EAPR Pathology & Pests

Reducing Pesticide Use while Preserving Potato Productivity and Profitability

HZPC
Growing with our potatoes

Neuchatel, September 3rd 2019

Doretta Boomsma








Which would you rather fight:
1 horse-sized duck or 100 duck-sized horses

EAPR Pathology & Pests

Reducing Pesticide use while Preserving
Potato Productivity and Profitability

+ Quality

Resistance Breeding

Neuchatel, September 3rd 2019

Doretta Boomsma
Programleader Plant Pathology & Cell Biology

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Potato Facts

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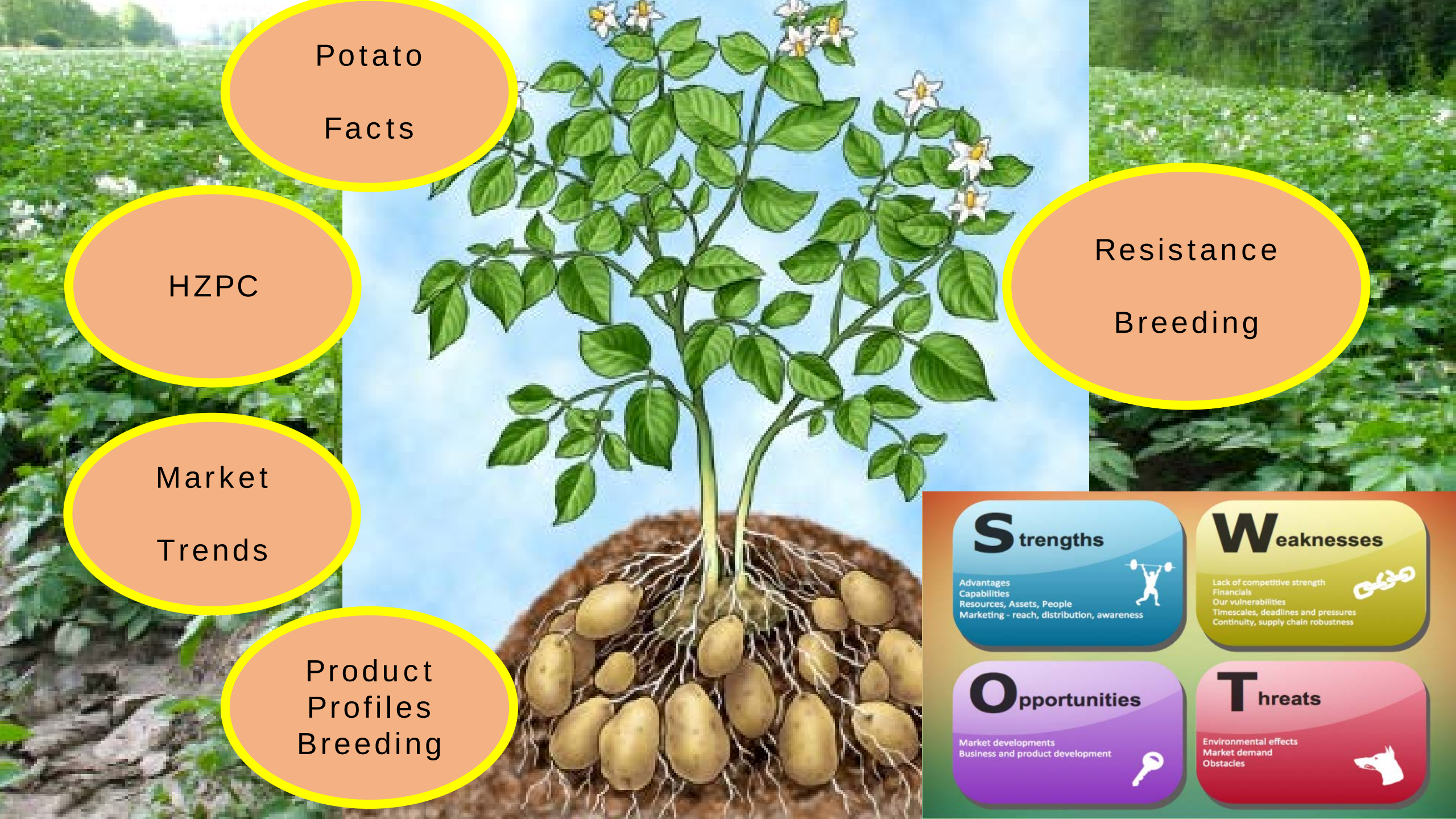
Market Trends

Product Profiles Breeding

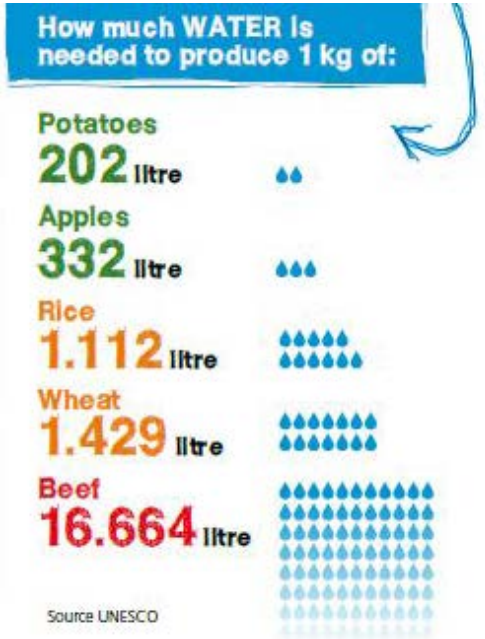
Resistance Breeding



Potato

Facts

Production per country (Top 10, in mln tonnes)



STAPLE CROP! also >2050!

- Annual production: ~ 388 mln tonnes
- Acreage: ~ 20 mln ha
- Strong variety dominance

Potato

Facts

disease control

Source: WUR, Francine Govers

HZPC

“HZPC is the innovative global market leader in potato breeding, seed potato trade and product concept development”

