ARC • LNR
Excellence in Research and Development

Geo-spatial Technologies for Land Productivity Assessment - from Plant to the Globe

Mohamed A. M. Abd Elbasit
(BSc, PGDip-IT, MSc, PhD)
ARC-Soil, Climate and Water, Geoinformation Division

ARC • LNR
Excellence in Research and Development

ARC • LNR
Excellence in Research and Development

Crop Yield:

$\int$ *ET* ↑

$\int$ *Rainfall + Irrigation* ↓

$\int$ *Radiation*

$\int$ *Temperature*

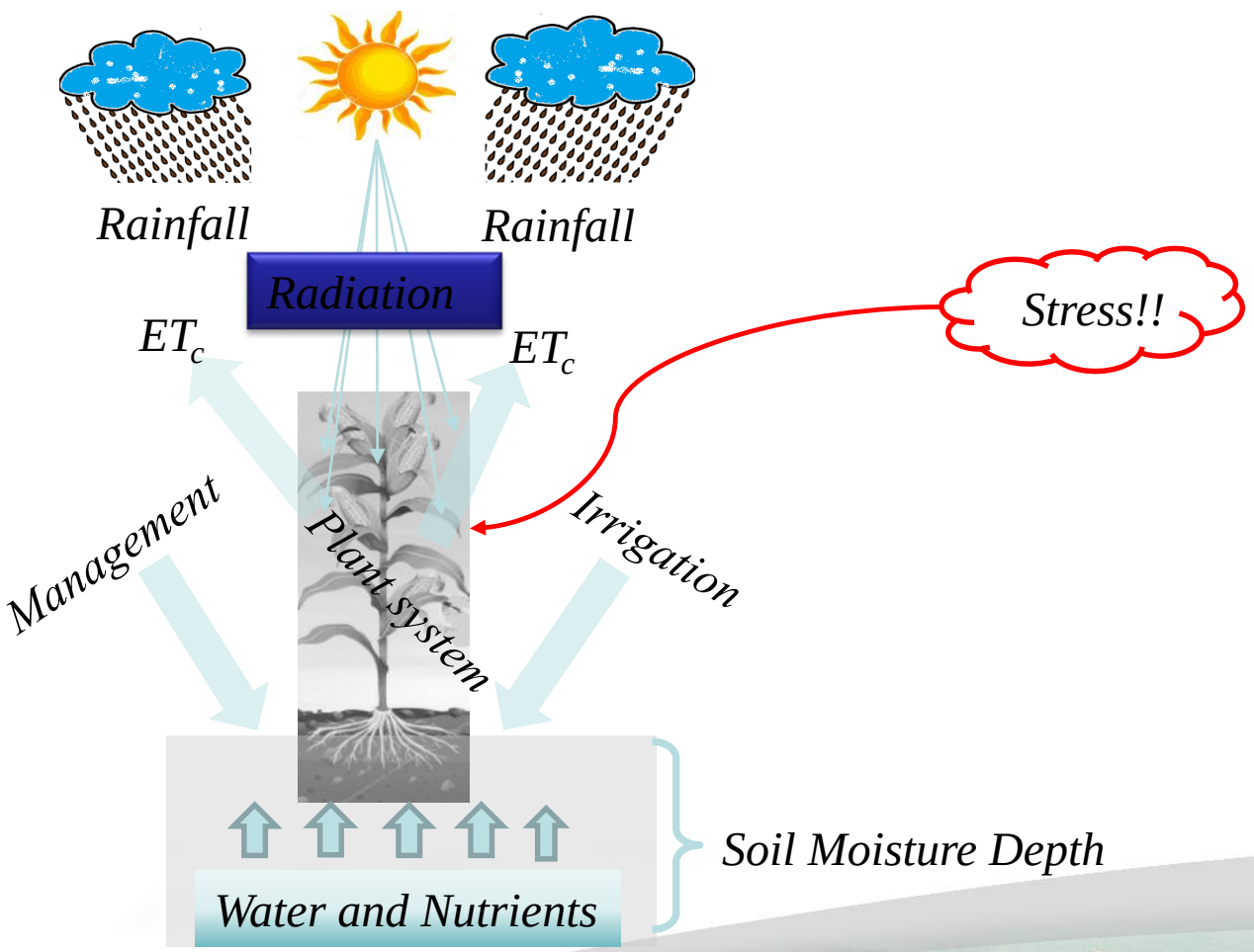
$\int$ *Nutrients*

$\int$ *Cultivers*

$\int$ *Management*

.
.
.

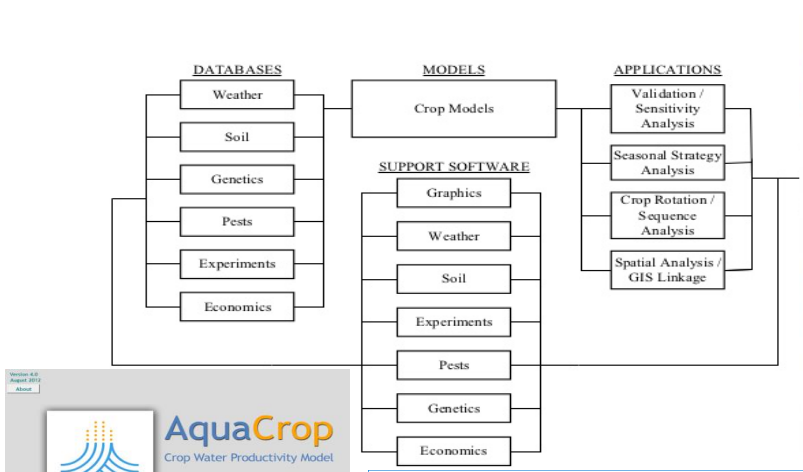
$\int$



ARC • LNR
Excellence in Research and Development

ARC • LNR

Excellence in Research and Development



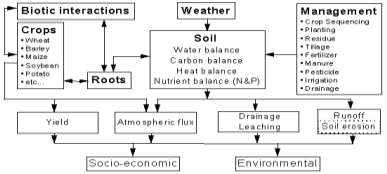
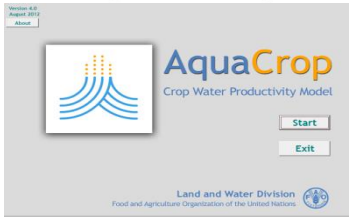
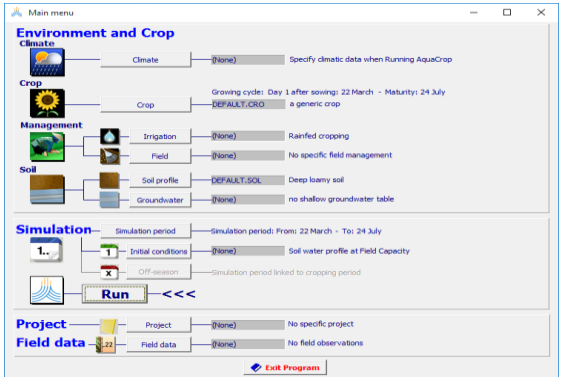
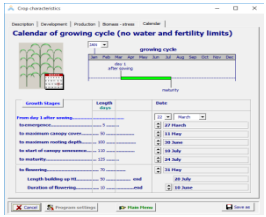
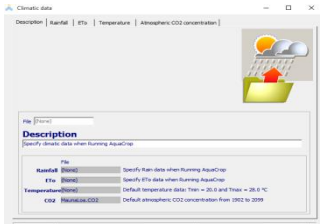


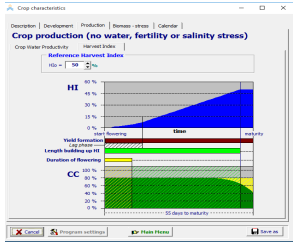
Figure 1. Diagram of the components of SALUS.

