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Proyecto Regional

La modelación como herramienta para la evaluación y predicción de los requerimientos de agua para producción de papa y sistemas de riego

Johan Ninanya

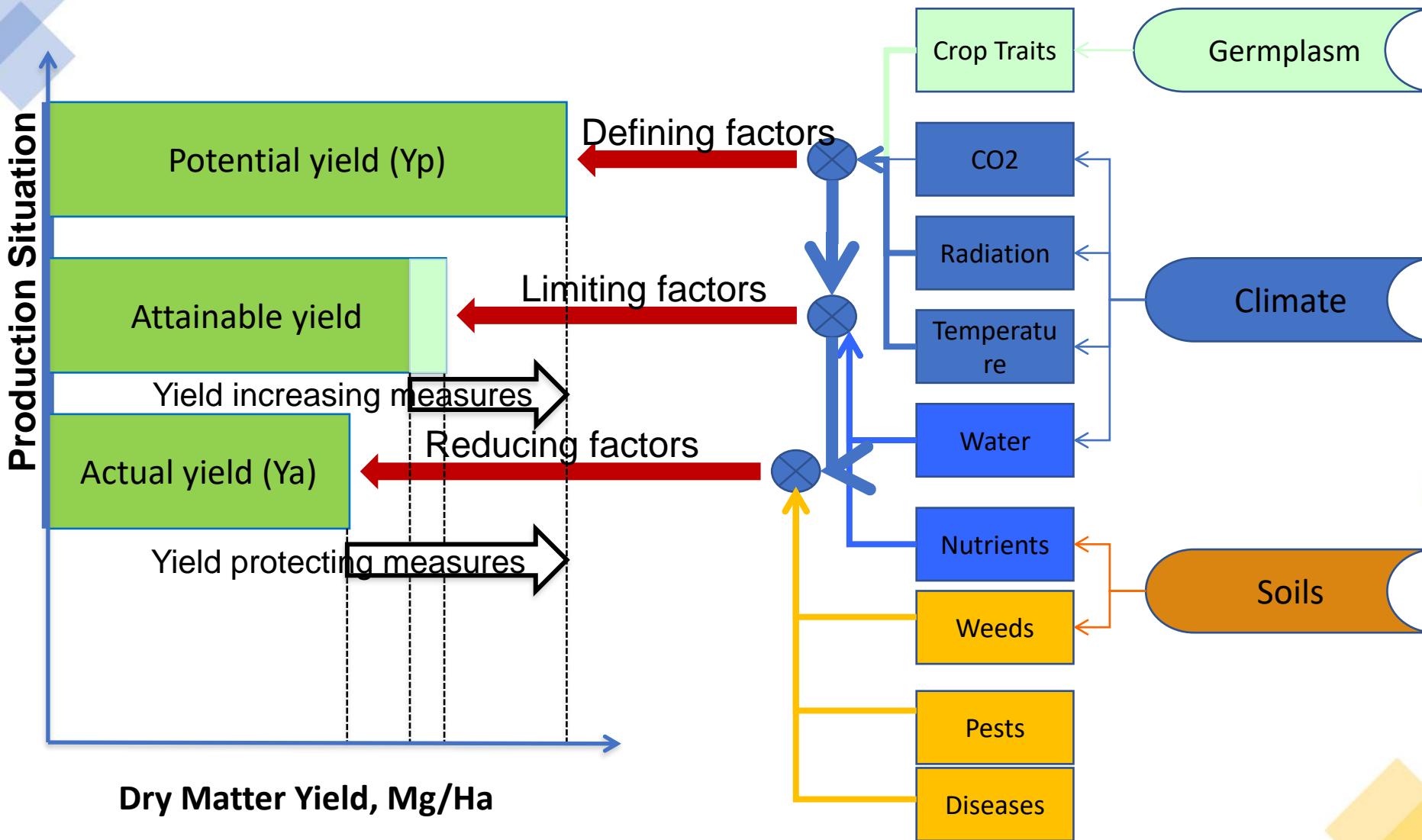
Centro Internacional de la Papa (CIP)

Serie de Seminarios virtuales "BPA-CI en sistemas agroalimentarios andinos basados en papa"

2021



Factores que determinan el rendimiento

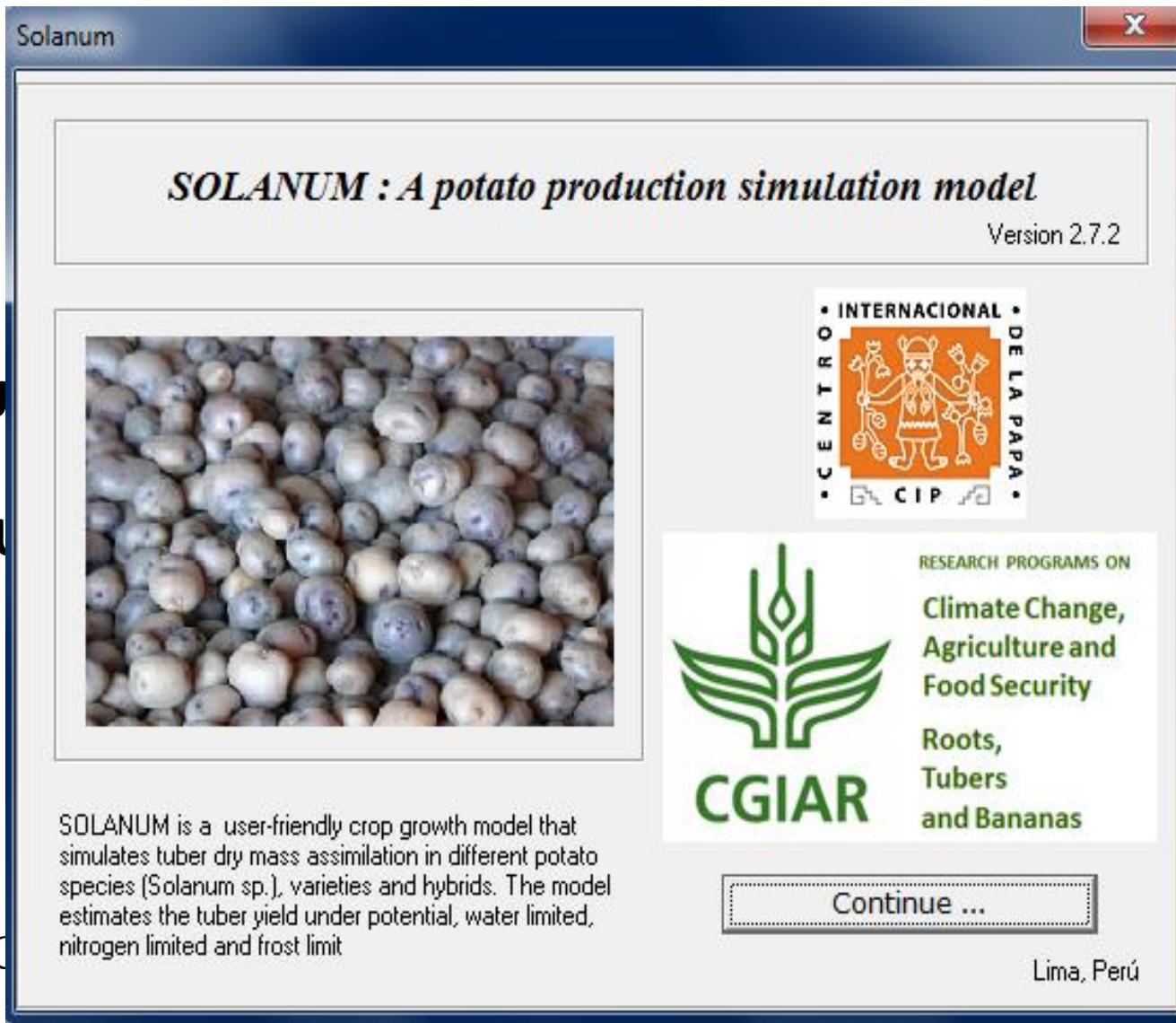


Modelo de crecimiento de cultivo (MCC)

Tipos

- RU
- WU

32 MCC



nósfera



<https://data.cipotato.org/dataset.xhtml?persistentId=doi:10.21223/P3/E71OS6>



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Research Software (CIP)

International Potato Center > Research Software > Solanum: A potato production simulation model

Metrics

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Solanum: A potato production simulation model Version 2.2

Condori, Bruno; Quiroz, Roberto; Barreda, Carolina; Gavilan, Carla; Guerrero, Jose; Osorio, Javier, 2017, "Solanum: A potato production simulation model", <https://doi.org/10.21223/P3/E71OS6>, International Potato Center, V2

Cite Dataset ▾

Learn about Data Citation Standards.

Description

SOLANUM is a user-friendly crop growth model that simulates tuber dry mass assimilation in different potato species (*Solanum* sp.), varieties and hybrids. The model estimates the tuber yield under potential, water limited and frost limited conditions.

Subject

Agricultural Sciences; Computer and Information Science

Keyword

Crop model, Yield prediction, Potato

Related Publication

Files

Metadata

Terms

Versions

1 File



solanum.rar

Unknown - 7.2 MB - Apr 4, 2017 - 93 Downloads
MD5: 9568c4d93c53b82835b2440acce080de

EXE

Download

<http://dx.doi.org/10.21223/P3/E71OS6>

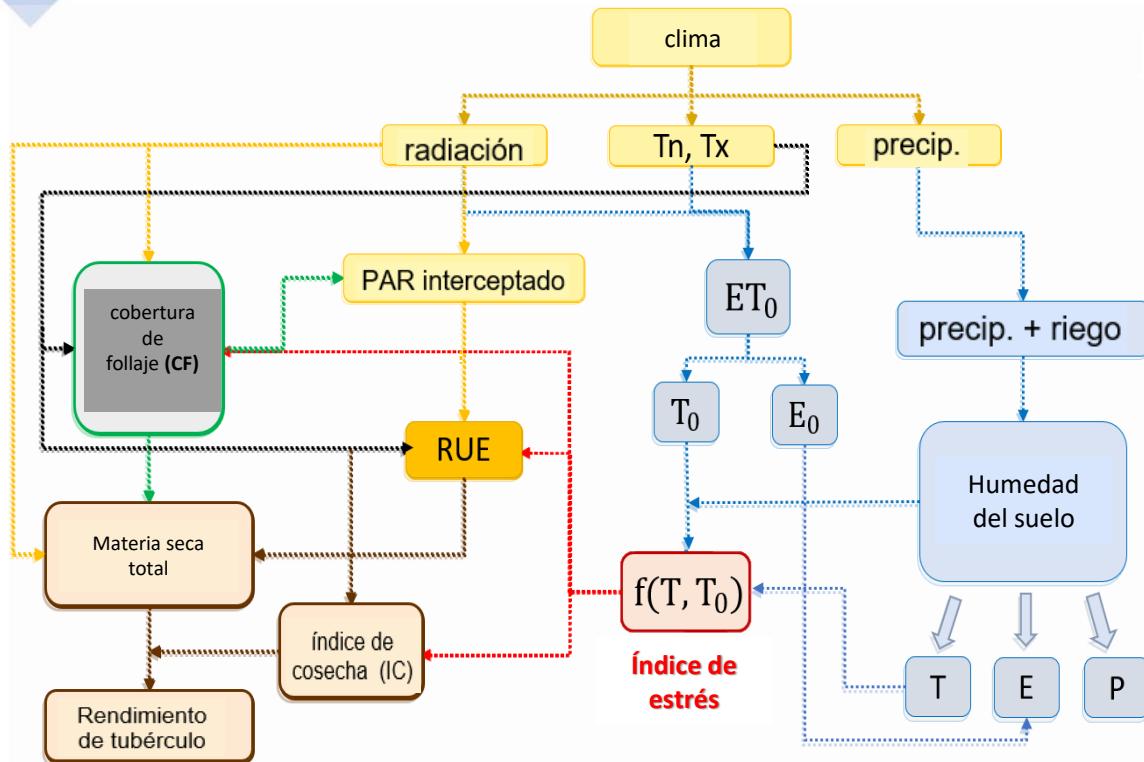
Tutorial Software Solanum



<https://www.youtube.com/watch?v=Jl9N8uKytDU&t=2s>

El modelo SOLANUM

Estimación del rendimiento bajo condiciones óptimas y de restricción hídrica



Biomasa total (TDM) y rendimiento (DTY)