370	800	19	55	>80
employees	growers	locations	breeders	countries

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HZPC
Vision
''We drive the development of responsible food for the world population.''
Mission
"We inspire the potato value chain worldwide by delivering innovative products and services."
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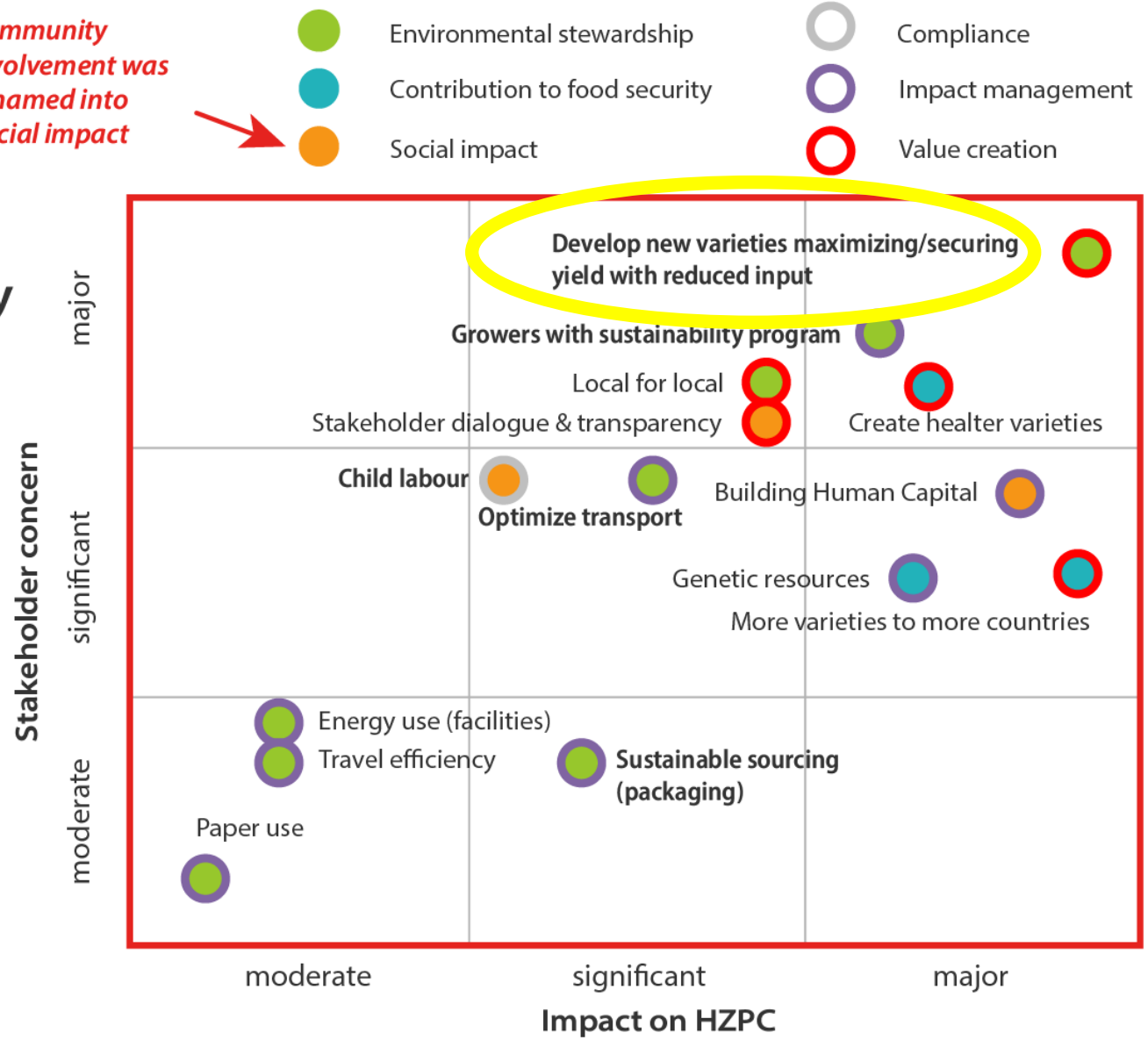
HZPC materiality matrix

Community involvement was renamed into Social impact



Market

Trends

(A)biotic tolerances
Climate extremes
Production at marginal soils
Handling in the value chain
Low input
Salinity
Easy storage.
...

Healthy seed potatoes,
certification systems (now)
True seed (as well)
Distribution channels
Knowledge via apps
Convenience
...

ROBUST
NUTRITIOUS
EASY ACCESS
LOW COST

No waste
Low foot print
Value to price
Honest product
...

Availability
Safety
Less meat
Nutrition rich and dense
Taste is the carrier
...

Product Profiles Breeding

Our Breeding Program serves all the Actors of the Value Chain

1

RESEARCH & DEVELOPMENT

SEED GROWER 2

3

PROCESSOR

QSR

PACKER

SUPERMARKET

GROWER

LOCAL MARKET

4

CONSUMER

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Product Profiles Breeding

- List of requirements translated into Product Profiles
- Each actor in value chain has different Product Profiles consisting of different traits
- A new variety has to be significantly better and/or has to contain new (combination of) traits
- About 50 ‘Must Haves’ traits per variety!

	CRITERIA			Crisp Main Crop										HZD 12-1634
Agronomic	MATURITY		70	50	55	60	65	70	75	80	85	90		65
	RELATIVE YIELD		100	80	85	90	95	100	105	110	115	120		99
	YIELD	t/ha	55	30	35	40	45	50	55	60	65	70		64
	SHAPE		3	1	2	3	4	5	6	7	8	9		2
	TUBERS 40+ / 10kg		95	55	65	75	85	95	105	115	125	135		
	TUBERS PER PLANT		15	10	11	12	13	14	15	16	17	18		13
	BRUISING		5	0		5		10		15		20		17
	DORMANCY PERIOD		75	20	30	40	50	60	70	80	90	99		91
Resistance	INTERNAL DEFECTS		> 85	50	55	60	65	70	75	80	85	90		87
	SPRAING		> 95	60	65	70	75	80	85	90	95	99		86
	VIRUS Yntn TUBER		> 90	20	30	40	50	60	70	80	90	99		99
	VIRUS RESISTANCE FOLIAGE		>90	20	30	40	50	60	70	80	90	99		92
	LATE BLIGHT FOLIAGE		> 80	20	30	40	50	60	70	80	90	99		46
	LATE BLIGHT TUBER		> 80	20	30	40	50	60	70	80	90	99		88
	COMMON SCAB		> 65	50	55	60	65	70	75	80				68

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Resistance Breeding

Use

Improve

Internal

External

Exploit

Mitigate

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Resistance Breeding

Genotyping (MAB)

Cooperation Academic-Companies

Diploid Breeding

Phenotyping

Stacking R- genes

Big Data Analysis

Resistant varieties

Explore and exploit wild species for R genes

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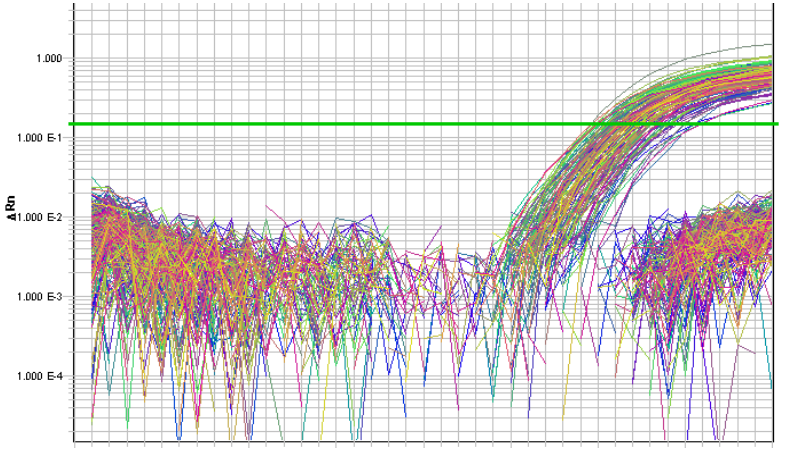
Phenotyping
(running)

Phenotyping
(in development)

Genotyping (MAB)

Benefits of molecular markers



1. Which crosses give the highest probability
   to result in progeny combining many traits from the product profile.
2. Allows us to select within 5 week after sowing for several traits.

