Participatory design of farm level adaptation to climate risks in an arable region in the Netherlands

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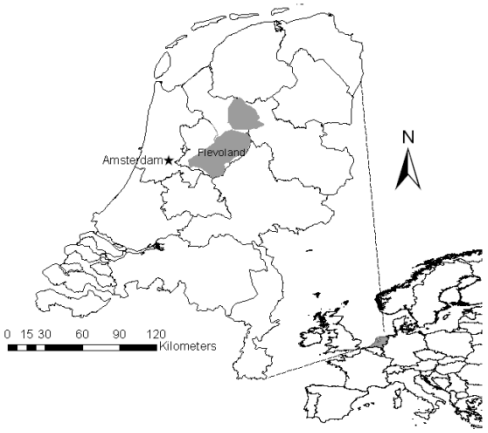
Introduction



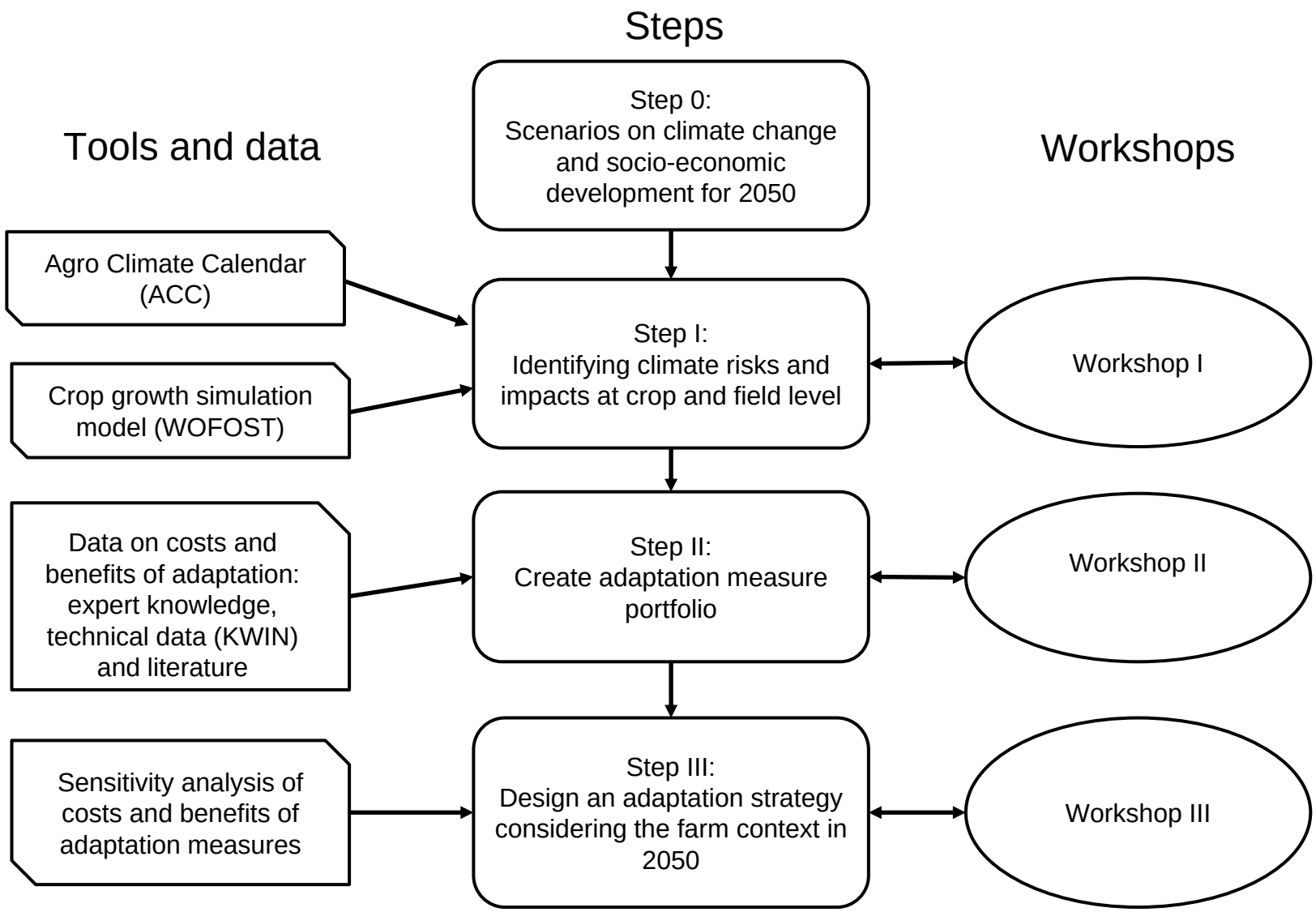
- Farmers organisation (LTO-Noord) and local policy makers: how to keep agriculture competitive given climate change challenges (and opportunities)?
- Typical rotation: seed/ware potato, sugar beet, winter wheat, onions and carrots
- Other crops: grass, rape seed, lily, tomato, cherry
- New crops: sunflower, artichoke, grape, reed