$$TDM = PAR_i \times CF \times RUE \quad (1)$$

$$DTY = TDM \times IC \quad (2)$$

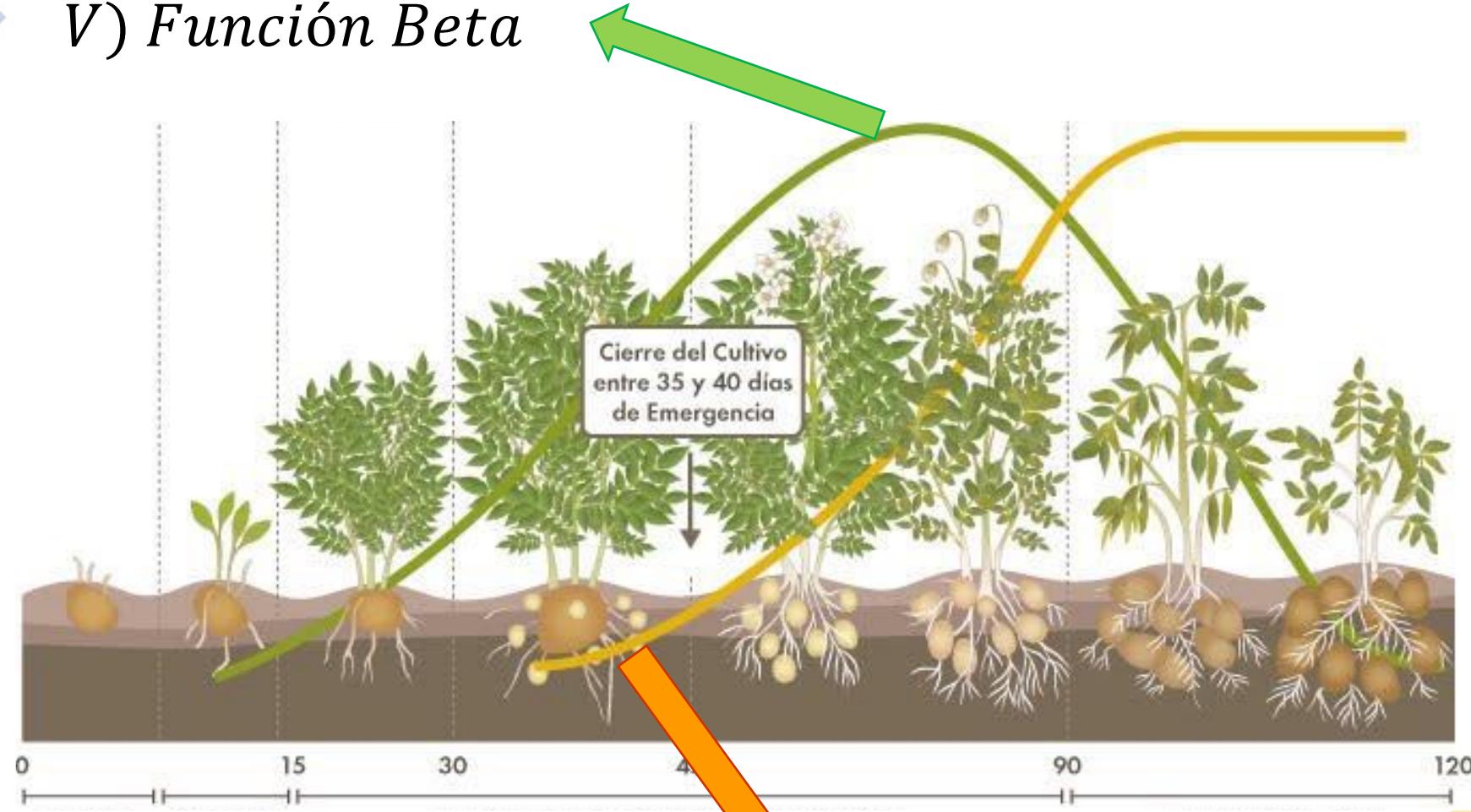
PAR_i: PAR Interceptada

IC: Índice de cosecha

Condori *et al.* (2010, 2017), Quiroz *et al.* (2017)

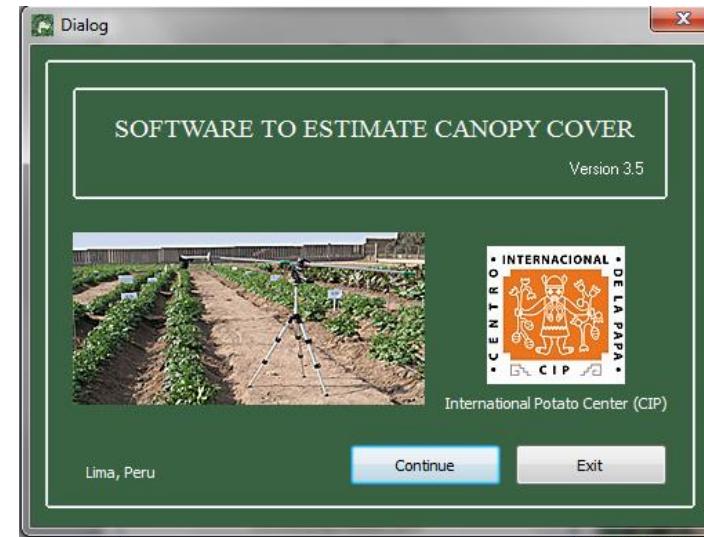
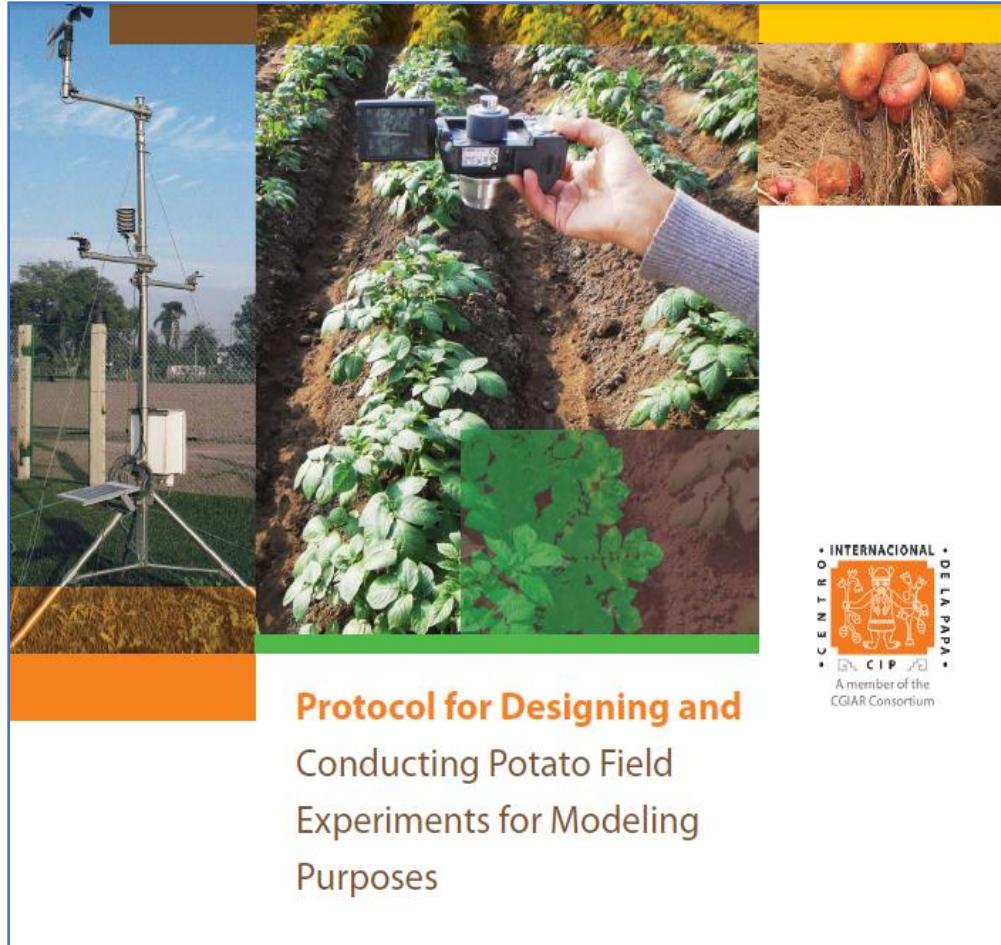
Crecimiento vegetativo (V) y reproductivo (R)

V) Función Beta



R) Función Gompertz

Protocolo para modelación y software para estimar cobertura de follaje



<https://doi.org/10.21223/P3/50TASS>

Evaluaciones: Protocolo para modelación (CIP 2013)

BIOMASA

Muestreo secuencial durante la temporada de crecimiento



Yield ($t ha^{-1}$)

FTY: Fresh tuber yield

DTY: Dry tuber yield

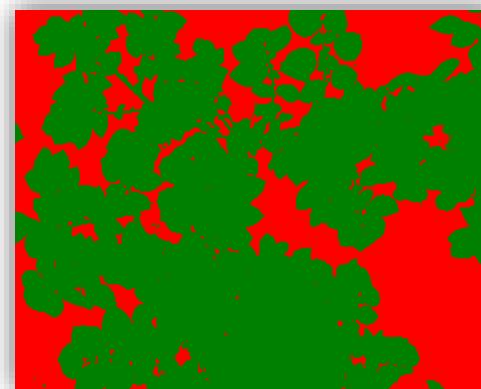
TDM: Total dry matter

Cobertura de Follaje (CF, %)

Con una cámara digital a 80cm del dosel.