Years after sowing of marker result

SPRAING		> 95	60	65	70	75	80	85	90	95	99	0
VIRUS Yntn TUBER		> 90	20	30	40	50	60	70	80	90	99	0
VIRUS RESISTANCE FOLIAGE		>90	20	30	40	50	60	70	80	90	99	0
LATE BLIGHT FOLIAGE		> 80	20	30	40	50	60	70	80	90	99	0
LATE BLIGHT TUBER		> 80	20	30	40	50	60	70	80	90	99	0
COMMON SCAB		> 65	50	55	60	65	70	75	80			4
POWDERY SCAB		> 65	50	55	60	65	70	75	80			6
Ro 1,4		> 8	1	2	3	4	5	6	7	8	9	0

At this moment mainly markers for dominant monogenic resistances:

PCN, PVY, LB, MCH, WD

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Diploid Breeding

Haploid Tuberosum /Andigena
(2n=2x=24)
***Female fertility/adaptation**
Ps/ps* (or) *ps/ps

×

Cultivated/wild species
(2n=2x=24)
***New genes/alleles**
ps/ps

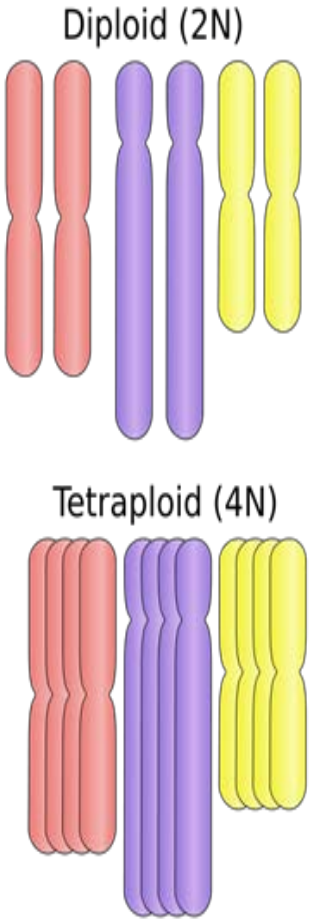
Agronomic superior cultivar
(2n=4x=48)
***Unrelated to haploid**

×

Haploid-species hybrid
(2n=2x=24)
ps/ps

2n-pollen

Diplandrous tetraploid hybrid
(2n=4x=48)
***Heterosis/allelic diversity**
***Desirable combination of traits**



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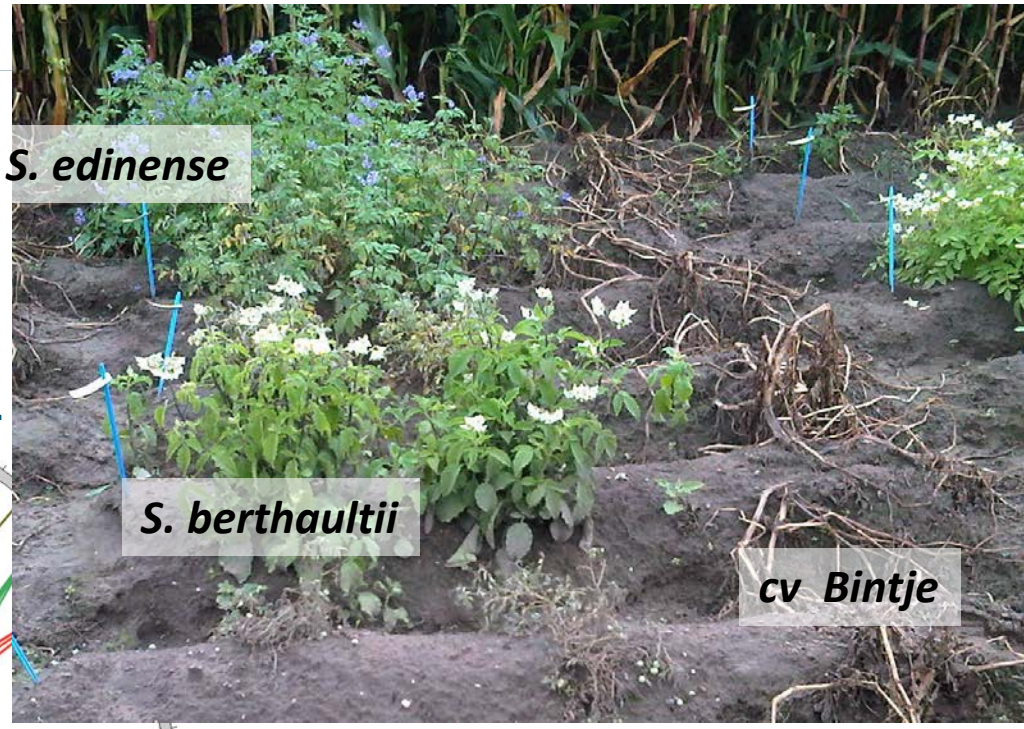
Cooperation Academic-Companies