Potato farming systems: high value, impacted by extreme events and pests and diseases → quality issues

Introduction

- Current literature on climate change impacts in agriculture:
    - T and CO_2, crop models, mostly grains
    - proposed adaptation: crop choice, shift sow-planting dates, irrigation
    - extreme events and pests and diseases lacking
- Adaptation strategies for arable farming:
    - multiple impacts including extreme events and pests and diseases
    - yield and quality of high value crops

Overview


Steps
Tools and data
Workshops
Step 0:
Scenarios on climate change and socio-economic development for 2050
Agro Climate Calendar (ACC)
Crop growth simulation model (WOFOST)
Step I:
Identifying climate risks and impacts at crop and field level
Workshop I
Data on costs and benefits of adaptation: expert knowledge, technical data (KWIN) and literature
Step II:
Create adaptation measure portfolio
Workshop II
Sensitivity analysis of costs and benefits of adaptation measures
Step III:
Design an adaptation strategy considering the farm context in 2050
Workshop III

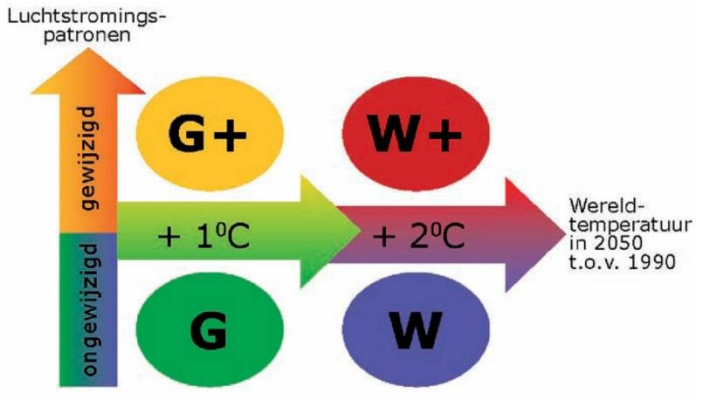
Workshop I: identifying climate risks

Crop expert consultation

Regional sessions with farmers:

- past damage from extremes and pests and diseases
- vulnerable periods
- adaptation measures

Crop Modelling



Crop	Historic (Mg/ha)	G+/B2 %	W+/A1 %
Seed potato	50.1	6.0	2.8
Ware potato	71.0	4.2	2.1
Seed onion	68.2	13.9	14.1
Sugar beet	84.6	19.4	28.6
Winter wheat	12.3	6.5	3.3

Crop yield changes (in %) for potential conditions as simulated with the WOFOST model for current climate conditions (reference period for historic weather is 1992–2008) in Lelystad, Flevoland and for future climate conditions around year 2050 in G+/B2 and W+/A1 scenarios