Image Canopy
Software[†]



[†]<http://dx.doi.org/10.21223/P3/50TASS>

Datos de entrada del modelo

Datos meteorológicos

Radiación y temperatura

Quiroz *et al.* (2017)
Condori *et al.* (2017)

Parámetros del cultivo

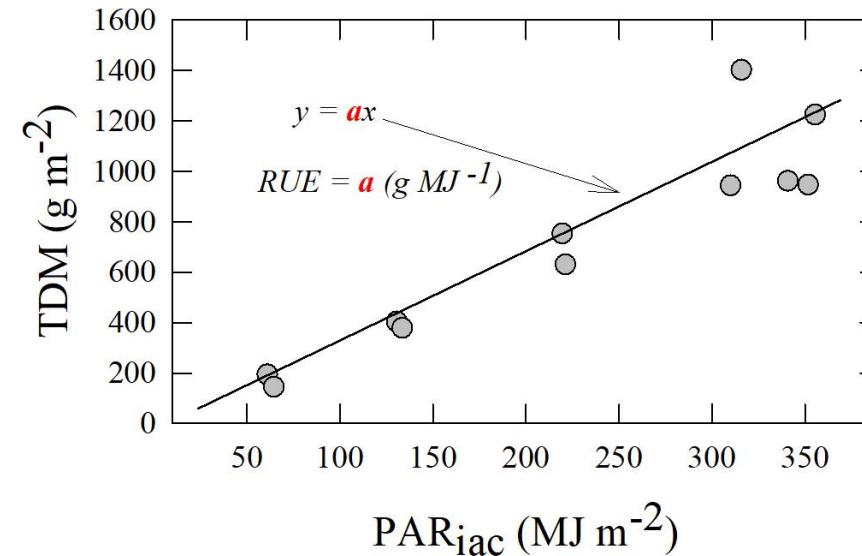
8 parámetros

Parámetros del suelo y relacionados a la fenología del cultivo

Parámetros / variables	Símbolo	Valor	Unidad
Temperatura mínima para el inicio de tuberización	T _b	4	°C
Temperatura óptima para el inicio de tuberización	T _o	17	°C
Temperatura máxima para el inicio de tuberización	T _u	35	°C
Fotoperiodo crítico	P _c	13	hr
Sensibilidad al fotoperiodo	w	0.25	hr ⁻¹
Temperatura crítica	T _{cr}	-3	°C
Temperatura de muerte de las hojas	T _{ld}	-5	°C
Temperatura de rebrote	T _{rg}	-8	°C
Profundidad del suelo	Z _{suelo}	0.3	m
Contenido inicial de agua en el suelo (en lámina de agua)	H _o	98.34	mm
Humedad volumétrica en capacidad de campo	θ_{cc}	32.78	%
Humedad volumétrica en el punto de marchitez permanente	θ_{pmp}	17.72	%

Determinación de los parámetros del cultivo

Uso eficiente de Radiación (RUE)



Kooman *et al.* (1996),
Condori *et al.* (2010)

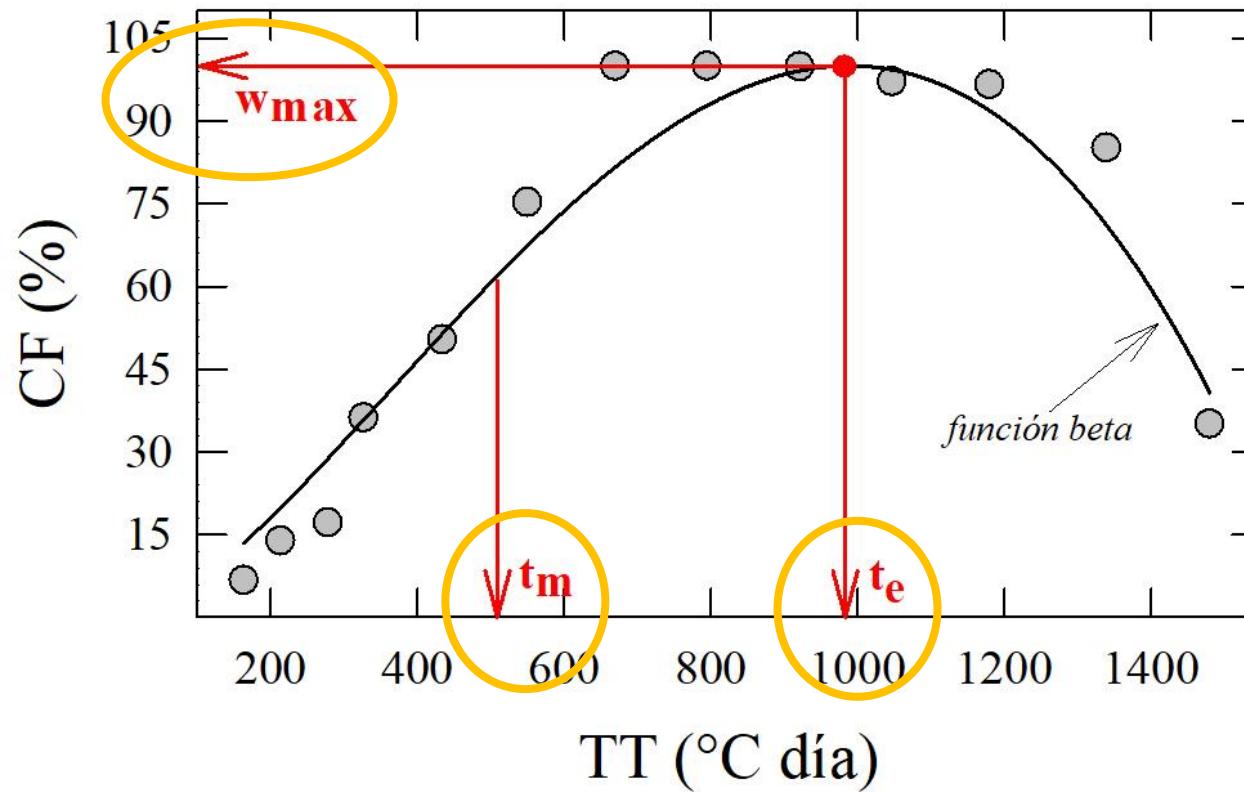
TDM: Materia seca total

PARiac: PAR interceptado y acumulado

Concentración de materia seca de tubérculo (DM_c)