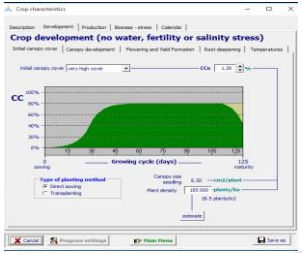


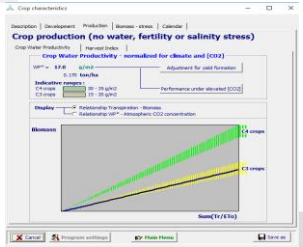


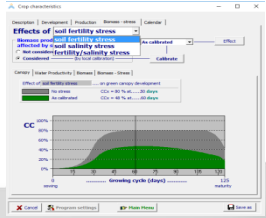


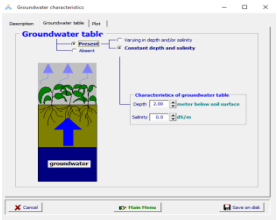


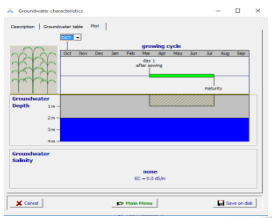


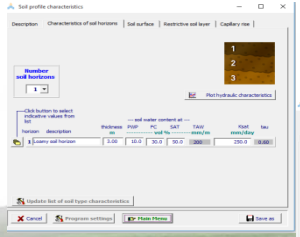


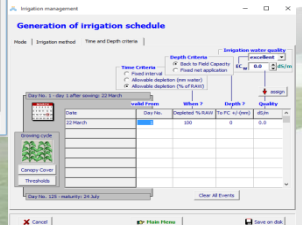


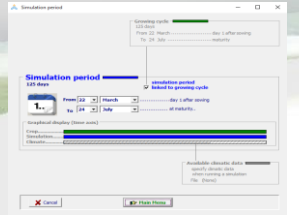




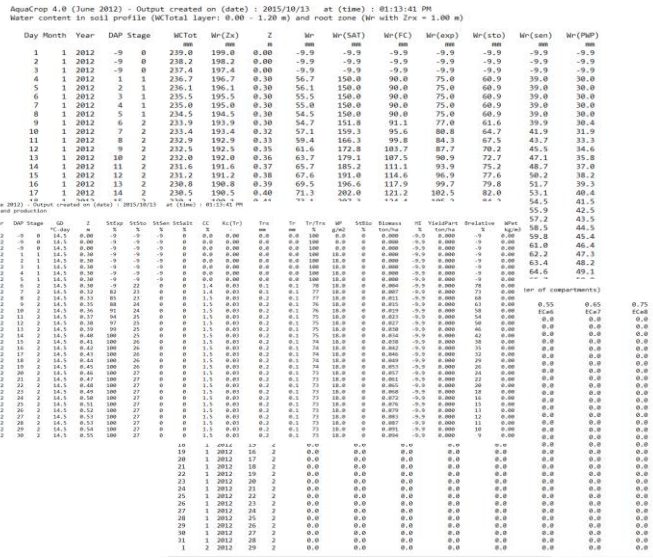








ARC • LNR
Excellence in Research and Development

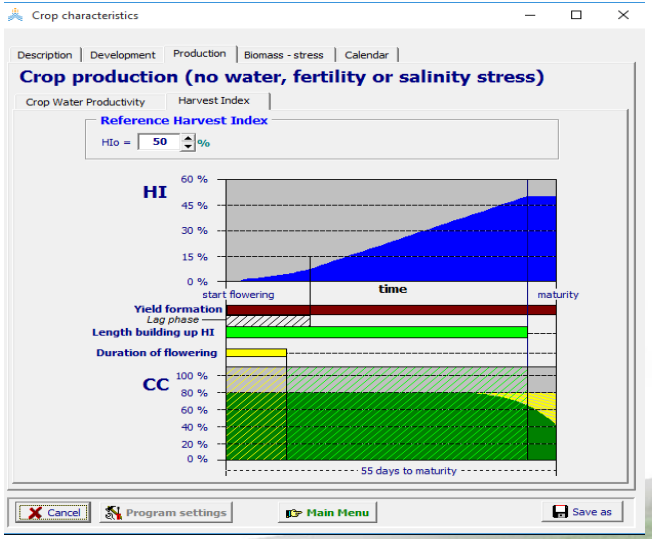


AquaCrop 4.0 (June 2012) - Output created on (date) : 2015/10/13 at (time) : 01:13:41 PM
Water content in soil profile (WCTotal layer: 0.00 - 1.20 m) and root zone (Wr with Zrx = 1.00 m)

Day	Month	Year	DAP	Stage	WCTot mm	Wr(Zx) mm	Z m	Wr mm	Wr(SAT) mm	Wr(FC) mm	Wr(exp) mm	Wr(sto) mm	Wr(sen) mm	Wr(PWP) mm
1	1	2012	-9	0	239.0	199.0	0.00	-9.9	-9.9	-9.9	-9.9	-9.9	-9.9	-9.9
2	1	2012	-9	0	238.2	198.2	0.00	-9.9	-9.9	-9.9	-9.9	-9.9	-9.9	-9.9
3	1	2012	-9	0	237.4	197.4	0.00	-9.9	-9.9	-9.9	-9.9	-9.9	-9.9	-9.9
4	1	2012	1	1	236.7	196.7	0.30	56.7	150.0	90.0	75.0	60.9	39.0	30.0
5	1	2012	2	1	236.1	196.1	0.30	56.1	150.0	90.0	75.0	60.9	39.0	30.0
6	1	2012	3	1	235.5	195.5	0.30	55.5	150.0	90.0	75.0	60.9	39.0	30.0
7	1	2012	4	1	235.0	195.0	0.30	55.0	150.0	90.0	75.0	60.9	39.0	30.0
8	1	2012	5	1	234.5	194.5	0.30	54.5	150.0	90.0	75.0	60.9	39.0	30.0
9	1	2012	6	2	233.9	193.9	0.30	54.7	151.8	91.1	77.0	61.6	39.9	30.4
10	1	2012	7	2	233.4	193.4	0.32	57.1	159.3	95.6	80.8	64.7	41.9	31.9
11	1	2012	8	2	232.9	192.9	0.33	59.4	166.3	99.8	84.3	67.5	43.7	33.3
12	1	2012	9	2	232.5	192.5	0.35	61.6	172.8	103.7	87.7	70.2	45.5	34.6
13	1	2012	10	2	232.0	192.0	0.36	63.7	179.1	107.5	90.9	72.7	47.1	35.8
14	1	2012	11	2	231.6	191.6	0.37	65.7	185.2	111.1	93.9	75.2	48.7	37.0
15	1	2012	12	2	231.2	191.2	0.38	67.6	191.0	114.6	96.9	77.6	50.2	38.2
16	1	2012	13	2	230.8	190.8	0.39	69.5	196.6	117.9	99.7	79.8	51.7	39.3
17	1	2012	14	2	230.5	190.5	0.40	71.3	202.0	121.2	102.5	82.0	53.1	40.4
18	1	2012	15	2	230.2	190.2	0.41	73.1	207.3	124.4	105.2	84.2	54.5	41.5

AquaCrop 4.0 (June 2012) - Output created on (date) : 15.9 /10/13 at (time) : 01:13:41 PM
Crop development and production