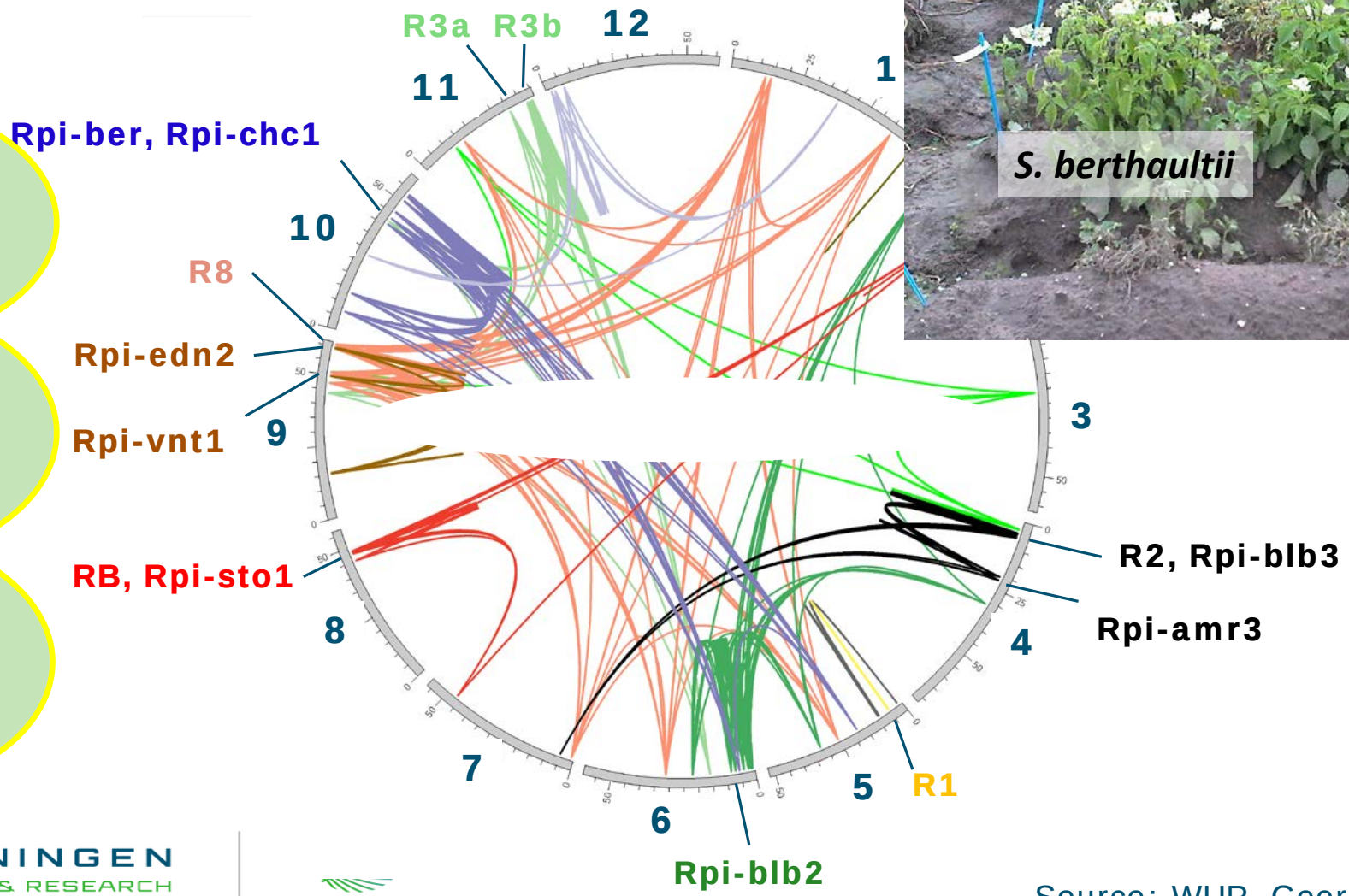
Explore and exploit R genes

Mapping Populations

Stacking R- genes

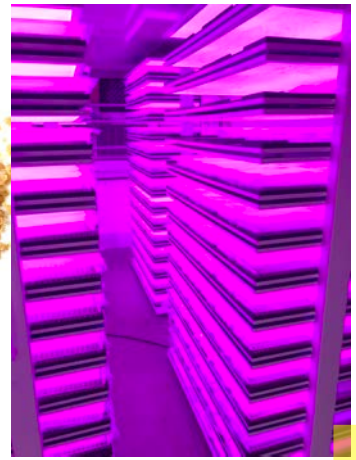
Late blight resistance

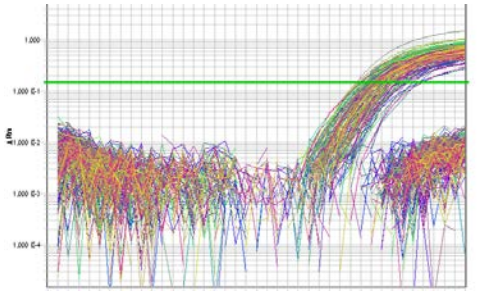




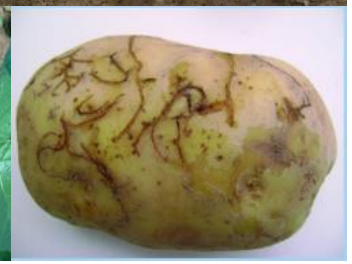
Source: WUR, Geert Kessel & Jack Vossen

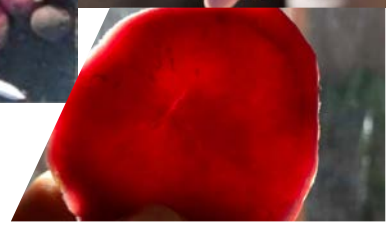
The Fields for potato breeding

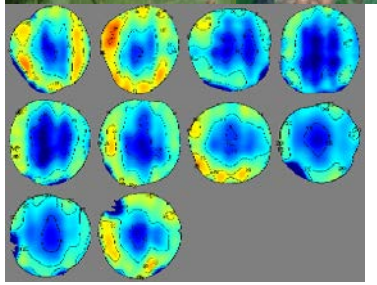




SEED TO VARIETY







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Resistant varieties

Late Blight
Based on one R gene
(R8, Blb2, venturi en berthaulti)

PVY (foliage)
e.g. Sagitta, Delia Red en Camelia

PCN (Gro-ABC & Gpa-DE)
e.g. Allison, Alcander, Primabella

WART (fysio 1, 2, 6, 18)
e.g. Althea, Cardyma

In about 5 years time:
New candidate varieties with <u>combination</u> of
PCN, PVY, Wart (1) and Late blight resistance

LB Res.Variety	Company
Alouette	Bio Select/Agrico
Levante	Bio Select/Agrico
Carolus	Bio Select/Agrico
Twinner	Bio Select/Agrico
Twister	Bio Select/Agrico
Acoustic	C. Meijer b.v.
Cammeo	Caithness Potatoes B.V.
Passion	Caithness Potatoes B.V.
Tentation	Caithness Potatoes B.V.
Sarpo Mira	Danespo
Connect	Den Hartigh
Otolia	Europlant
Alanis	Interseed Holland B.V.
Bionica	N. Vos
Sevilla	N. Vos
Cephora	Plantera B.V.
Vitabella	Plantera B.V.

Resistance Breeding

Combining all traits of interest

Time consuming (phenotyping, seed multiplication rate)

Phenotyping & Genotyping quantitative/ polygenic traits

Yield, Quality, Resistances

BOTTLENECKS

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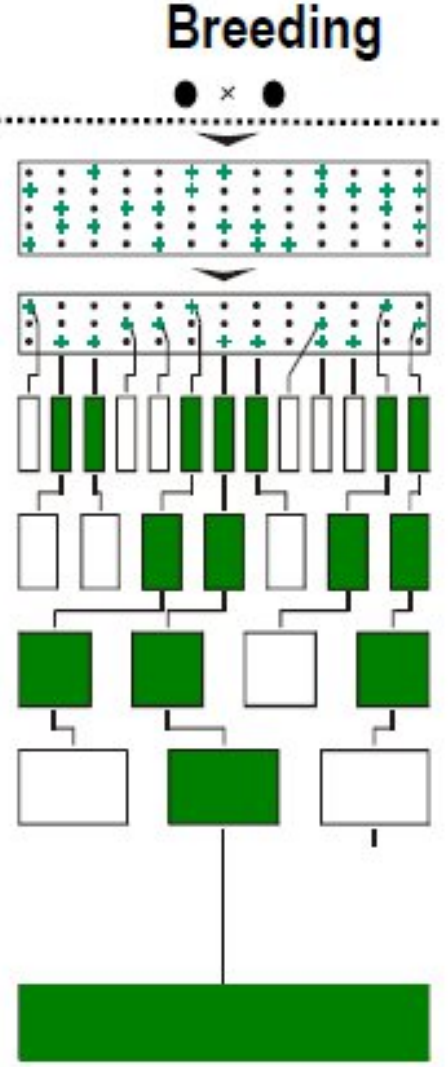
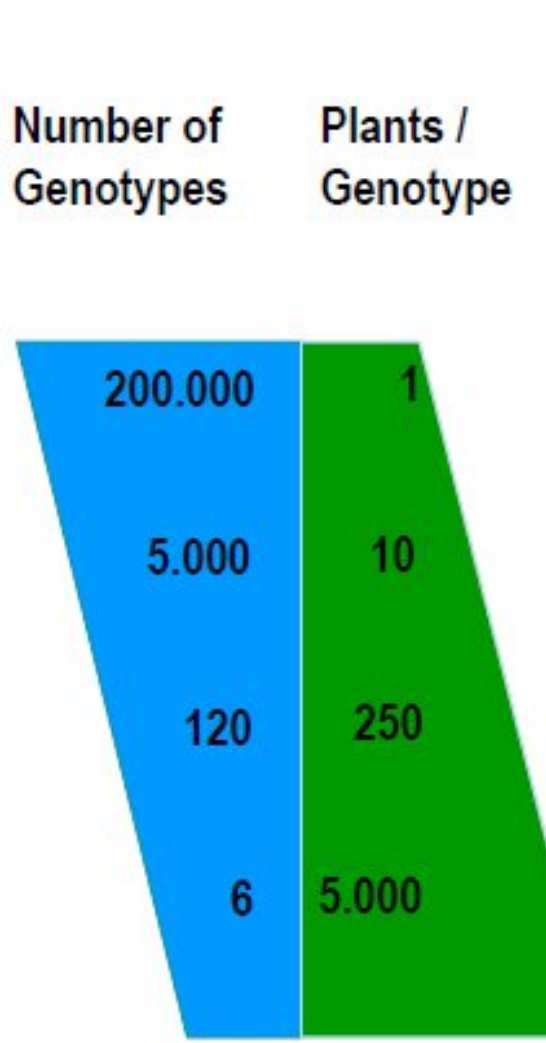
Time consuming