$$DM_c = \frac{\text{Peso seco de tubérculo}}{\text{Peso fresco de tubérculo}}$$

Crecimiento vegetativo – Función Beta

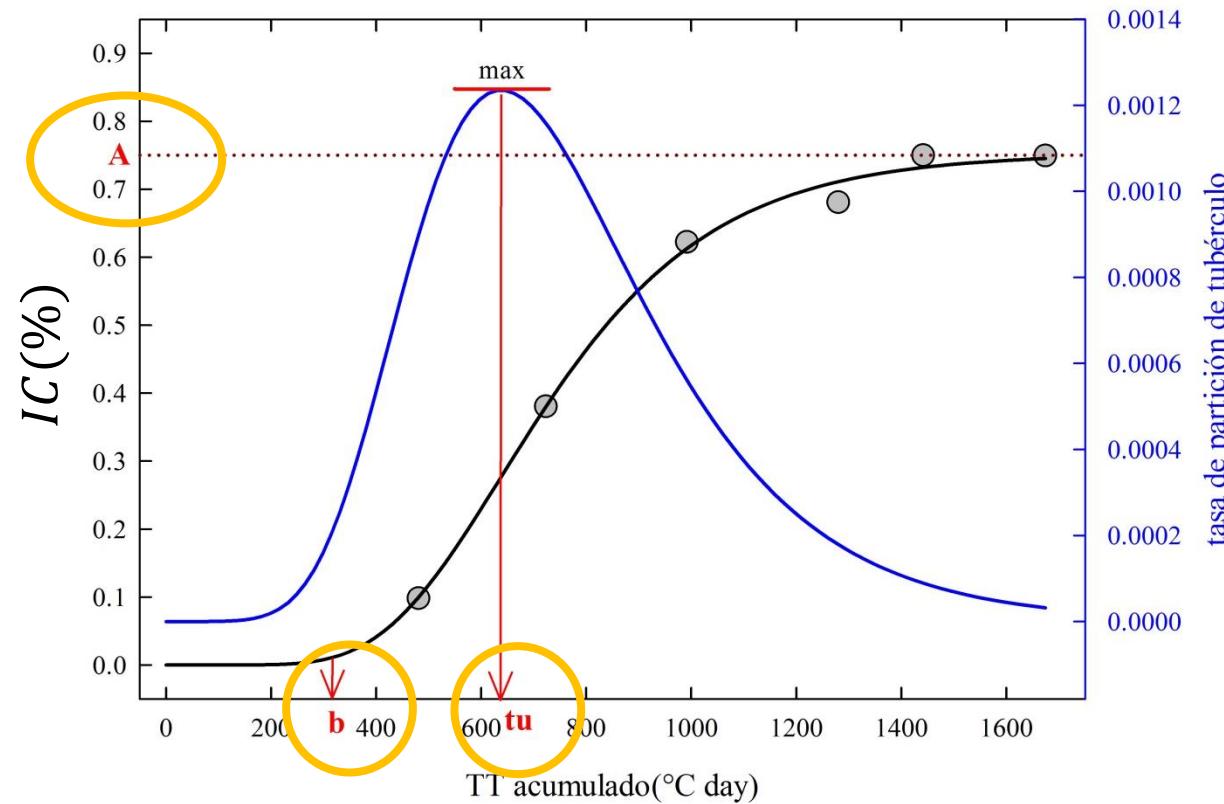


w_{max} : Máximo valor de la cobertura de follaje

t_e : Tiempo termal cuando se alcanza w_{max}

t_m : Tiempo termal cuando ocurre la tasa máxima de crecimiento

Crecimiento reproductivo – Función Gompertz



$$IC = \frac{\text{tubérculo}}{\text{Total}}$$

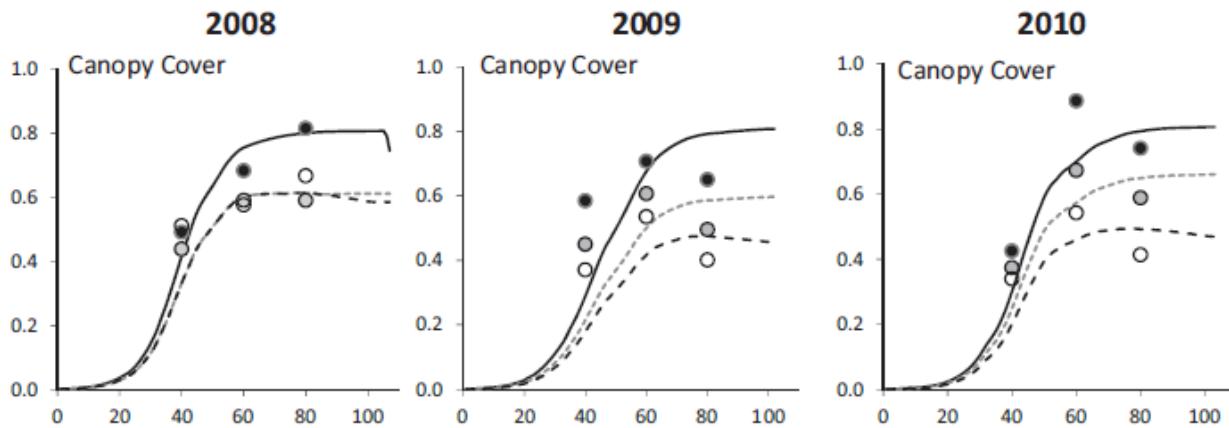
A: Máximo valor del índice de cosecha

t_u : Tiempo termal cuando ocurre la tasa máxima de partición

b: Tiempo termal cuando ocurre la pendiente inicial



ELSEVIER



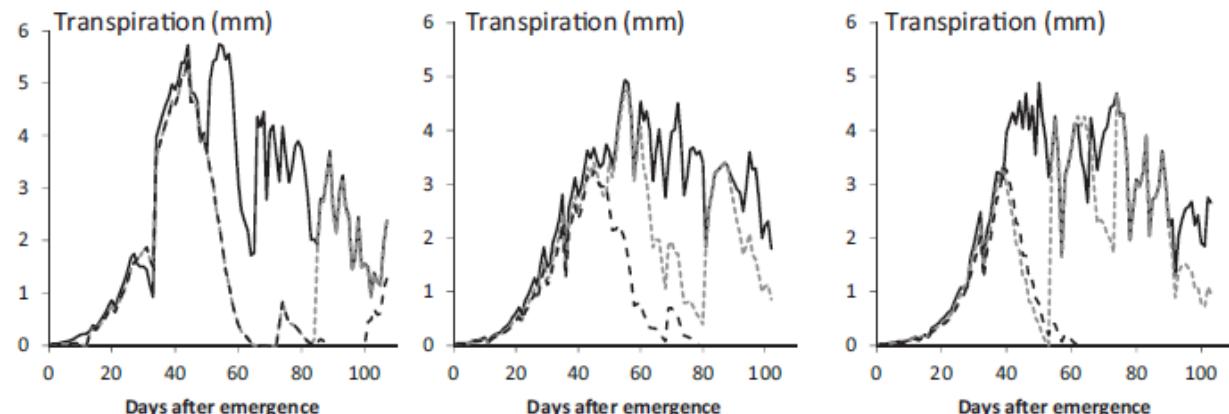
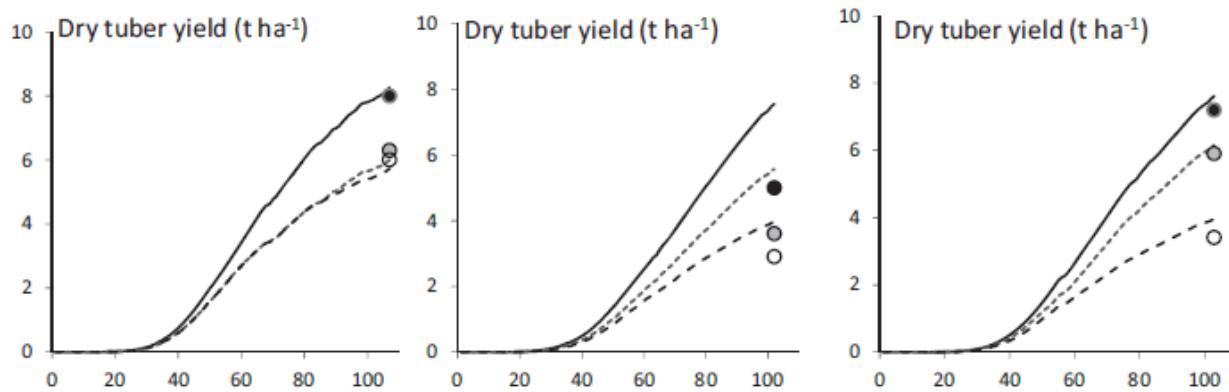
Effect of different quality of potato in Uzbekistan: A

C. Carli^{a,*}, F. Yulda

^a International Potato Center-Lima

^b International Potato Center-Lima

^c International Potato Center, Almaty



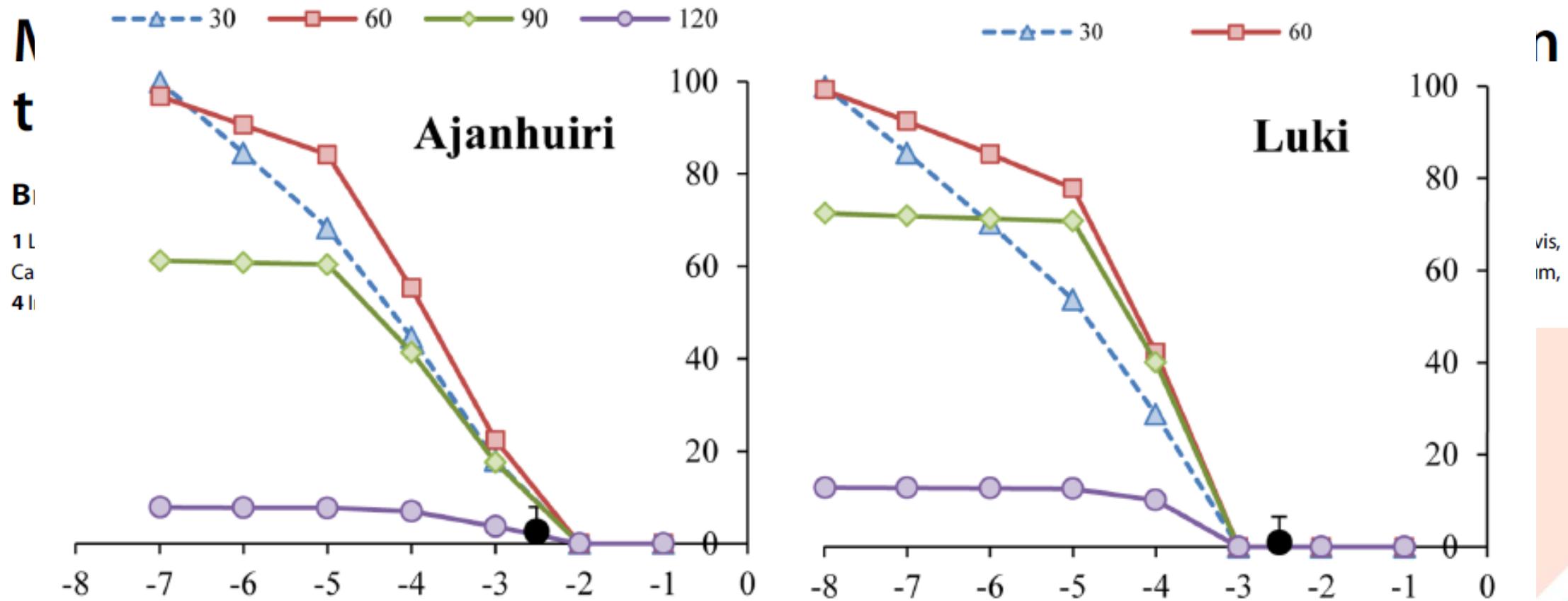
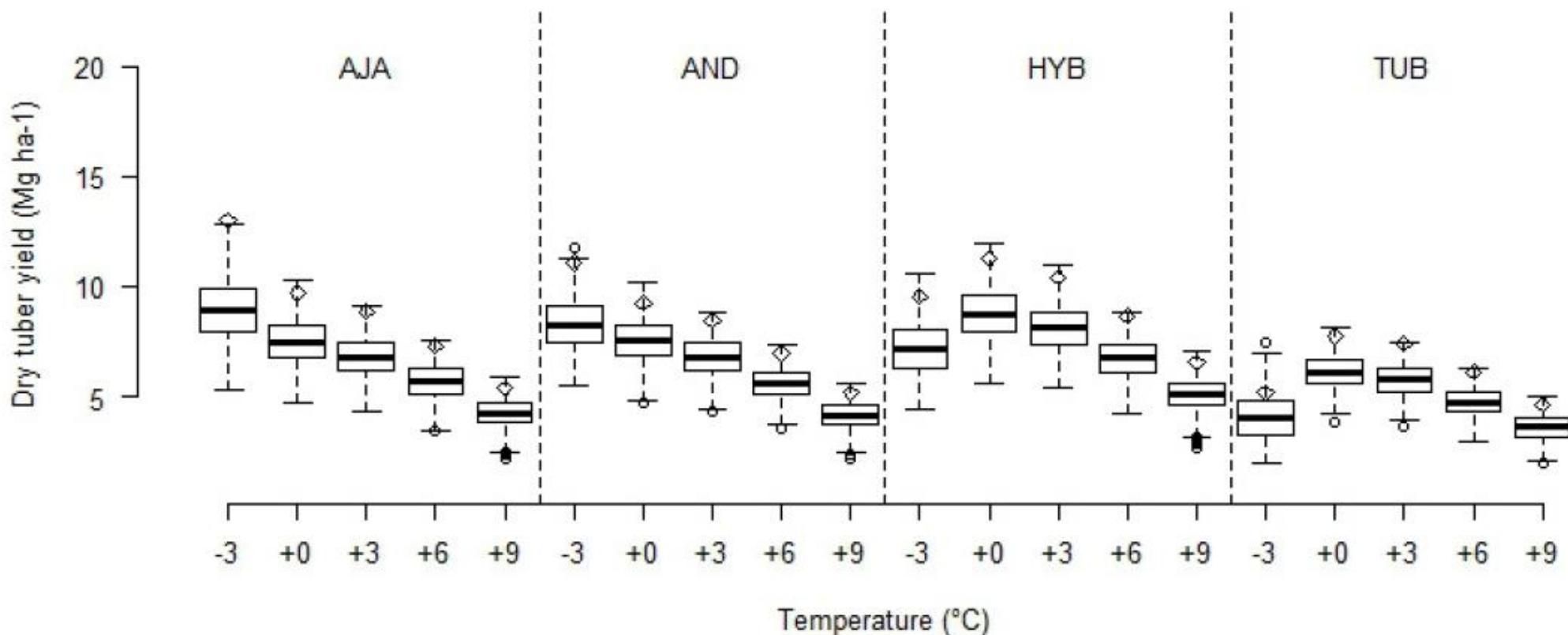
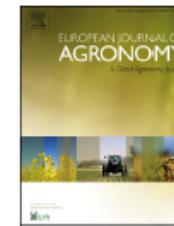


Figure 4. Percentage of tuber yield loss affected by frost ($^{\circ}\text{C}$) at 30, 60, 90 and 120 days after planting on four potato varieties. In circles real losses on yield caused by frost (-2.51°C) occurred at 94 DAP.
doi:10.1371/journal.pone.0081510.g004

Roberto Quiroz*, David A. Ramírez, Jürgen Kroschel, Jorge Andrade-Piedra, Carolina Barreda, Bruno Condori, Victor Mares, Philippe Monneveux, Willmer Perez

Impact of climate change on the potato crop and biodiversity in its center of origin





Research Paper

Linking process-based potato models with light reflectance data: Does model complexity enhance yield prediction accuracy?

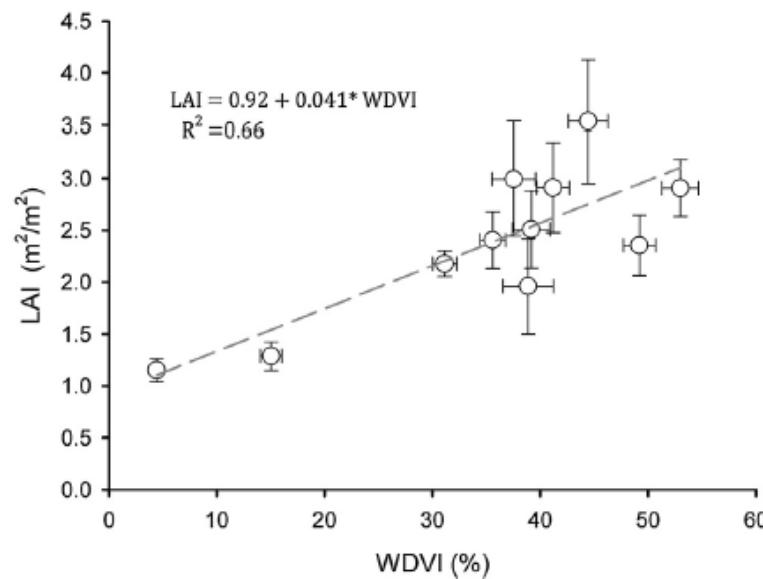
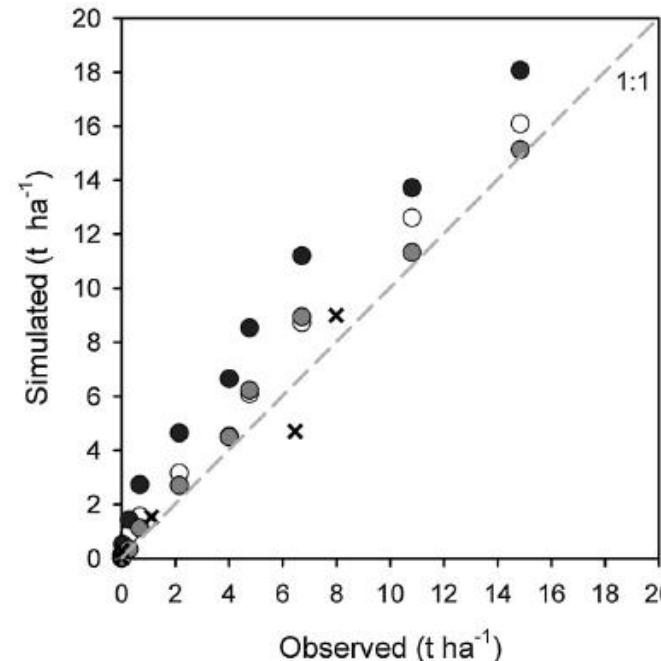
R. Quiroz^a, H. Loayza^a, C. Barreda^a, C. Gavilán^{a,b}, A. Posadas^a, D.A. Ramírez^{a,c,*}^a International Potato Center (CIP), P.O. Box 1558, Lima 12, Peru^b Present address: Soil and Water Science Department, University of Florida, P.O. Box 110290, Gainesville, FL 32611-0290, USA^c Gansu Key Laboratories of Arid and Crop Science, Crop Genetic and Germplasm Enhancement, Agronomy College, Gansu Agricultural University, Lanzhou 730070, China