Day	Month	Year	DAP	Stage	GD °C-day	Z m	StExp %	StSto %	StSen %	StSalt %	CC %	Kc(Tr)	Trx mm	Tr mm	Tr/Trx %	WP g/m2	StBio %	Biomass ton/ha	HI %	YieldPart ton/ha	Brelative %	WPet kg/m3
1	1	2012	-9	0	14.5	0.00	-9	-9	-9	0	0.0	0.00	0.0	0.0	100	0.0	0	0.000	-9.9	0.000	-9	0.00
2	1	2012	-9	0	14.5	0.00	-9	-9	-9	0	0.0	0.00	0.0	0.0	100	0.0	0	0.000	-9.9	0.000	-9	0.00
3	1	2012	-9	0	14.5	0.00	-9	-9	-9	0	0.0	0.00	0.0	0.0	100	0.0	0	0.000	-9.9	0.000	-9	0.00
4	1	2012	1	1	14.5	0.30	-9	-9	-9	0	0.0	0.00	0.0	0.0	100	18.0	0	0.000	-9.9	0.000	-9	0.00
5	1	2012	2	1	14.5	0.30	-9	-9	-9	0	0.0	0.00	0.0	0.0	100	18.0	0	0.000	-9.9	0.000	-9	0.00
6	1	2012	3	1	14.5	0.30	-9	-9	-9	0	0.0	0.00	0.0	0.0	100	18.0	0	0.000	-9.9	0.000	-9	0.00
7	1	2012	4	1	14.5	0.30	-9	-9	-9	0	0.0	0.00	0.0	0.0	100	18.0	0	0.000	-9.9	0.000	-9	0.00
8	1	2012	5	1	14.5	0.30	-9	-9	-9	0	0.0	0.00	0.0	0.0	100	18.0	0	0.000	-9.9	0.000	-9	0.00
9	1	2012	6	2	14.5	0.30	-9	22	0	0	1.4	0.03	0.1	0.1	78	18.0	0	0.004	-9.9	0.000	78	0.00
10	1	2012	7	2	14.5	0.32	82	23	0	0	1.4	0.03	0.2	0.1	77	18.0	0	0.007	-9.9	0.000	73	0.00
11	1	2012	8	2	14.5	0.33	83	23	0	0	1.5	0.03	0.2	0.1	77	18.0	0	0.011	-9.9	0.000	68	0.00
12	1	2012	9	2	14.5	0.35	84	24	0	0	1.5	0.03	0.2	0.1	76	18.0	0	0.015	-9.9	0.000	63	0.00
13	1	2012	10	2	14.5	0.36	91	24	0	0	1.5	0.03	0.2	0.1	76	18.0	0	0.019	-9.9	0.000	58	0.00
14	1	2012	11	2	14.5	0.37	94	25	0	0	1.5	0.03	0.2	0.1	75	18.0	0	0.023	-9.9	0.000	54	0.00
15	1	2012	12	2	14.5	0.38	97	25	0	0	1.5	0.03	0.2	0.1	75	18.0	0	0.027	-9.9	0.000	50	0.00
16	1	2012	13	2	14.5	0.39	99	25	0	0	1.5	0.03	0.2	0.1	75	18.0	0	0.030	-9.9	0.000	46	0.00
17	1	2012	14	2	14.5	0.40	100	25	0	0	1.5	0.03	0.2	0.1	75	18.0	0	0.034	-9.9	0.000	42	0.00
18	1	2012	15	2	14.5	0.41	100	26	0	0	1.5	0.03	0.2	0.1	74	18.0	0	0.038	-9.9	0.000	38	0.00
19	1	2012	16	2	14.5	0.42	100	26	0	0	1.5	0.03	0.2	0.1	74	18.0	0	0.042	-9.9	0.000	35	0.00
20	1	2012	17	2	14.5	0.43	100	26	0	0	1.5	0.03	0.2	0.1	74	18.0	0	0.046	-9.9	0.000	32	0.00
21	1	2012	18	2	14.5	0.44	100	26	0	0	1.5	0.03	0.2	0.1	74	18.0	0	0.049	-9.9	0.000	29	0.00
22	1	2012	19	2	14.5	0.45	100	26	0	0	1.5	0.03	0.2	0.1	74	18.0	0	0.053	-9.9	0.000	26	0.00
23	1	2012	20	2	14.5	0.46	100	27	0	0	1.5	0.03	0.2	0.1	73	18.0	0	0.057	-9.9	0.000	24	0.00
24	1	2012	21	2	14.5	0.47	100	27	0	0	1.5	0.03	0.2	0.1	73	18.0	0	0.061	-9.9	0.000	22	0.00
25	1	2012	22	2	14.5	0.48	100	27	0	0	1.5	0.03	0.2	0.1	73	18.0	0	0.065	-9.9	0.000	20	0.00
26	1	2012	23	2	14.5	0.49	100	27	0	0	1.5	0.03	0.2	0.1	73	18.0	0	0.068	-9.9	0.000	18	0.00
27	1	2012	24	2	14.5	0.50	100	27	0	0	1.5	0.03	0.2	0.1	73	18.0	0	0.072	-9.9	0.000	16	0.00
28	1	2012	25	2	14.5	0.51	100	27	0	0	1.5	0.03	0.2	0.1	73	18.0	0	0.076	-9.9	0.000	15	0.00
29	1	2012	26	2	14.5	0.52	100	27	0	0	1.5	0.03	0.2	0.1	73	18.0	0	0.079	-9.9	0.000	13	0.00
30	1	2012	27	2	14.5	0.53	100	27	0	0	1.5	0.03	0.2	0.1	73	18.0	0	0.083	-9.9	0.000	12	0.00
31	1	2012	28	2	14.5	0.53	100	27	0	0	1.5	0.03	0.2	0.1	73	18.0	0	0.087	-9.9	0.000	11	0.00
1	2	2012	29	2	14.5	0.54	100	27	0	0	1.5	0.03	0.2	0.1	73	18.0	0	0.090	-9.9	0.000	9	0.00
2	2	2012	30	2	14.5	0.55	100	27	0	0	1.5	0.03	0.2	0.1	73	18.0	0	0.094	-9.9	0.000	9	0.00



DAP : Days after planting
Stage : 0: before/after planting
Stage : 1: emergence or transplant recovery
Stage : 2: vegetative stage
Stage : 3: flowering
Stage : 4: yield formation and ripening
GD : Growing degrees
Z : Effective rooting depth
StExp : Percent water stress reducing leaf expansion
StSto : Percent water stress inducing stomatal closure
StSen : Percent water stress triggering early canopy senescence
StSalt : Percent salinity stress
CC : Green Canopy Cover
Kc(Tr) : Crop coefficient for transpiration
Trx : Maximum crop transpiration
Tr : Crop transpiration
Tr/Trx : Relative crop transpiration (100 Tr/Trx)
WP : Crop water productivity adjusted for CO2, soil fertility and products synthesized
StBio : Percent temperature stress affecting biomass production
Biomass : Cumulative biomass produced
HI : Harvest Index adjusted for failure of pollination, inadequate photosynthesis and water stress
Yield Part : Yield (HI x Biomass)
Brelative : Relative biomass (Reference: no water, no soil fertility, no soil salinity stress)
WPet : ET Water productivity for yield part (kg yield produced per m3 water evapotranspired)

Yield Part : Yield (HI x Biomass)

Biomass : Cumulative biomass produced

ARC • LNR
Excellence in Research and Development

Crop Growth models
Crop Simulation
Crop Yield Simulation

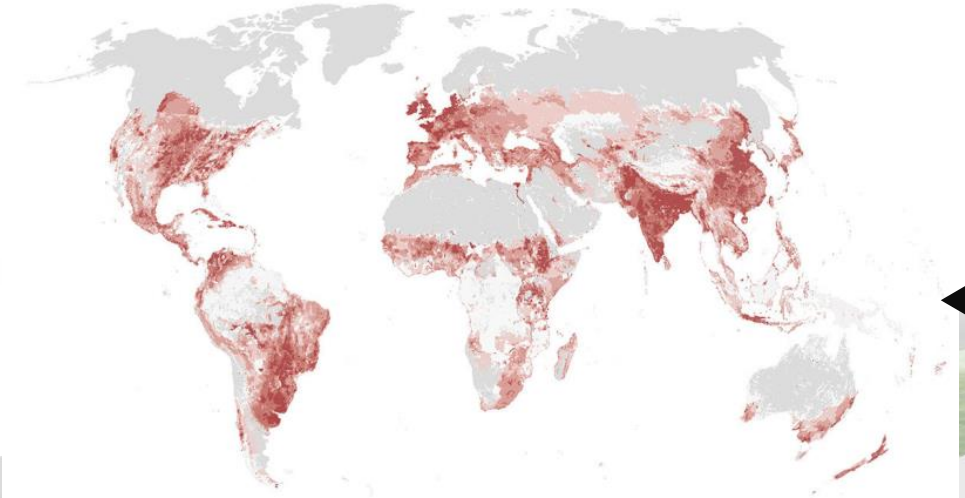
Mechanistic Models

Empirical/Statistical Models

Functional Models

Crop Growth/Production

→ Weather Conditions
→ Soil Conditions
→ Crop Management
→ Biotic Factors
→ Stress



ARC • LNR
Excellence in Research and Development

Geo-spatial /GEO-ICT

ICT is an acronym that stands for Information & Communication Technology

Geospatial technology can be refer to **GEO-ICT** (Location-ICT) this including GIS, Spatial modeling and spatial data and geospatial services.