Year	Generation
1	Cross parents
2	Pot seedlings
3	Field seedlings
4	A clones
5	B clones
6	C clones
7	D clones
8-9	Official testing
10-12	Positioning
13	Commercial





Combining all traits of interest

- Potato is autotetraploid: 4 sets of 39000 genes randomly reassorted in each generation
- Highly heterozygous: awful lot of genetic variation
- Complex genetics
- Difficult to manage and predict
- Hardly any genetic gain
- Majority of high impact traits are polygenic & more difficult to phenotype

“Numbers Game”

Start selection (500 individuals)

- After 3 years of selection 2% is left
- Probability is very small that they all have these traits

VIRUS Yntn TUBER		> 90	20	30	40	50	60	70	80	90	99		5
VIRUS RESISTANCE FOLIAGE		>90	20	30	40	50	60	70	80	90	99		7
LATE BLIGHT FOLIAGE		> 80	20	30	40	50	60	70	80	90	99		5
LATE BLIGHT TUBER		> 80	20	30	40	50	60	70	80	90	99		4
COMMON SCAB		> 65	50	55	60	65	70	75	80				4
POWDERY SCAB		> 65	50	55	60	65	70	75	80				6
Ro 1,4		> 8	1	2	3	4	5	6	7	8	9		5

Conclusion: New variety will be a compromise

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Resistance Breeding

Hybrid potato - TPS

Unravel genetics plant-pathogen interaction

Market trends – sustainable agriculture

New Technologies (Cis-genesis, GMO, Gene-editing)

Genomic selection

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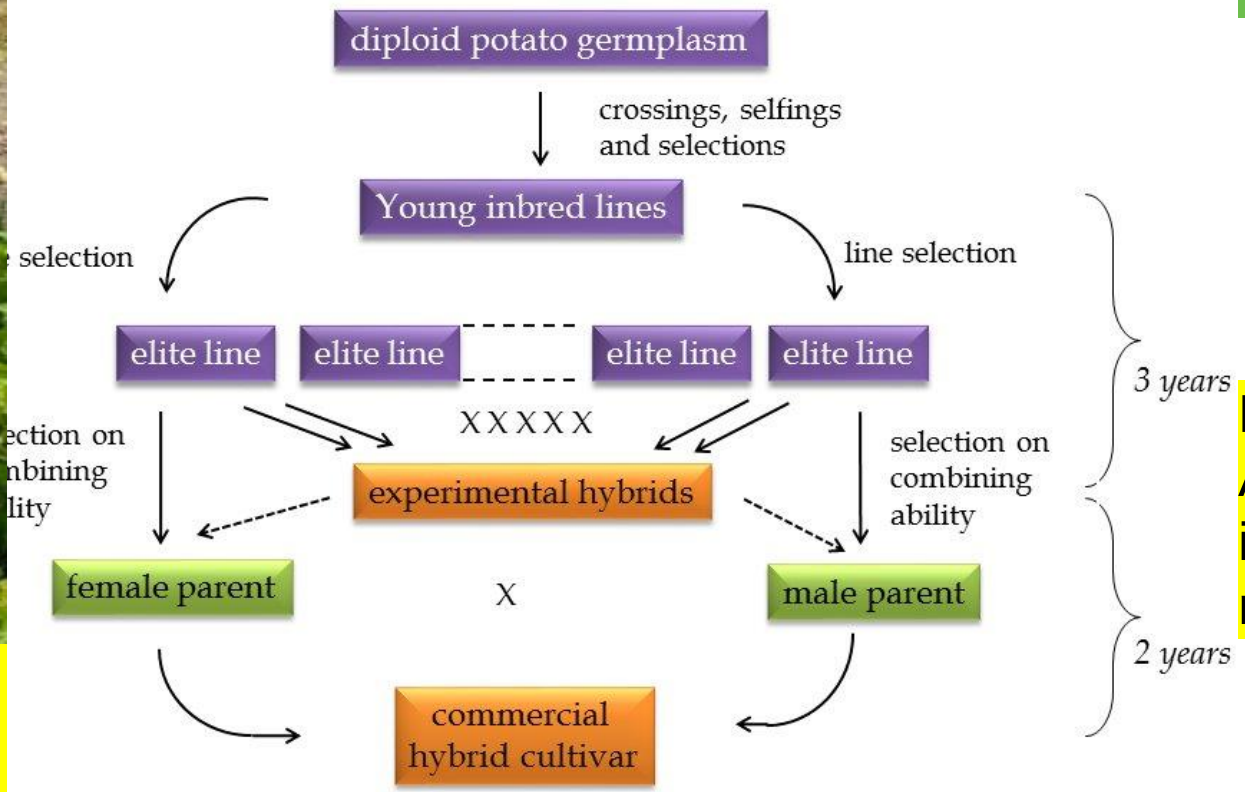
Clonal vs Hybrid Breeding

Control & time gain !
Fix traits of interest in homozygous lines
Stack & combine specific traits in hybrids

Clonal 2n= 4x

Potential: 120 tons/ha
Achievement: >100 tons/ha, 90% marketable

Diploid F_1 hybrid breeding



TPS 2n= 2x & 4x

Potential: unknown
Achievement: improving on marketable yield!