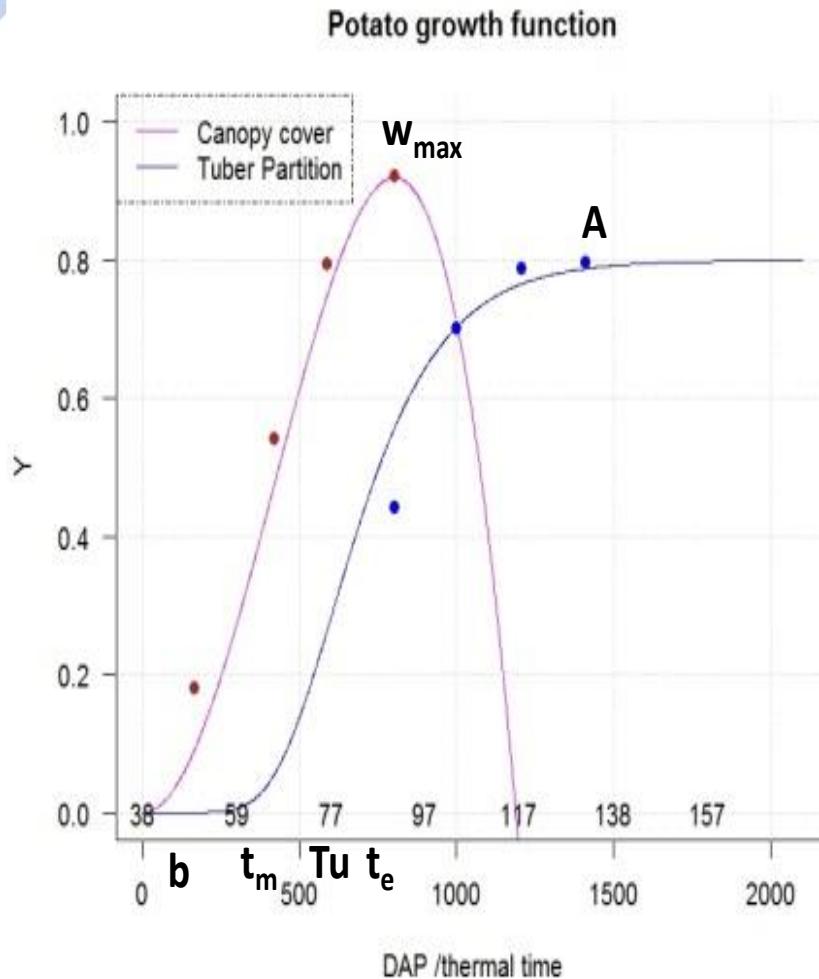
Fig. 1. Relationship between measured leaf area index (LAI) and the weighted difference vegetation index (WDVI).



Qué hacemos si no podemos realizar un experimento de campo?



CALCULADOR DE PARAMETROS (CP)



Canopy Cover Curve

w_{max} , the maximum value of canopy cover
 t_m , the thermal time at maximum canopy cover rate
 t_e , the thermal time at the end of the growth period

Tuber Partition Curve

A, the maximum value of tuber partition
Tu, the thermal time at maximum tuber partition rate
b, the thermal time just before the tuber initiation process

Preguntas: Propuesta Metodológica para Identificación de prácticas de Agricultura Climáticamente Inteligentes aplicables a los Sistemas AAbP

- 1.-¿Qué variedades de papas siembran?
- 2.-En qué tipo(s) de suelo siembran: arcilloso, arenoso, etc.
- 3.-¿Cuál es el distanciamiento entre plantas y surcos que suelen usar?
- 4.-En que fechas suelen realizar la siembra.
- 5.-Aproximadamente, a partir de cuantos días después de la siembra ocurre lo siguiente:
 - a) Emergencia de las plantas:
 - b) Inicio de tuberización (o floración):
 - c) El cultivo expresa su máximo follaje:
 - d) Las hojas (parte superior) empiezan a amarillarse-secarse (senescencia):
 - e) Cosecha:
- 6.-¿Cuánto es la producción (peso/area) que alcanzan habitualmente?
- 7.-Del 1 al 10. ¿Cuán frondoso considera que es llegar a ser el follaje del cultivo?
- 8.-¿Cuál es la altura máxima que alcanza el cultivo?

Parameter Calculator

* If you want to open a new climate file, you can do it in the climate form

Climate file (*)	C:\Program Files (x86)\Solanum\climate.prm
Minimum temperature	Tmin
Maximum temperature	Tmax

Emergence day	13	dap	Days to reach 1% canopy cover	19	dap	Days at physiological maturity	100	dap	Photoperiod sensitivity	0.5
Maximum canopy cover index	0.89		Days at maximum canopy cover	75	dap	Critical photoperiod	15			
Maximum harvest index	0.77									

#	Day	Month	Year	Minimum Temp	Maximum Temp	
1	1	1	1995	5.2	19	
2	2	1	1995	6.2	18.1	
3	3	1	1995	7	19	
4	4	1	1995	6.1	21	
5	5	1	1995	3.4	22.8	
6	6	1	1995	4.2	22.3	
7	7	1	1995	4	23.2	
8	8	1	1995	5	24	

Planting date: 1995-04-10
Harvest date: 1995-09-10
Select data

#	Day	Month	Year	Minimum Temp	Maximum Temp	TT
1	10	4	1995	3.5	19.2	0
2	11	4	1995	5.7	18.2	0
3	12	4	1995	7.6	15.1	0
4	13	4	1995	4.4	21	0
5	14	4	1995	3.7	22	0
6	15	4	1995	4.2	22	0
7	16	4	1995	4.7	21.6	0
8	17	4	1995	7.3	20.2	0
9	18	4	1995	3	20.2	0
10	19	4	1995	-2	20.1	0
11	20	4	1995	2.5	19.2	0
12	21	4	1995	2.8	19.6	0

Growth functions

Calculate parameters ...

Derivatives

Fresh tuber yield

Expected fresh yield: 27.49 t/ha days

Parameters

- tu TT at maximum tuber partition rate: 500 oCd
- b TT just before the tuber initiation process: 112 oCd
- te TT at maximum canopy cover: 610 oCd
- tm TT at the maximum canopy cover growth rate: 416 oCd

Adjust parameters

Results

Variety name: EnterNameHere

Add parameter to DB

Save parameters

Save Thermal time

X Close

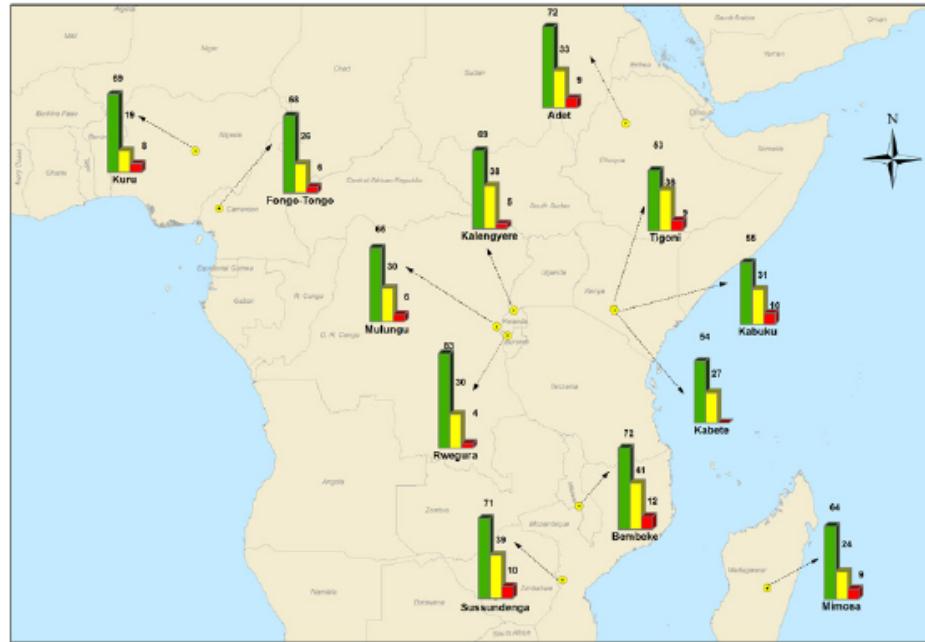
Dieudonné Harahagazwe*, Bruno Condori, Carolina Barreda, Astère Bararyenya, Arinaitwe Abel Byarugaba, Danbaba Anthony Kude, Charles Lung'aho, Carolino Martinho, Daniel Mbiri, Bouwe Nasona, Bruce Ochieng, John Onditi, Jean Marc Randrianaivoarivony, Christopher M. Tankou, Alemu Worku, Elmar Schulte-Geldermann, Victor Mares, Felipe de Mendiburu, Roberto Quiroz*

How big is the potato (*Solanum tuberosum* L.) yield gap in Sub-Saharan Africa and why? A participatory approach

Table 1. Comparative assessment of model parameters as estimated by sequential harvest or with the Parameters Estimator

Statistical metrics	Estimated model parameters					
	W_{\max}	t_m	t_e	A	T_u	b
r	0.856	0.932	0.978	0.824	0.959	0.869
RRMSE	0.126	0.155	0.029	0.058	0.051	0.132
RMAE	0.094	0.171	0.02	0.046	0.044	0.108

r = Pearson correlation coefficient; RRMSE = Relative root mean square error; RMAE = Relative mean absolute error; W_{\max} = maximum value of canopy cover; t_m = thermal time at maximum canopy cover rate; t_e = thermal time at the end of the growth period; A = maximum value of tuber partition; T_u = thermal time at maximum tuber partition rate; b = thermal time just before the tuber initiation process.