ARC • LNR
Excellence in Research and Development

Scale is important aspect in geospatial and we can apply "**scale independent approaches**" that allow tracking of changes at any spatial domain:

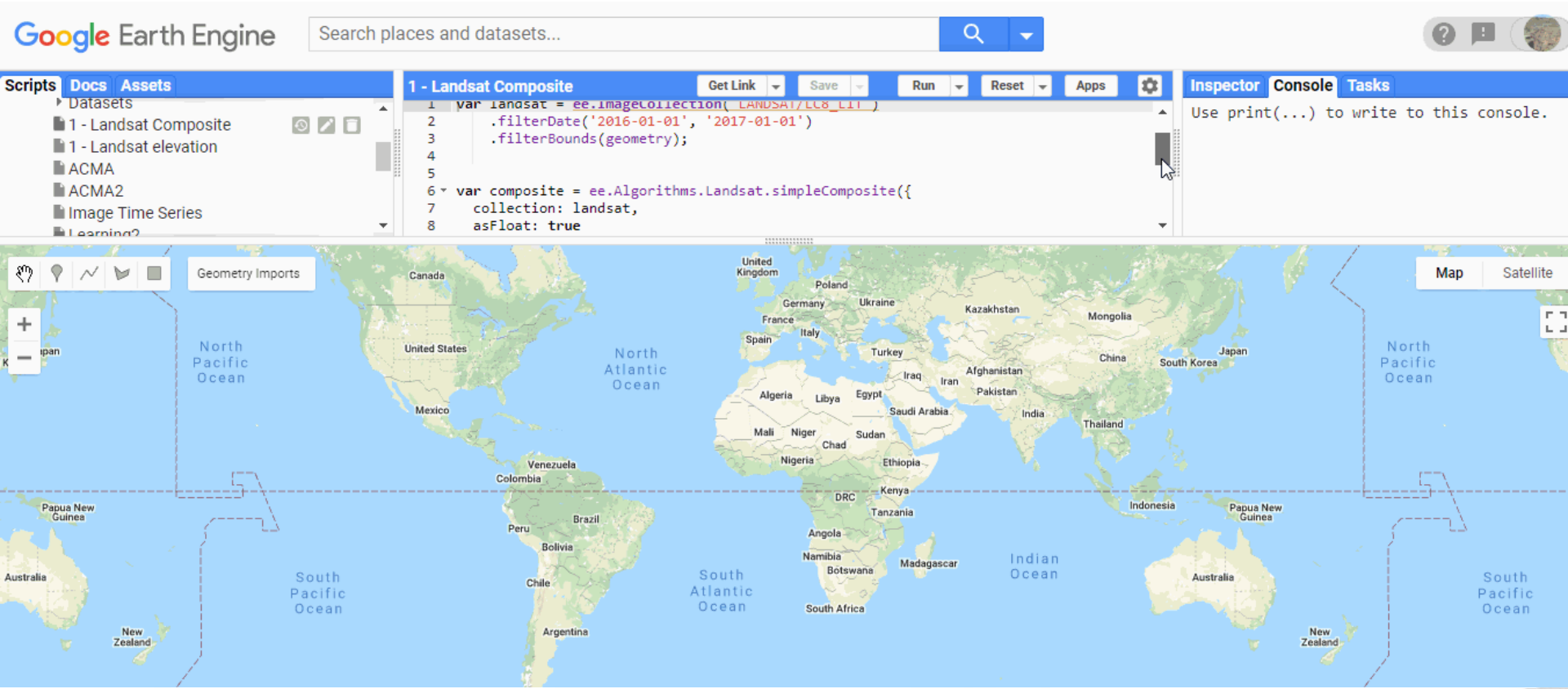
Global-> National -> Basin-> Farms ->Fields -> Buildings -> Petri dish -> Cell

This kind of development gives the multi- and cross-disciplinary nature of the geospatial sciences an technology.