Agro Climate Calendar (ACC)

Climate factor	Vulnerable period	Meteorological description	Farm management	Impact on crop	Weight of economic loss (%)
Wet field	Oct - Apr	Period of 21 days of more than 0.5mm rainfall on 75% of the days	Ploughing/ planting bed prep.	Delayed planting date	-
High int. rainfall	May – Sep	Daily precipitation of at least 45 mm or at least 60 mm in three days	-	Rotting of the tubers	25-75
Heat wave	**Jul – Sep**	**Heat wave (at least 3 days with more than 30°C in a period of at least five days above 25°C)**	**-**	**Second-growth**	**25-75**
Warm and wet	Jul - Sep	At least 14 consecutive days with a maximum temperature above 20°C and for 50% of the days at least 0.5 mm precipitation	-	Erwinia causes soft rot and black leg	10-50
Sustained wet	**Jun – Sep**	**A period of at least 21 days with more than 0.5 mm precipitation on 75 % of the days**	**Spraying**	**Not possible to spray against Phytophthora**	**50-100**
Wet field	Aug - Oct	Period of 21 days of more than 0.5mm rainfall on 75% of the days	Harvest	Damage to tubers	N.A.
Warm winter	Dec – Mar	Period of at least 14 days with a maximum temperature above 10°C	Storage	Rotting of tubers and early sprouting in March	25-75

Agro Climate Calendar (ACC)

- Frequency of climate factors over 30 years around 1990

Climate factor	1990 (1976-2005)	J	F	M	A	M	J	J	A	S	O	N	D
Wet field *Delayed planting*		13	5	5	0						5	8	9
High int. rainfall *Rotting of tubers*						0	0	0	2	1			
Heat wave *Second-growth*								**2**	**6**	**0**			
Warm and wet *Erwinia*								0	1	0			
Sustained wet *Phytophthora*						**5**	**8**	**7**	**5**				
Wet field *Damage to tubers*									5	4	5		
Warm winter *Rot and early sprouting*		0	0	3									0

Agro Climate Calendar (ACC)

- Frequency change 2050 compared to historic climate (over 30 year period)

Climate factor	Scenario	J	F	M	A	M	J	J	A	S	O	N	D
Wet field	G+	+1	0	0	0						0	+1	+2
Delayed planting	W+	+4	+1	0	0						-1	0	+3
High int. rainfall	G+					0	0	0	0	+1			
Rotting of tubers	W+					0	0	0	-1	+1			
Heat wave	G+							+2	+7	+1			
Second-growth	W+							+12	+12	+3			
Warm and wet	G+							+4	+5	+1			
Erwinia	W+							+6	+6	+2			
Sustained wet	G+					-2	-2	-2	-4				
Phytophthora	W+					-2	-4	-5	-3				
Wet field	G+								-3	0	0		
Damage to tubers	W+								-3	-1	-1		
Warm winter	G+	0	+1	+3									+1
Rot and early sprouting	W+	+2	+3	+8									+1

