil strength. A comparison can be made between the two. Severe compaction will occur in case stress exceeds the soil strength significantly.

Table 4. Soil compaction index (SCI) calculated as the log to the ratio of stress and strength (see section 14 in the Terranimo Introduction file).

Axle	Soil layer [cm]														
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Front axle	+0.13	+0.22	+0.32	+0.18	+0.27	+0.37	+0.48	+0.55	+0.63	+0.71	+0.76	+0.81	+0.84	+0.87	+0.86
Rear axle	0.19	0.14	0.07	0.24	0.17	0.08	-0.02	-0.08	+0.16	+0.23	+0.26	+0.32	+0.35	+0.38	+0.37
Front axle	0.22	0.16	0.09	0.26	0.19	0.10	0.00	-0.06	+0.14	+0.21	+0.26	+0.30	+0.33	+0.36	+0.34
Mid axle	0.16	0.11	0.04	0.20	0.14	0.04	-0.06	-0.12	+0.20	+0.27	+0.32	+0.36	+0.39	+0.42	+0.41
Rear axle	0.22	0.16	0.09	0.26	0.19	0.10	0.00	-0.06	+0.14	+0.21	+0.26	+0.30	+0.33	+0.36	+0.34

SCI<-0.12: No compaction risk. -0.12<SCI<0.1: Intermediate compaction risk. SCI>0.1: High compaction risk.

A graph showing the soil profile stress and strength for all tyres is displayed in Appendix 4.

Recommendation

If SCI>0.1 (especially if this is the case for layers deeper than 0.5 m), the intended traffic should not be undertaken. We suggest one or more of the following actions: Change tyre, reduce inflation pressure (primarily affecting stresses in upper soil layers), reduce wheel load (primarily affecting stresses in the deeper soil layers), wait with the intended traffic to soil water content has reduced (which will increase soil strength).

Comments

Further information

- An Introduction to Terranimo: https://www.terranimo.dk/Pages/pdf.aspx?filename=An-introduction-to-Terranimo_January2020_UK&directory=1
- AHDB webinar:

Potato Soil Health: Is your kit killing your soil? – YouTube

Includes the background to Terranimo and worked examples