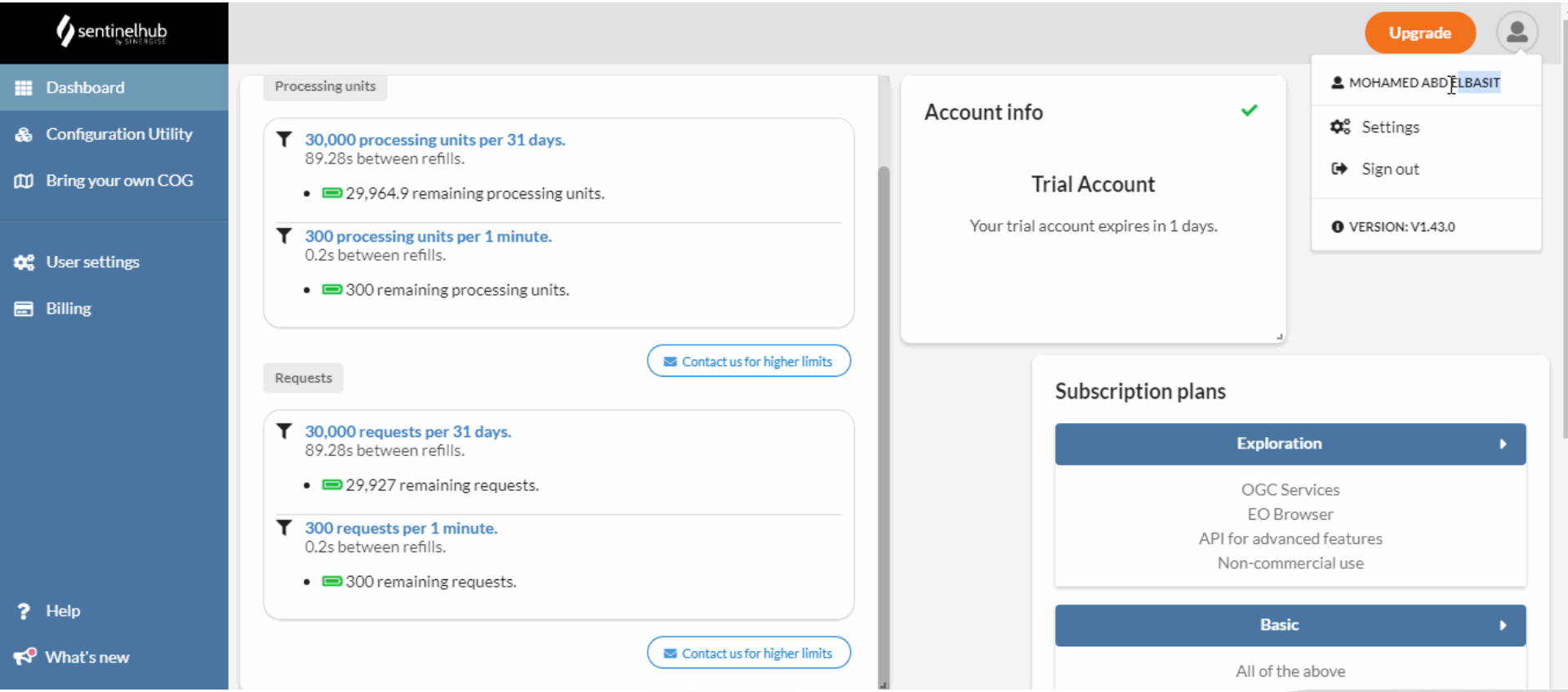
Multi-Platform Analysis /Visualization

ARC • LNR
Excellence in Research and Development

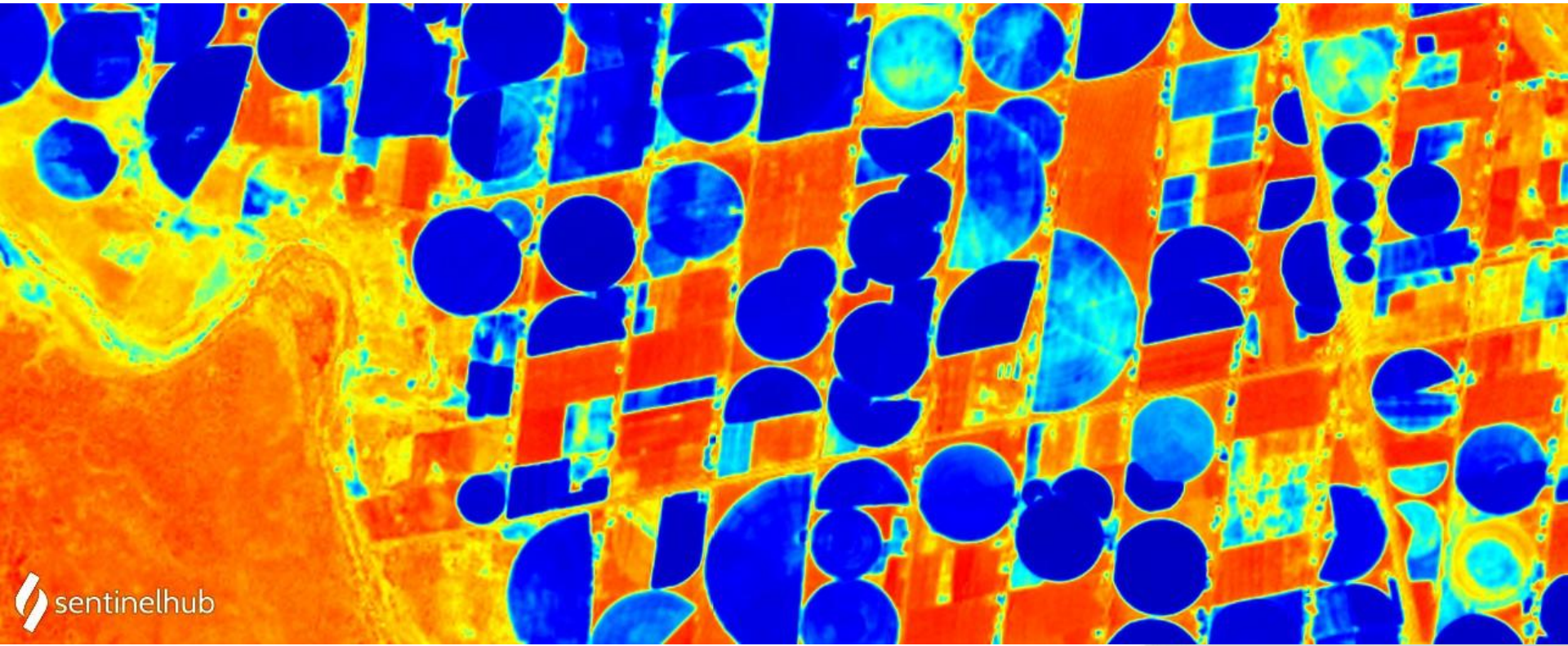
esa



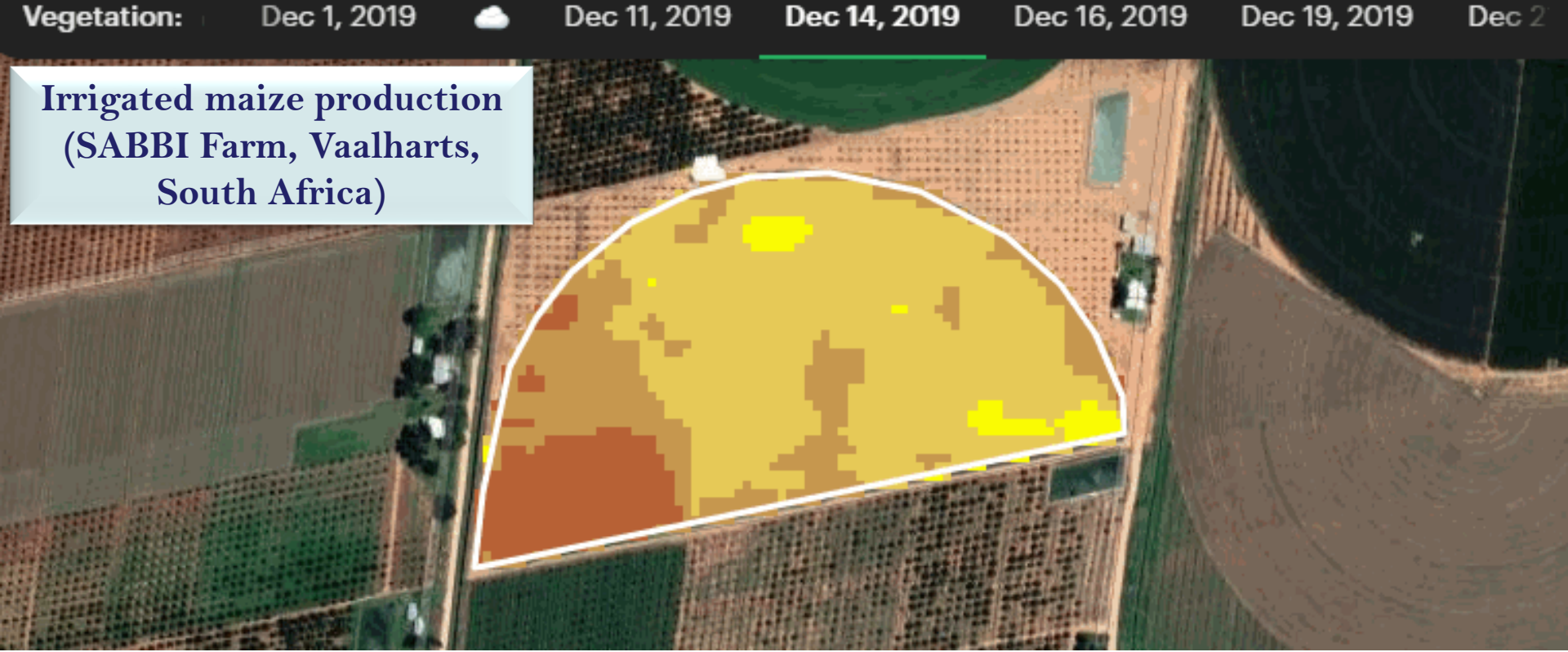
ARC • LNR
Excellence in Research and Development



ARC • LNR
Excellence in Research and Development



ARC • LNR
Excellence in Research and Development



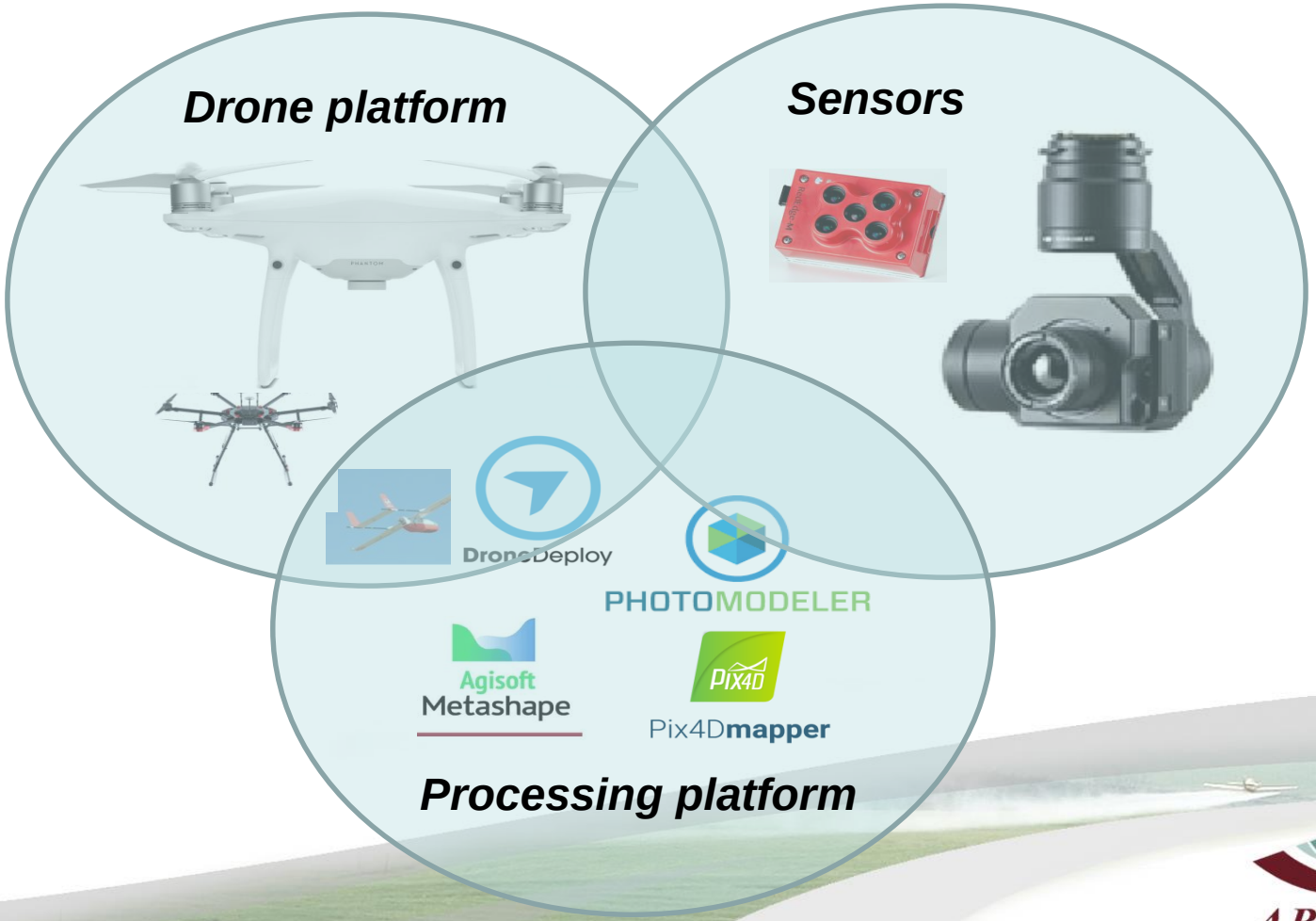
Irrigated maize production (SABBI Farm, Vaalharts, South Africa)