Workshop II: create an adaptation portfolio

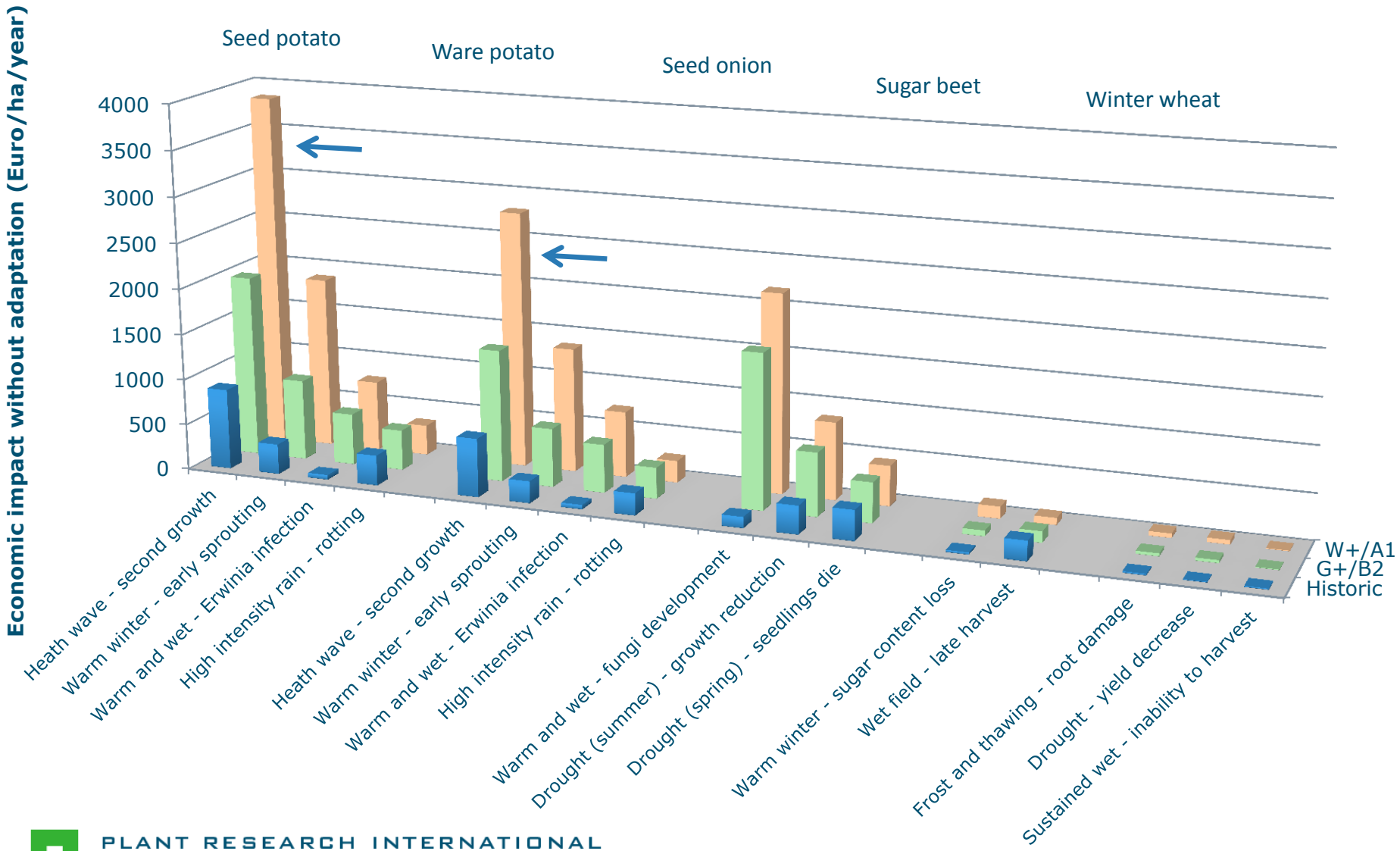
Sharing thoughts on adaptation such as effectiveness, costs and other factors.

Outcome: improved list of adaption measures

List of adaptation measures

Seed and Ware potato	Impact (-)	Level	Effective-ness (-)	Annual costs (k€/ha)	Investment costs (k€/ha)
Heat wave – second-growth (July-Sept.)	0.25-0.75				
Plant in wider ridges		Crop/Farm	0.75	-	>50 [a]
Plant and harvest earlier		Crop/Farm	0.25	-	-
Cooling by drip irrigation		Crop/Farm	0.9	1	-
Optimise crop cover (planting distance and fert.)		Crop	0.5	0 – 0.5	-
Warm and wet – Erwinia spp. infection (July-Sept.)	0.10-0.50				
Optimise nutrient management		Crop/Farm	0.5	0 - 0.5	-
Warm winter – early sprouting (Dec.-March)	0.25-0.75				
Air conditioning		Crop/Farm	0.9	0.1 - 0.2	
Sprouting control		Crop/Farm	0.5	0.1 - 0.2	-
High intensity rainfall – rotting of tubers (May-Oct.)	0.25-0.75				
Increase permeability of sub soil		Farm	0.1	0.2 - 1	-
Increase ability for surface drainage		Crop/Farm	0.75	0.1 - 0.2	-
Intensify drainage		Farm	0.9	0.1 - 0.2	0.5 - 2.5