Potato yields and yield gaps in SSA

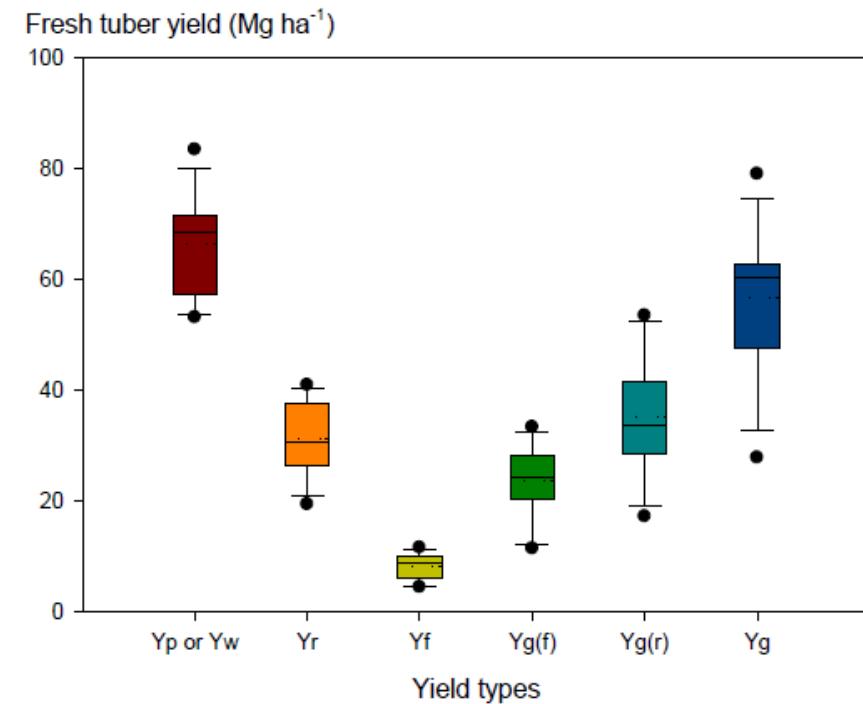
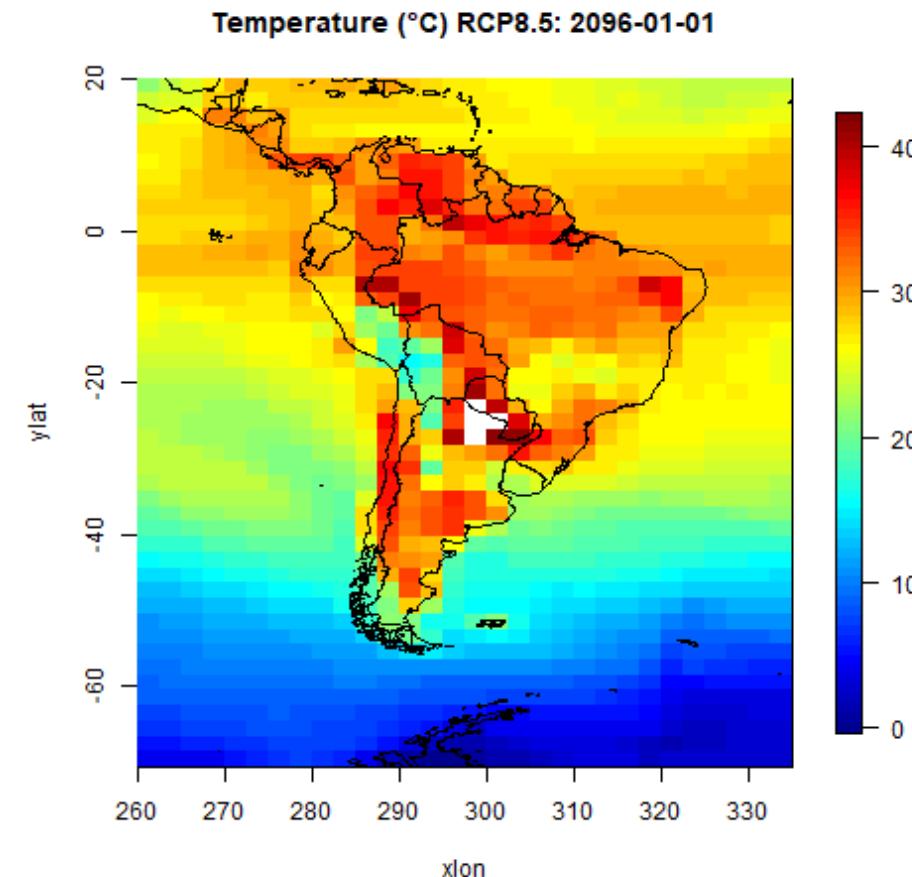


Figure 2: Levels of potato yields and yield gaps in selected sites of Sub-Saharan Africa: georeferenced graphs showing Y_p , Y_r and Y_f (**left**); box-plots (**right**). The X-Axis presents the following yields: Y_p = potential yield; Y_w = water-limited potential yield used for Winter potato (Bembike and Sussundenga); Y_r = maximum yield attained by researchers; Y_f = actual yield obtained by farmers; $Y_{g(r)}$ = research yield gap; $Y_{g(f)}$ = farmers' yield gap; Y_g = absolute yield gap. Lines within boxes show the medians (solid line) and the boxes and whiskers represent 25th to 75th and 10th to 90th percentiles, respectively. Green, yellow and red graphs on the left represent Y_p or Y_w , Y_r and Y_f , respectively

Ejemplo caso de estudio: Proyecto Euroclima – Ecuador

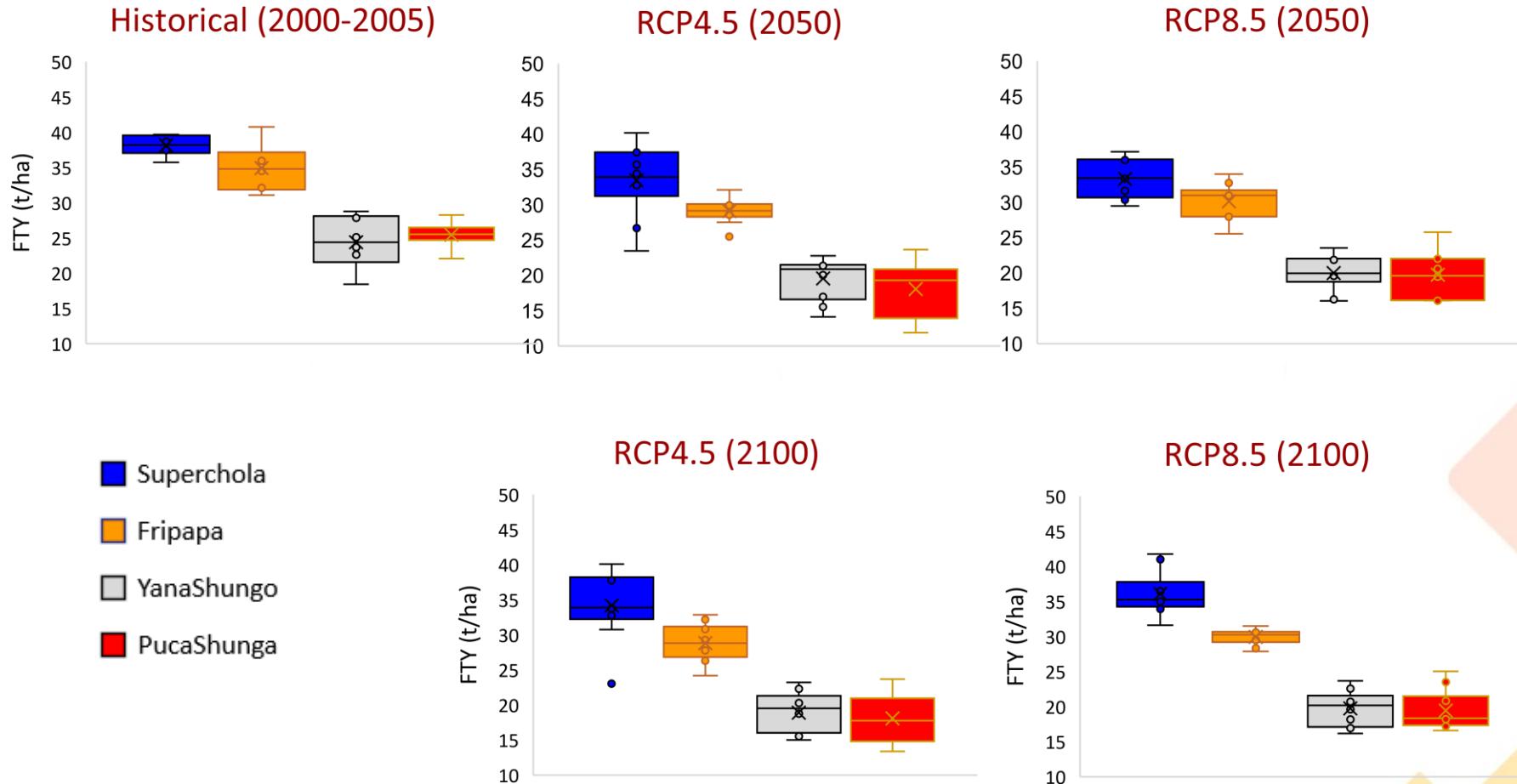
Datos de modelos climáticos

The screenshot shows the homepage of the Copernicus Climate Data Store. At the top, there are logos for Copernicus, ECMWF, and Climate Change Service. A navigation bar includes links for Home, Search, Datasets, Applications, Toolbox, FAQ, and Live. On the right, there are buttons for Login/register and a feedback link. The main content area is titled "Welcome to the Climate Data Store" and encourages users to explore climate data. It features a search bar with placeholder "Enter search term(s)" and dropdown options "All" and "Search". Below the search bar are three buttons: "Climate Data Store Toolbox", "Climate Data Store API", and "Access the C3S Forum". There is also a small text note about the service being freely available and functioning as a one-stop shop for climate data.



<https://cds.climate.copernicus.eu/cdsapp#!/dataset/projections-cmip5-daily-single-levels?tab=form>

Ejemplo caso de estudio: Proyecto Euroclima – Ecuador





Nuevas perspectivas ...

¿Cómo determinamos el estrés hídrico?

Preguntemos al suelo

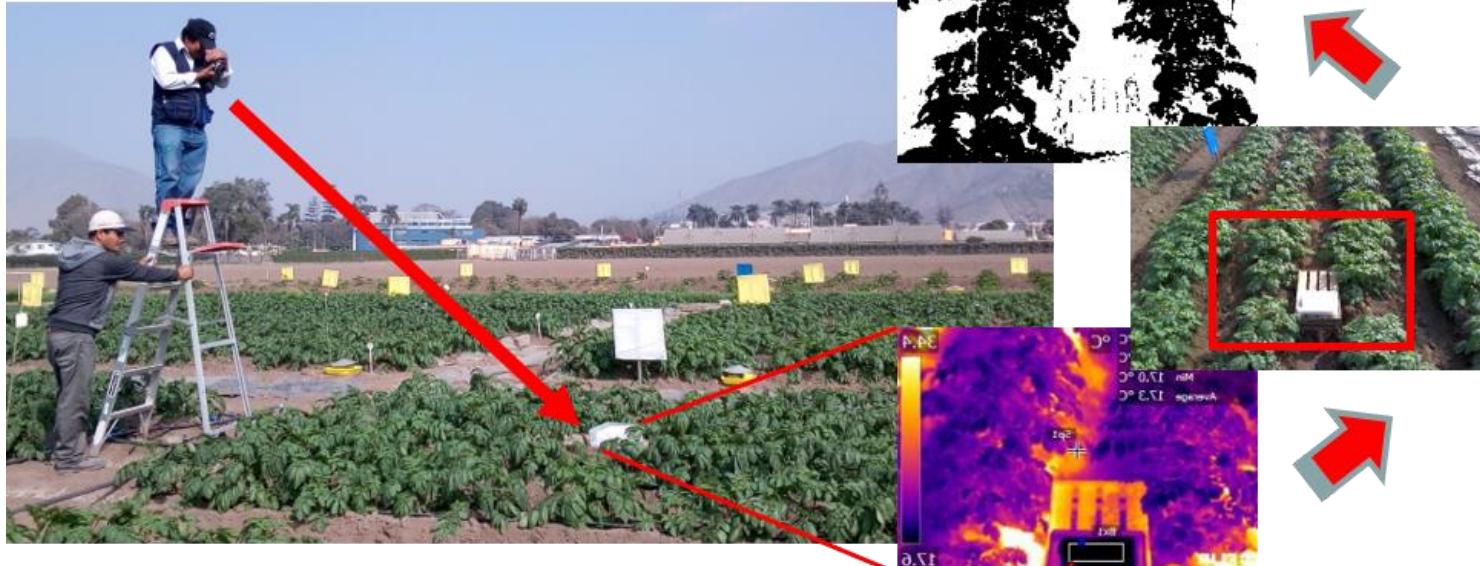
Contenido de agua en el suelo



¿Cómo determinamos el estrés hídrico?