ARC • LNR
Excellence in Research and Development

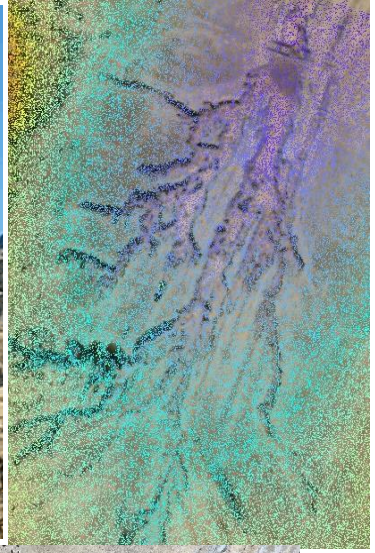
Irrigated Barley production (SABBI Farm, Vaalharts, South Africa)

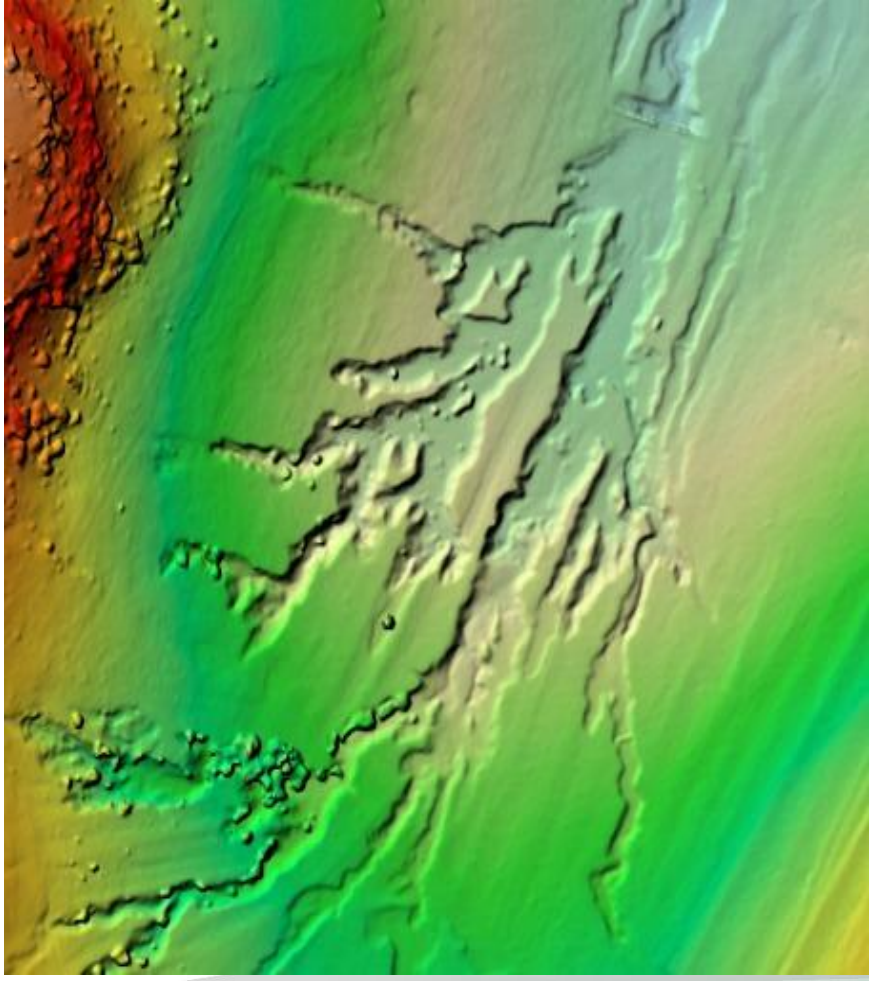
ARC • LNR
Excellence in Research and Development

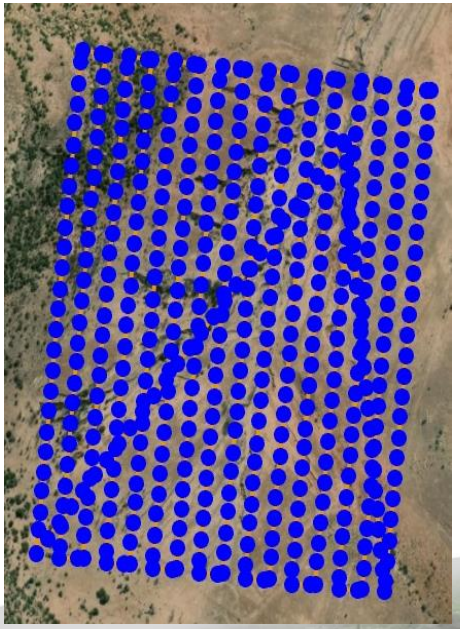
UAS application components



ARC • LNR
Excellence in Research and Development







ARC • LNR

Excellence in Research and Development

Agricultural UAV applications

Agricultural application are in three categories:

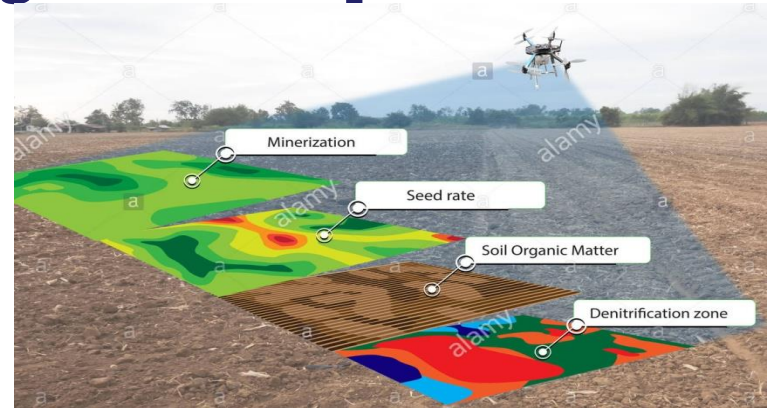
→Agricultural optimization

→ Monitoring operation

→ Increase of productivity

Source: DJI

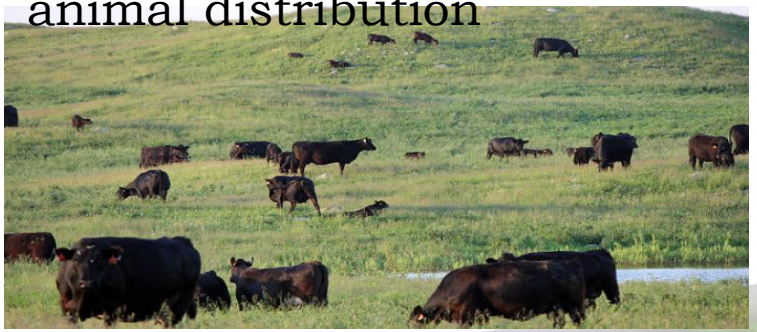
Agricultural optimization



Land unit mapping
Terrain analysis for tillage operation
Weed control

Pest control

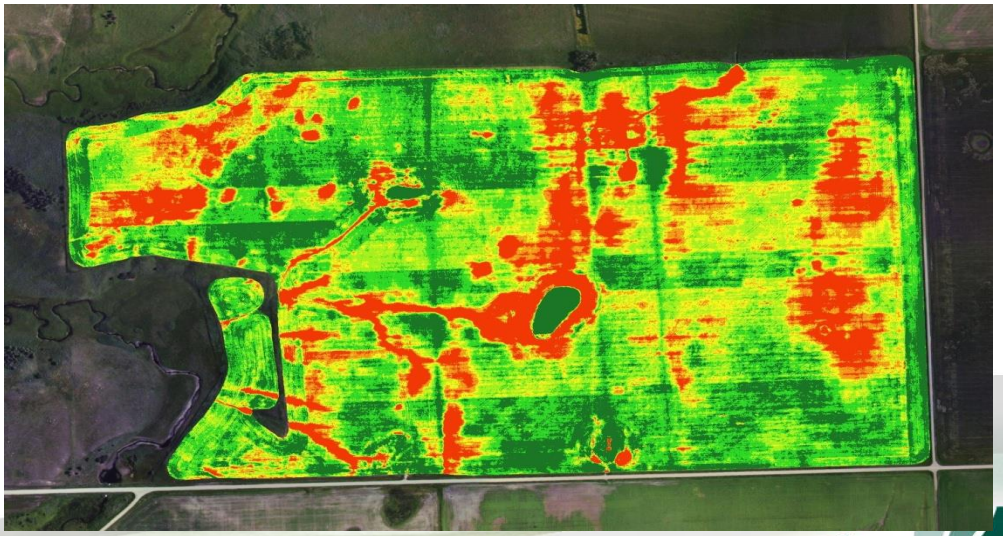
Rangeland mapping/management and animal distribution



ARC • LNR
Excellence in Research and Development

Monitoring operation

Mapping of crop types
Monitoring of growth stages
Weed mapping
Water requirement
Mapping crop stress (biotic/Abiotic)

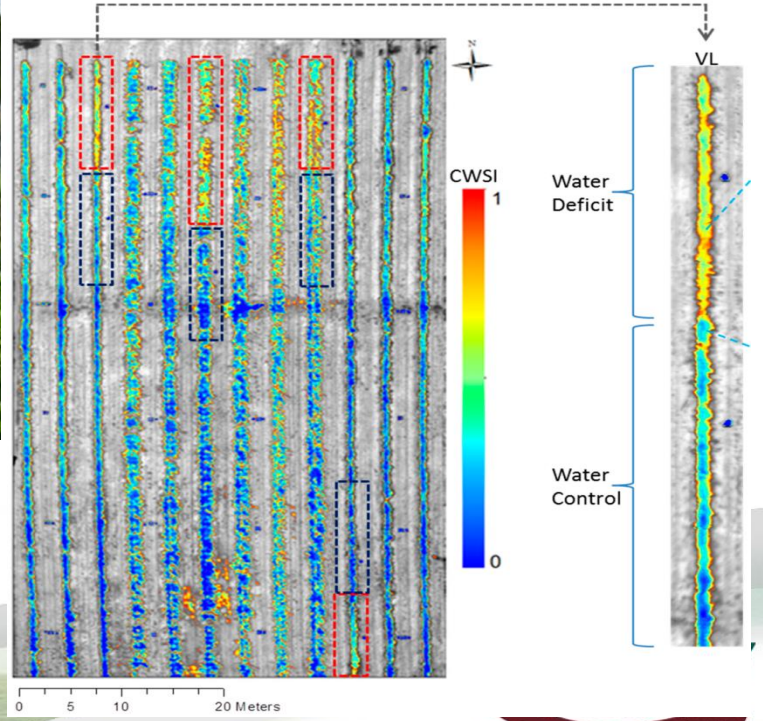


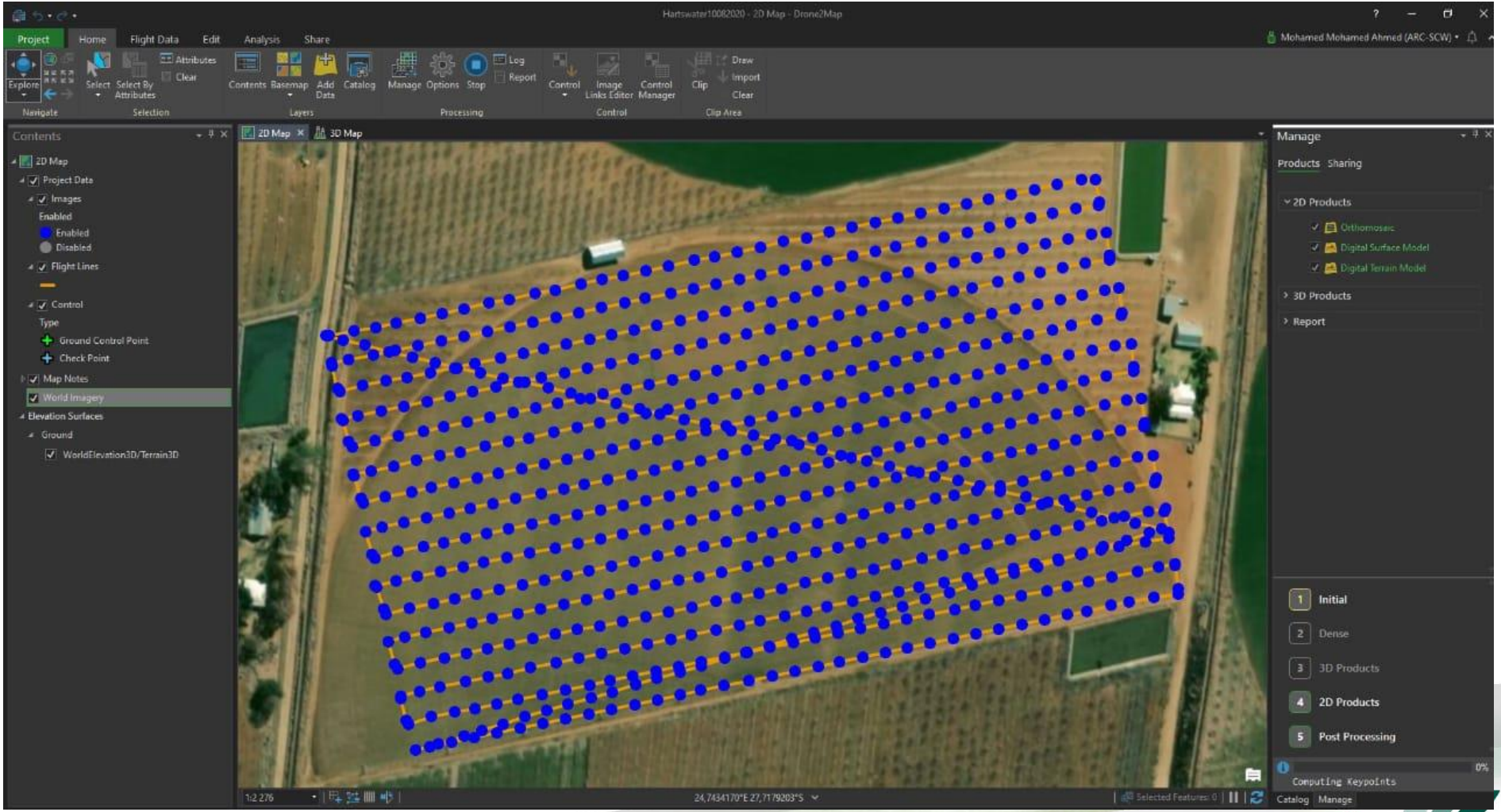
Yield and production estimation
Insurance index