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New Technologies

Transgene

1-*R*-gene transgenic Desiree differential set in the field

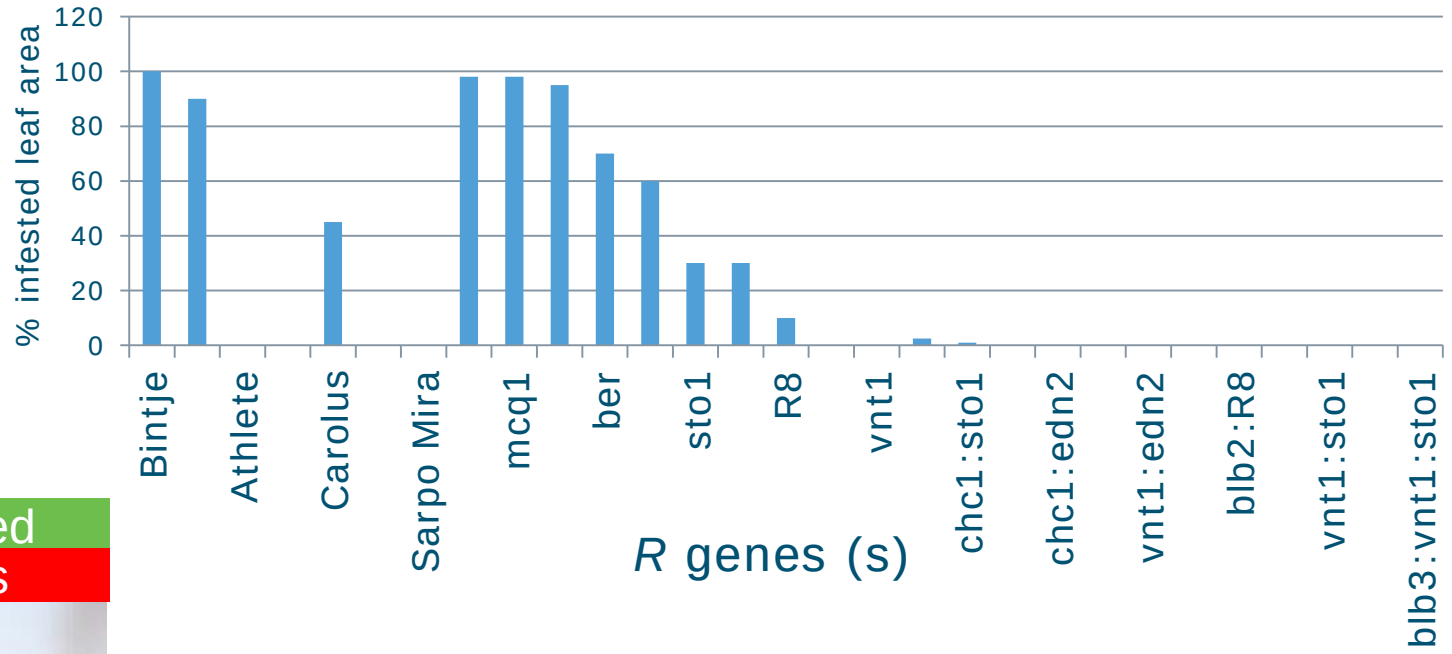
Rpi-vnt1

Rpi-sto1

Rpi-blb3

Desiree

Disease progress 48 d after start LB epidemic (2016)



Gene edited mutations

Block S genes

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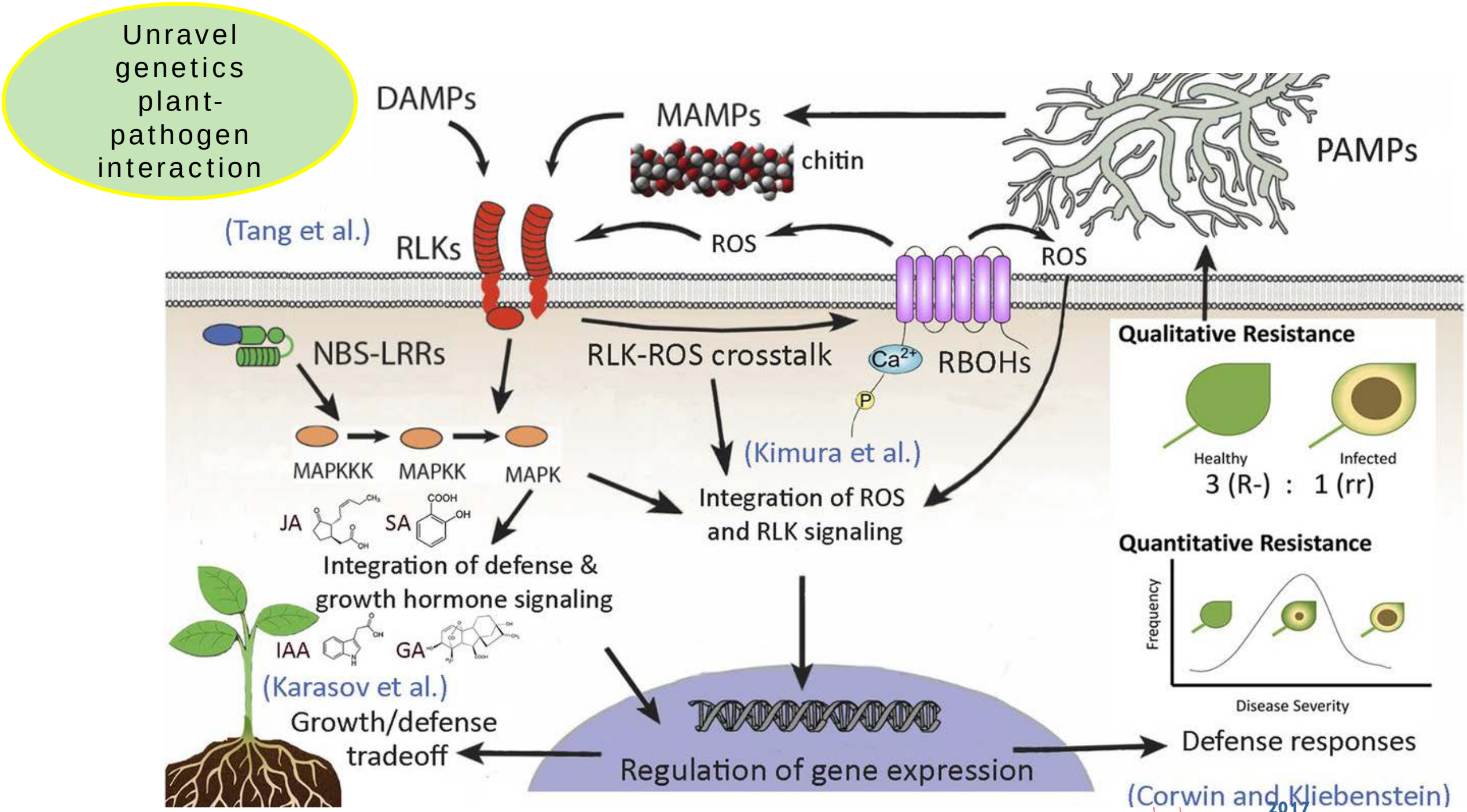
Source: WUR, Geert Kessel & Jack Vossen

Unravel genetics plant-pathogen interaction



2017

Resistance

Breeding

Regulation
Gene editing
& GMO

Resistance
breakdown
(e.g. Pi)

Climate
change

Adaptation
of
pathogens

Increased
global trade

Market
demands

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Market demands

- Market demands can change fast – traditional breeding is slow
- Market penetration of novel varieties is very slow
- Competition of free varieties
- Yield&Quality vs Resistances