Preguntemos a la planta

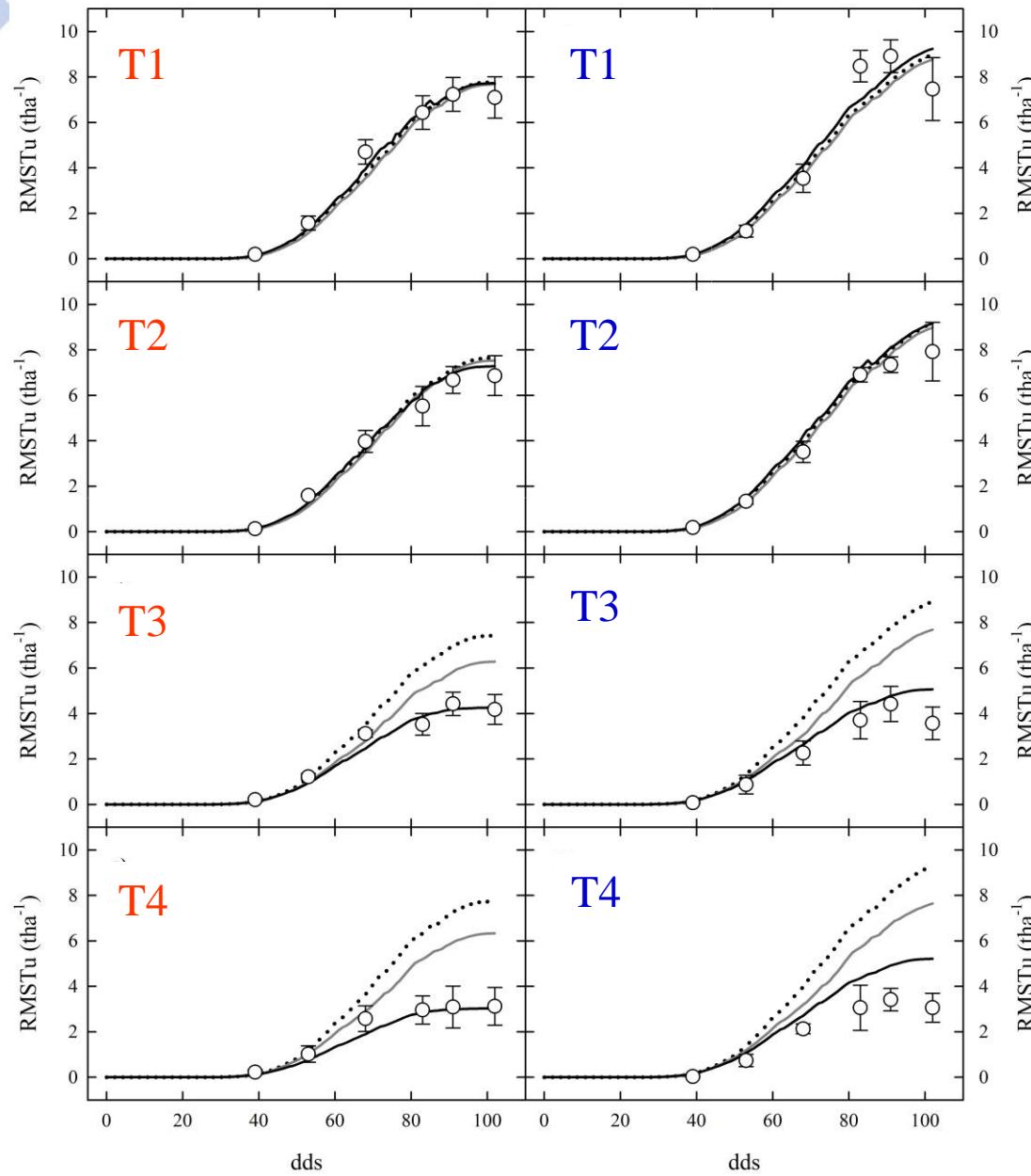
Temperatura del cultivo



CWSI: Índice de estrés hídrico del cultivo

1 = estrés máximo

0 = sin estrés



Incorporación del CWSI

RMFTu: Rendimiento de materia fresca de tubérculo

Módulo Potencial

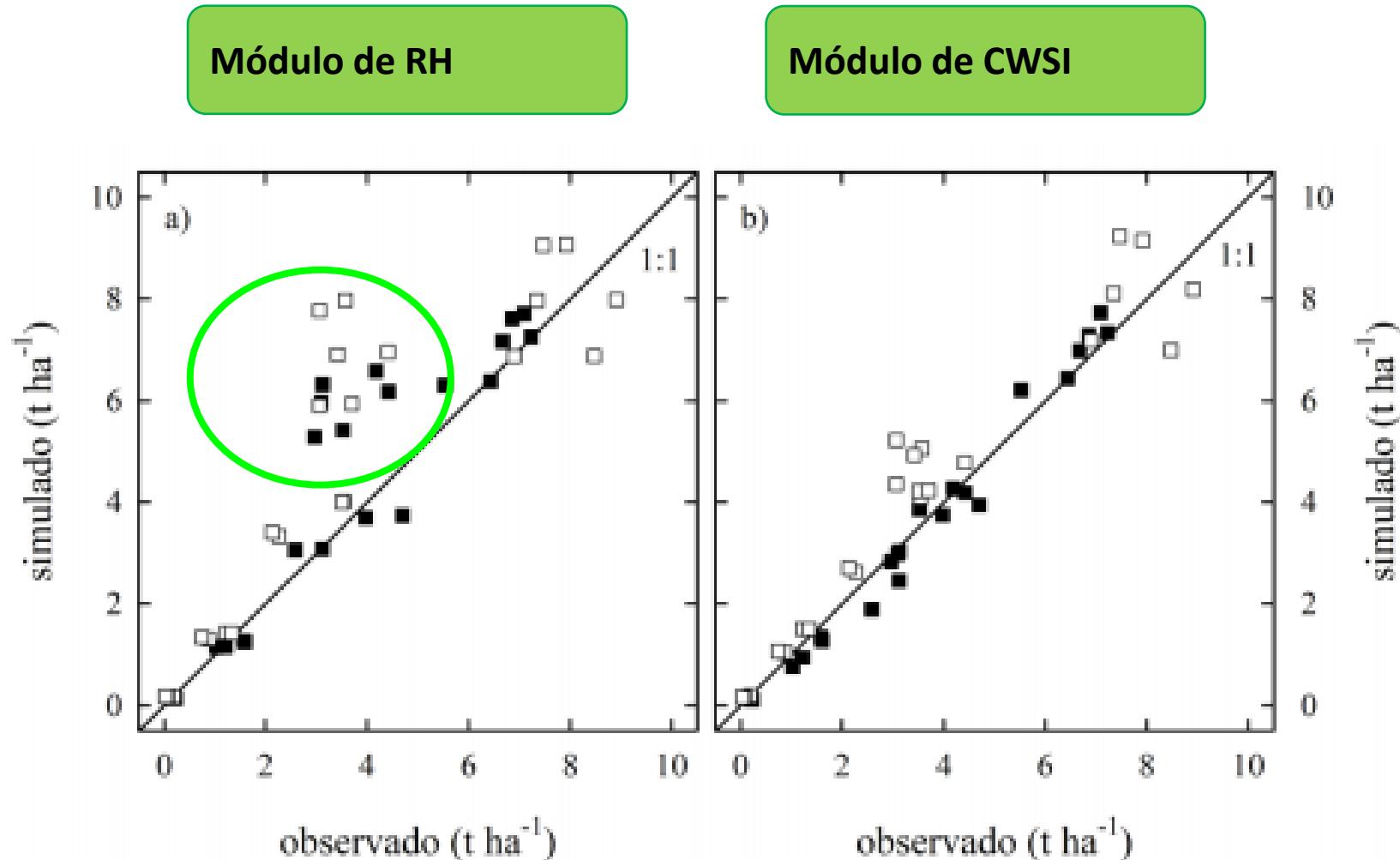
Módulo de RH

Módulo de CWSI

GOTEÓ

GRAVEDAD

Evaluación del performance del modelo SOLANUM



Fecha óptima de siembra



Impacts
cultivar:

Mitch E. E

Department of Ag



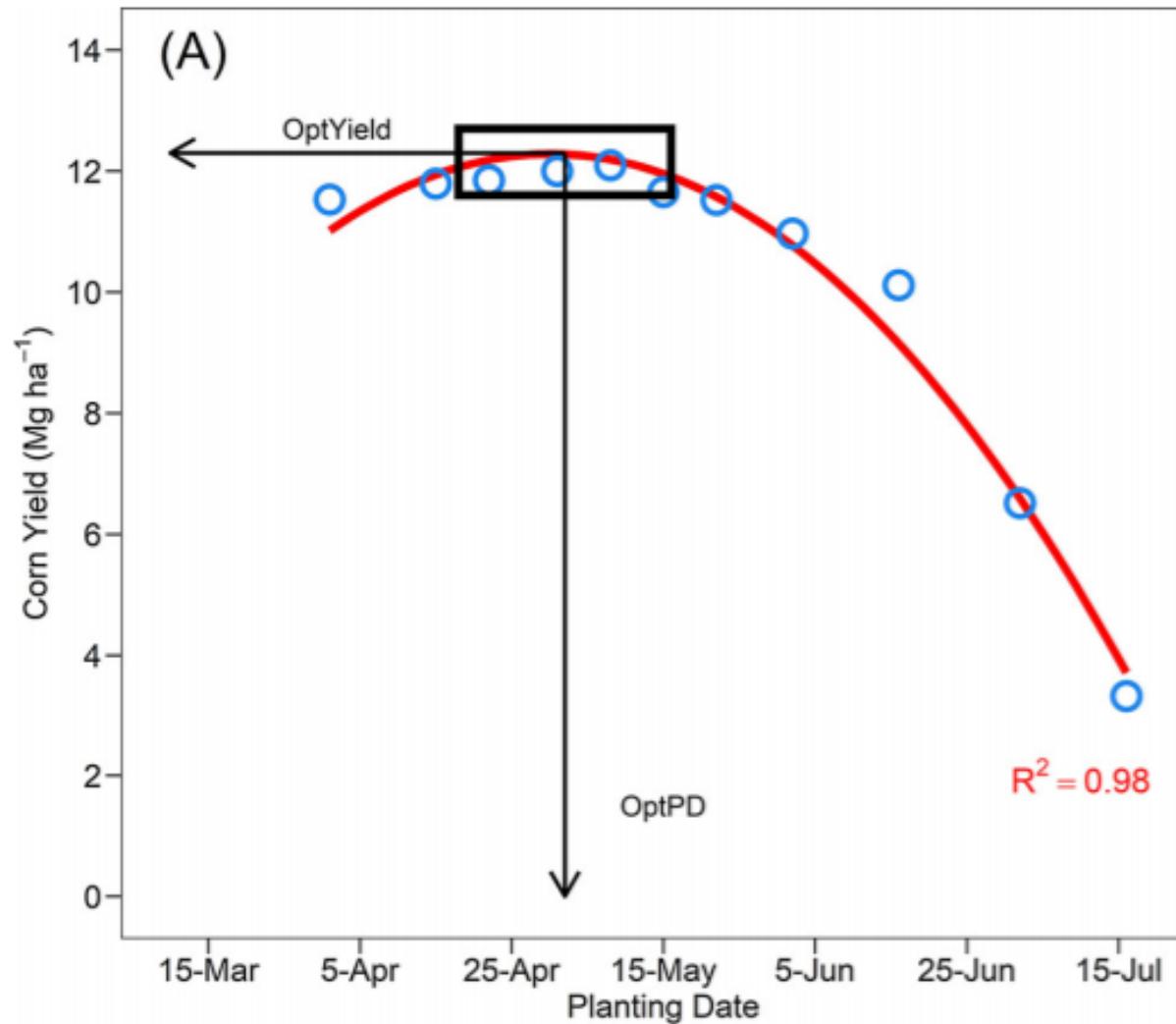
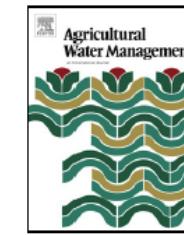
Deter
preci
M. Ban