ARC • LNR
Excellence in Research and Development

Increase of productivity

Crop water use
Irrigation efficiency
Fertilizer management
Rangeland Capacity





ARC • LNR
Excellence in Research and Development

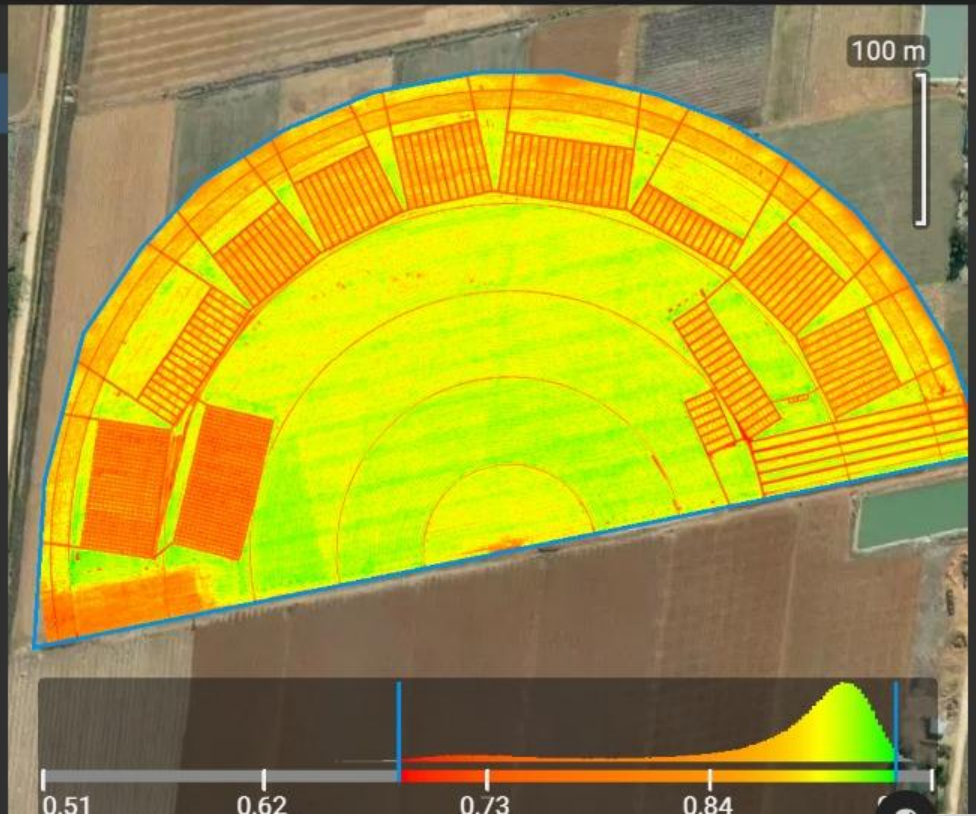
Hartswater

LAYERS

- BNDVI 2
- GNDVI 2
- LCI 2
- MCARI 2
- NDRE 2
- NDVI 2
- SIPI2 2
- TGI 2
- VARI 2
- DVI

Zonation

FIELD BOUNDARIES



INDEX

Index
BNDVI

Dimensions
6 952 x 4 299 pixels

GSD
9,44 cm/px

File Size
66,0 MB

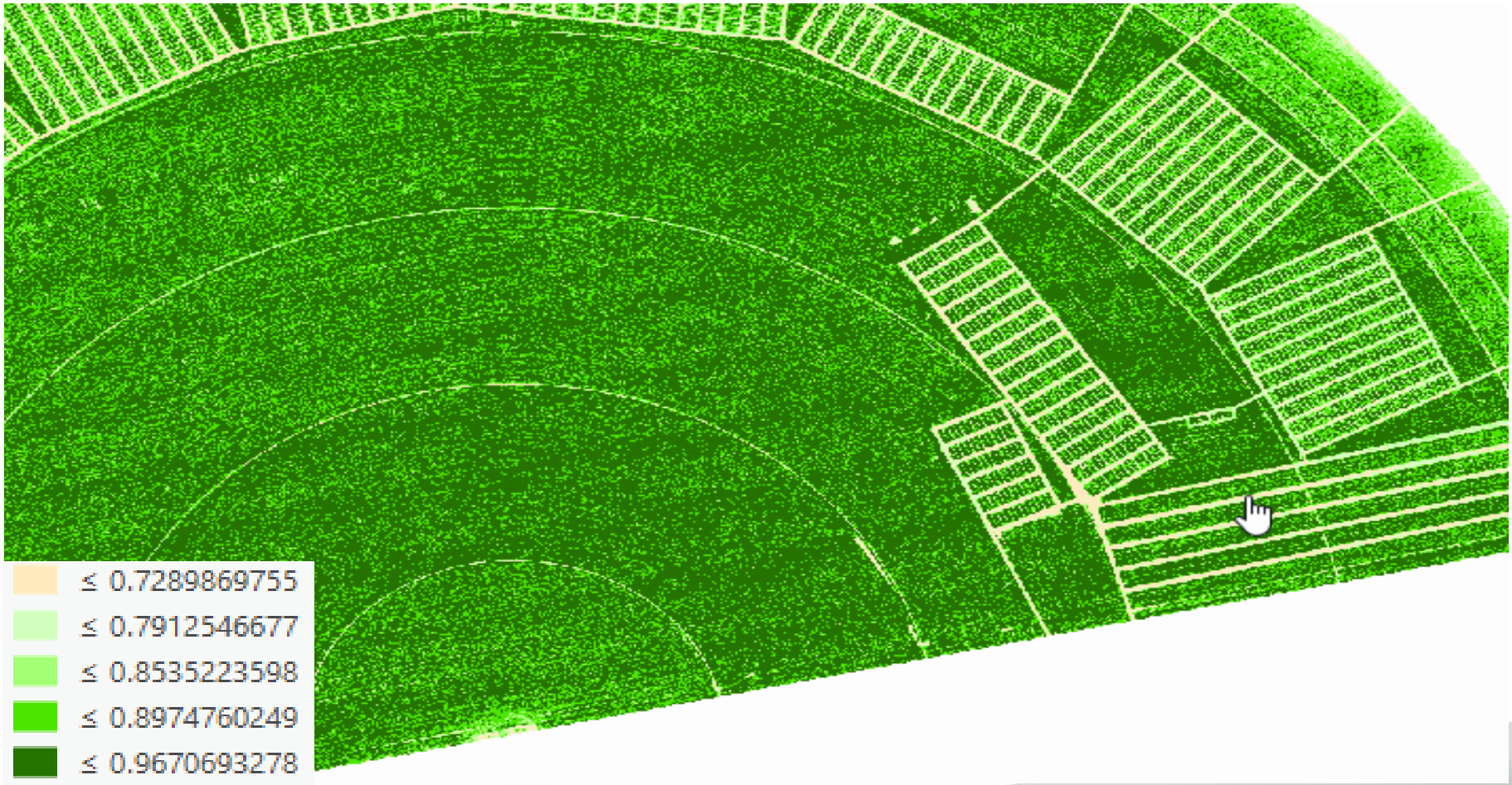
Data Type
Float32

Coordinate System
EPSG:32735

Bands
Gray

Acquisition

ARC • LNR
Excellence in Research and Development



ARC • LNR
Excellence in Research and Development

Remarks:

→ The rapid development in satellite/low-altitude data acquisition and cloud processing platforms make the use of these technologies much available for researchers and specialist and open many doors for high-level applications (e.g. WEF, WaPRO, LaPro,…)

→ Sharing of monitoring, modeling and simulation results with end users (farmers, specialists, & decision makers) in a way that can have impact on their cultivation practices for better use of resources and maximize the productivity of the land

ARC • LNR
Excellence in Research and Development

Mohamed A. M. Abd Elbasit
ARC-Soil, Climate and Water
Geoinformation Division
mohamedahmedm@arc.agric.za