Potato varieties in NL

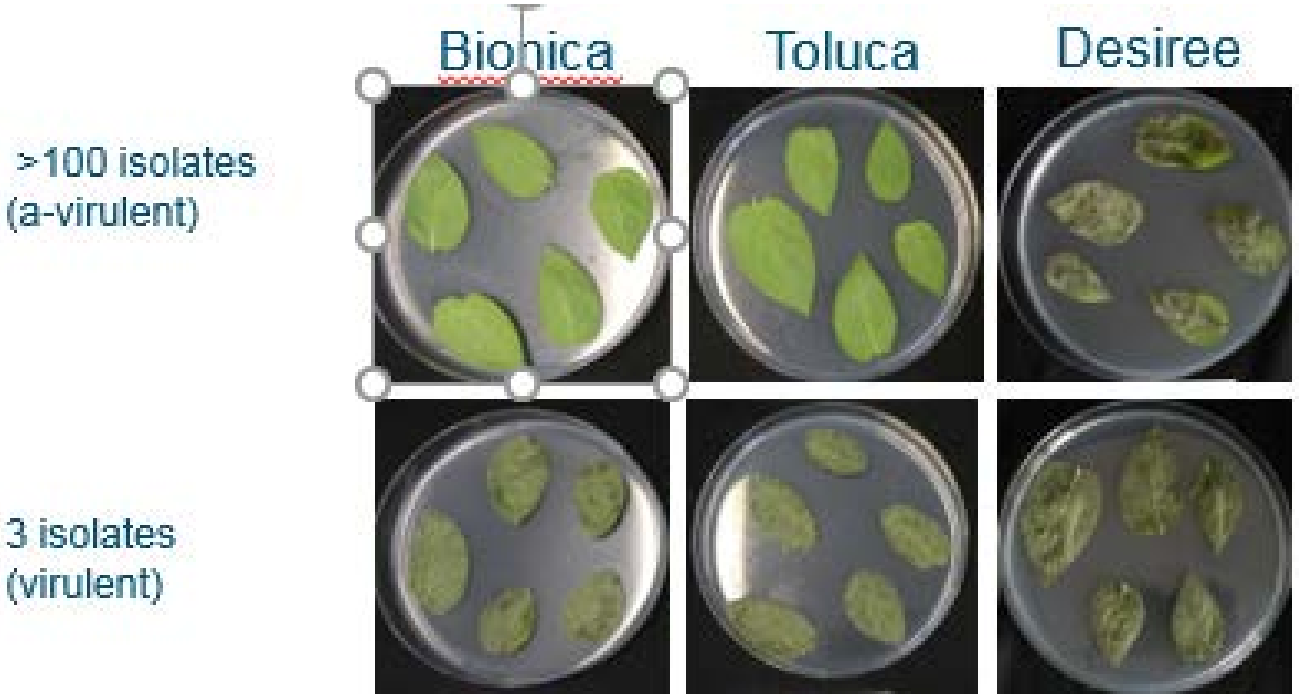
	Registration (year)#	Seed prod 2016 NL (% of total)##
Bintje	1910	2
Desiree	1962	2
Spunta	1968	15
Agria	1985	4
Innovator	1998	4
Fontane	1999	8
Sarpo Mira	<2003	0,009
Toluca	2006	0
Carolus	2012	0,09
Avito	2013	0,03
Alouette	2014	0,02

#Source: http://10.73.177.202/potatopedigree/
##Source: https://www.nak.nl/

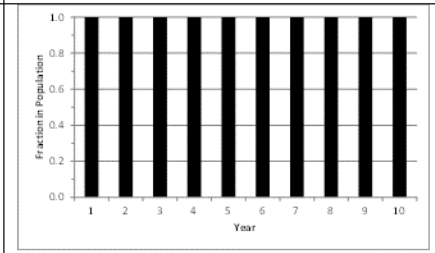
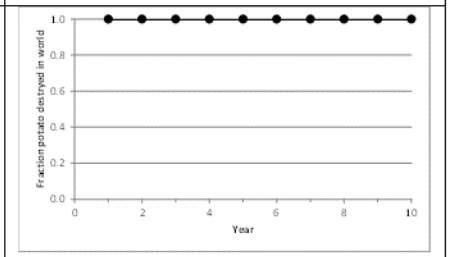
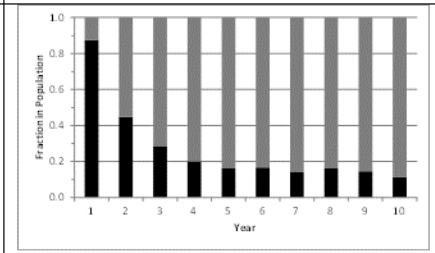
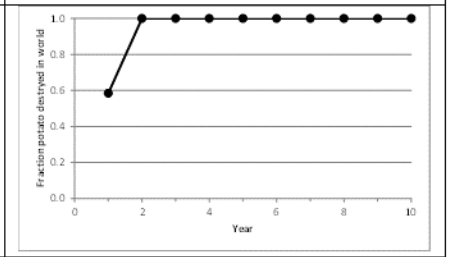
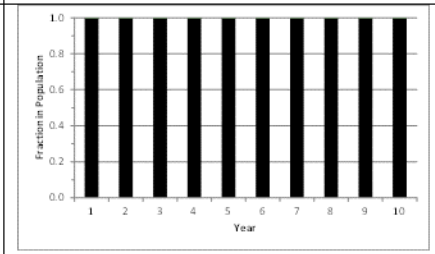
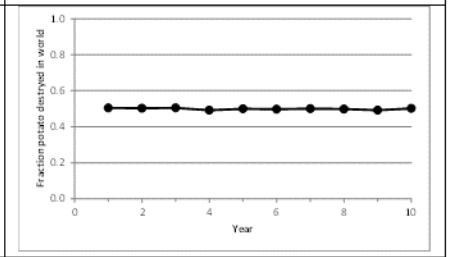
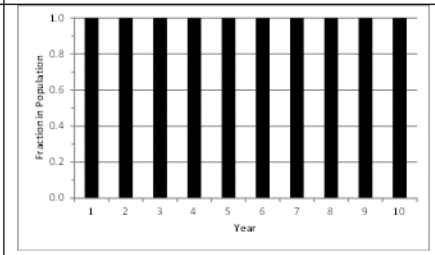
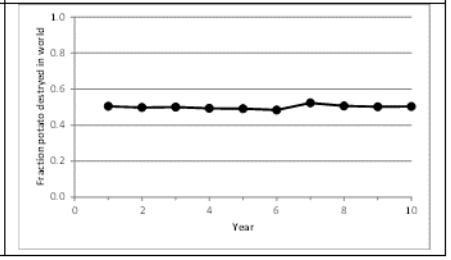
Adaptation of pathogens

Resistance breakdown (e.g. Pi)

Rpi-blb2 breaking in 2008



Stacking vs non-stacking

Host diversity	Pathogen population diversity	Potato destroyed in landscape
100% R0		
50% R0 + 50% R1		
50% R0 + 50% R12		
50% R0 + 50% R123		

Source: WUR, Geert Kessel & Jack Vossen

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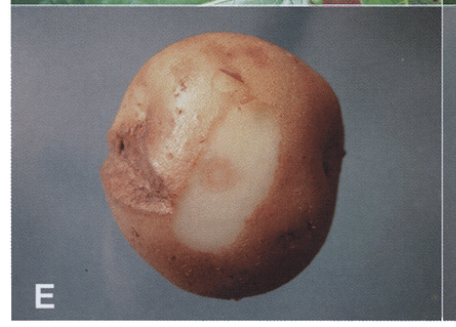
100years 1918 — 2018