Economic impact extremes on major crops



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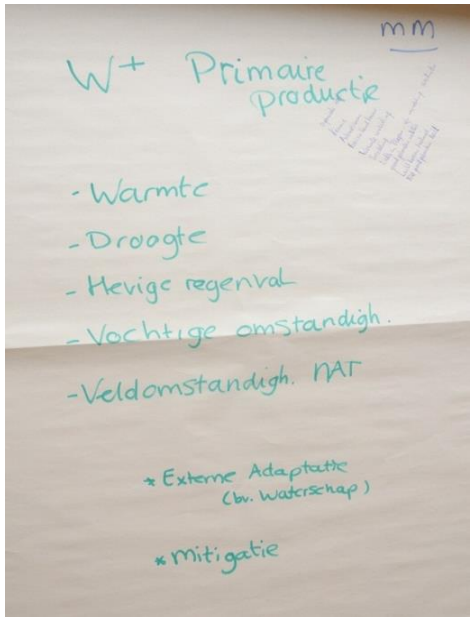
Cost-benefit analysis for adaptation measures

Heat wave impact on potato: second growth

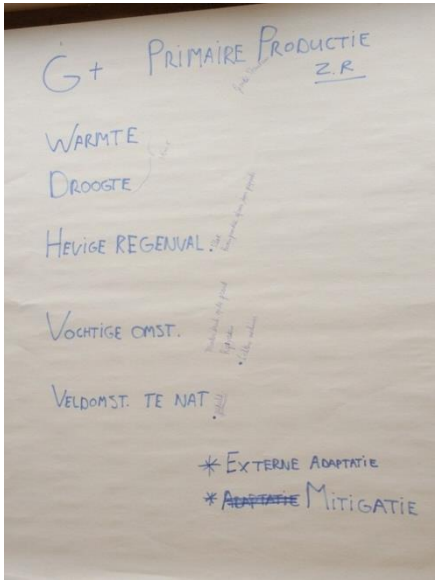
Workshop III: design of adaptation strategies with farmers, sector, policy and research

Farmers, sector and policy makers design adaptation strategies in context of climate changes socio-economic assumptions



W+/A1

G+/B2



Design of adaptation strategies with farmers, sector, policy and research

- For Flevoland, potential yields of main crops were projected to increase, but five main climate risks were identified, and these offset the positive impacts.
- Main climate risk is *heat wave* that causes second-growth in seed and ware potato:
  - W+/A1 scenario and high impact: drip irrigation was identified as the best adaptation measure
  - G+/B2 scenario and low impact: other options including no adaptation are more cost-effective

Highlights

- All crops and all climate risks can be addressed, and all adaptation measures can be explored.
- Adaptation strategies can be designed with relatively simple techniques and a participatory process.
- Identified adaptation strategies are directly recognizable and relevant for stakeholders.

Schaap, B., M. Blom-Zandstra, et al. (2011). "Impact changes of climatic extremes on arable farming in the north of the Netherlands." Regional Environmental Change **11**(3): 731-741.

Ben Schaap, Pytrik Reidsma, Jan Verhagen, Joost Wolf and Martin van Ittersum (2013). “Participatory design of farm level adaptation to climate risks in an arable region in the Netherlands”. European Journal of Agronomy 48: 30-42

Thank you

Discussion..

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