^a Ferdowsi U

^b Institute of Crop Science and Resource Conservation, University of Bonn, Kaisenboulevard 2, Bonn D-53115, Germany

^c AgWeatherNet, Washington State University, 24106 North Bunn Road, Prosser, WA 99350-8694, USA

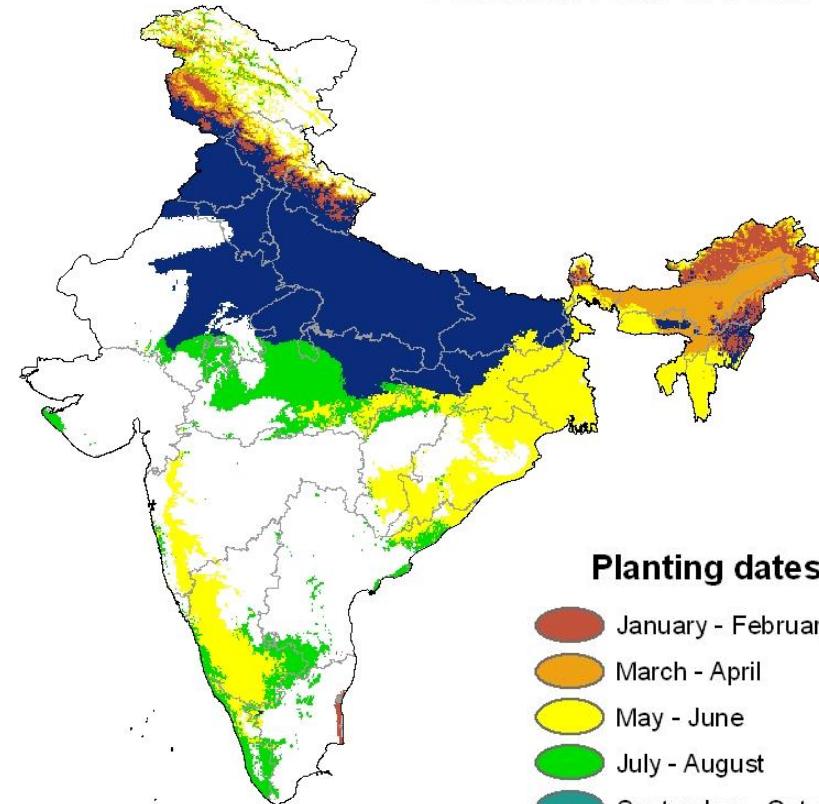
Content lists available at ScienceDirect



Fecha óptima de siembra - India

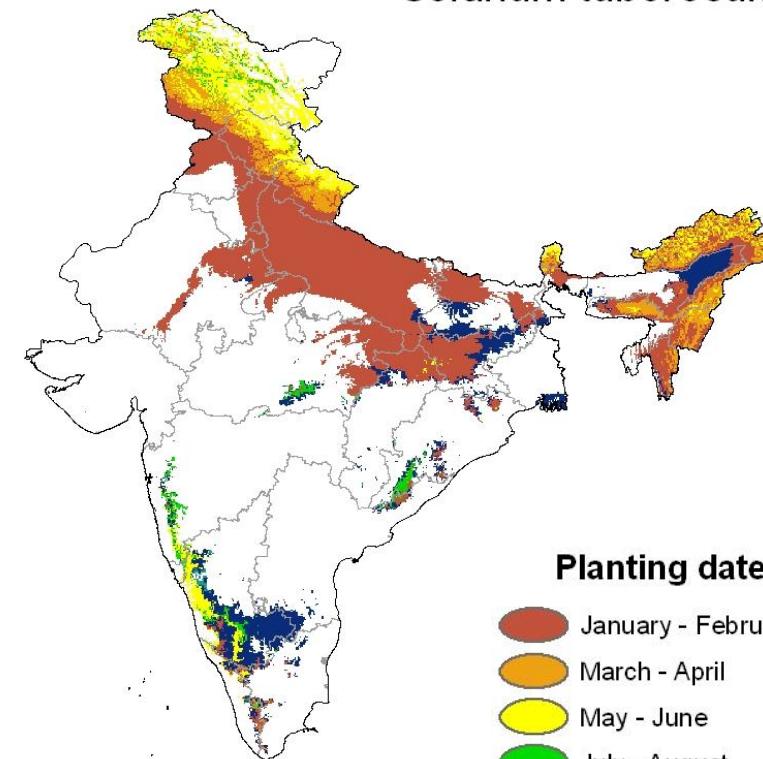
2000

Solanum tuberosum



2050

Solanum tuberosum



Planting dates

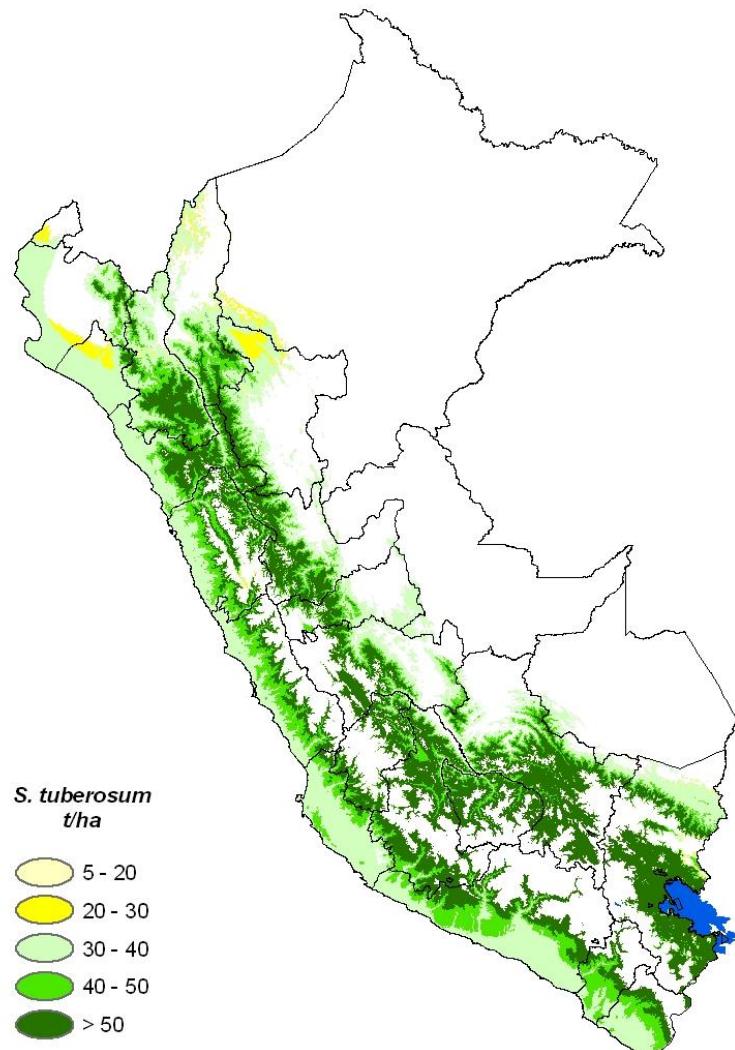
- January - February
- March - April
- May - June
- July - August
- September - October
- November - December

Planting dates

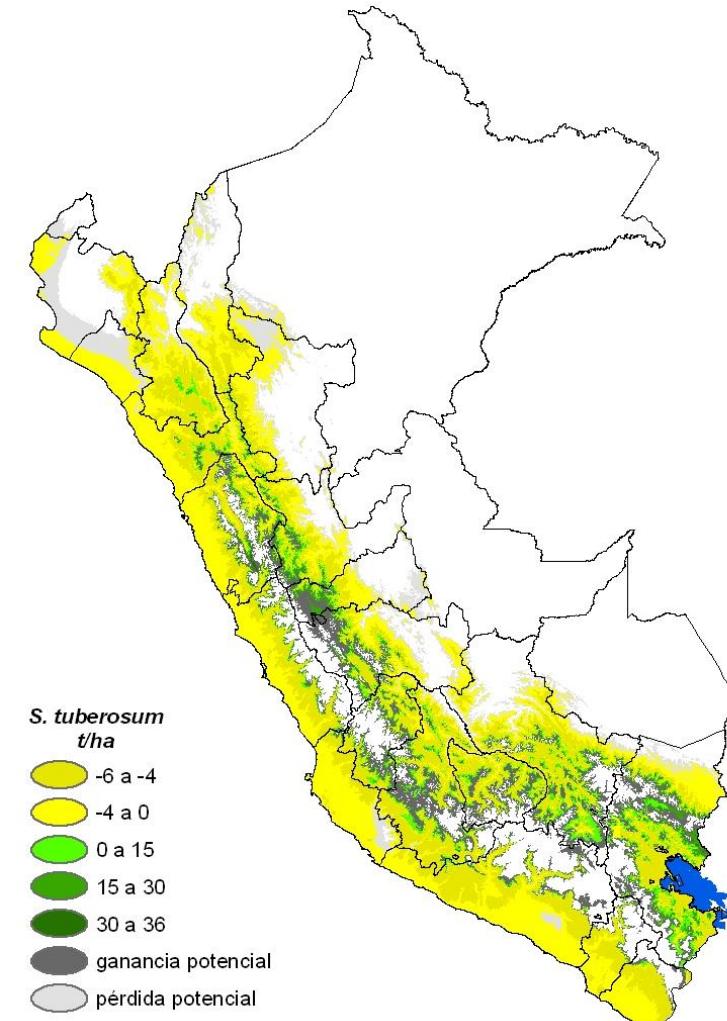
- January - February
- March - April
- May - June
- July - August
- September - October
- November - December

Cambio en la productividad- Perú

2000



2050



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Proyecto Regional

GRACIAS



2021