New challenges

Climate Change

Increased global trade



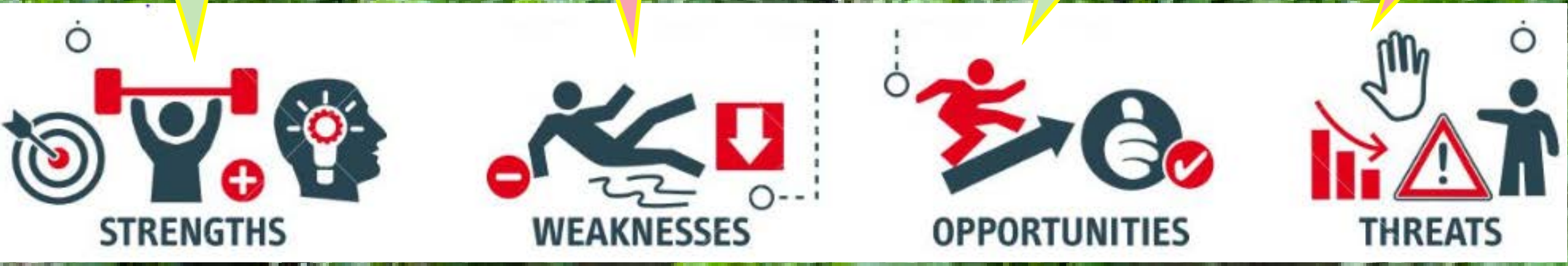
Conclusion

Use

Improve

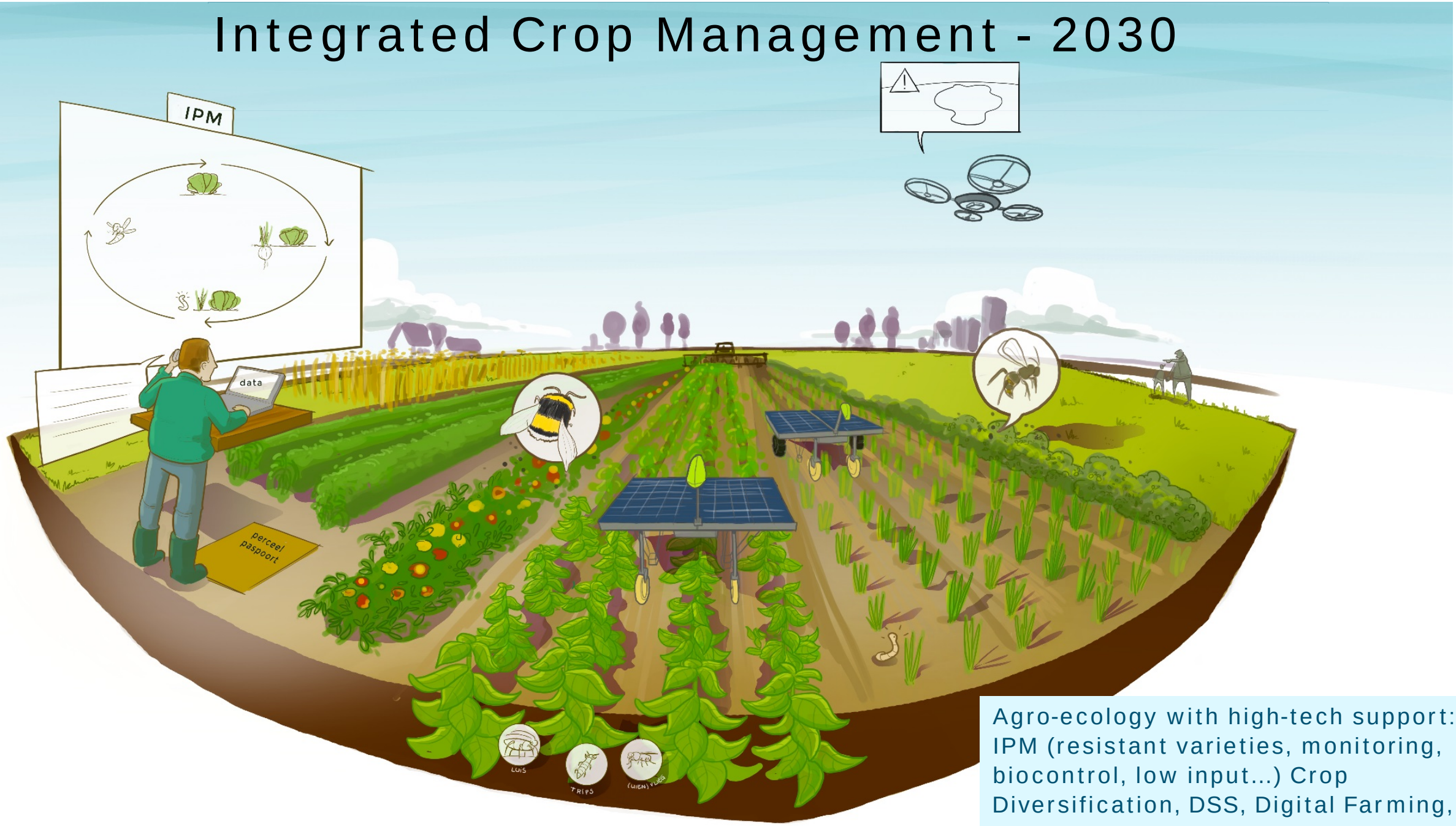
Exploit

Mitigate



RESISTANT VARIETIES

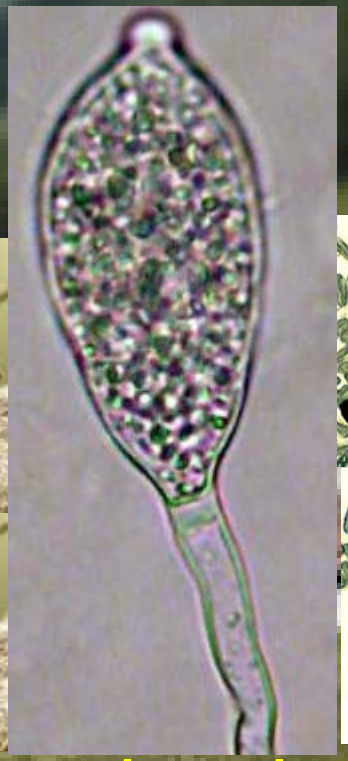
Integrated Crop Management - 2030

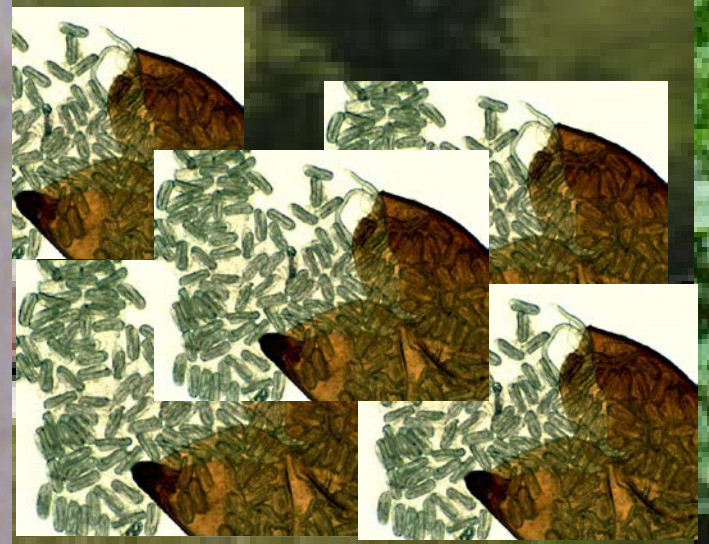


Agro-ecology with high-tech support: IPM (resistant varieties, monitoring, biocontrol, low input...) Crop Diversification, DSS, Digital Farming, Drones....

WUR Marleen.Riemens@wur.nl, +31 317 480499

Thank you for your attention





Together we can win the fight !!