Approach and methodology for climate risk assessments

For select crops including: canola, corn, oats, potato, soybean, sugar beet, sugarcane sunflower, and wheat

Prepared by the Alliance of Bioversity-CIAT

Table of contents

List of figures

List of tables

Objective of the climate risk assessments

Climate change can intensify already existing challenges for farmers and suppliers across the world. Impacts of climate change, in the form of higher temperatures and highly varied precipitation will significantly affect crop performance. There is an urgent need from decision makers and farmers for detailed information on magnitude of climate change impacts, strategy for climate change adaptation, and implication on business operation. The Alliance of Bioversity-CIAT carried out the climate risk study with the aim to increase understanding within the supply chain of local risks and opportunities arising from climate change and creating a resilient farming system.

The goal of this methodology document is to make the study's approach transparent and accessible by users of the online Climate Impact Tool. Section I covers background information on the climate data used in the analyses and the advantages of this data in a science-based approach. Section II describes how the climate data is used in a specific agri-climatic modelling approach for climate suitability to potato crop. Section III describes the wider-reaching approach to anticipate climate impact on supplier sourced commodities more generally.

I. Modelling approach to understand the influence of climate change and variability on crop productivity

Overall approach

An improved understanding of the resilience of global crop production and how this may shift with climate change is urgently needed. Two main categories of factors that have great influence on plant growth as well as on the increase of crop yield/production are biotic and abiotic factors. Biotic factors (e.g., crop variety) and abiotic factors (e.g., temperature, rain, humidity, solar radiation, soil moisture etc.) affect plant growth and crop yield. Agricultural crops normally undergo a series of physiological processes during phenological stages of their life cycles that are sensitive to different environmental and climate conditions.

Several studies indicate strong associations between climate change and agricultural crops, either by using empirical (statistical) models, mechanistic (process-based) approaches or a combination of both. However, there are only a few studies that focus on this relationship at the plot level over large domains or countries due to lack of data, underscoring the importance and value of these data. Empirical models can be used to predict how these factors drive crop yields (Schlenker and Roberts 2009; Lobell and Burke 2010; Lobell et al. 2011; Urban et al. 2012; Osborne and Wheeler 2013; Moore and Lobell 2014; Ray et al. 2015). These models use local environmental conditions, including climate data as well as all available grower data. Previous research has shown that these empirical models are well-suited to determine the impact of climate and agricultural practices on growth and development, and that they can be a useful tool to assess the long-term impact of climate and associated environmental risks on crop yield.

For crops sourced directly, we are able to use the large amount of direct grower data in the PepsiCo-CGIAR partnership to run empirical models. Empirical modelling allows us to leverage extensive potato grower data from direct crop souring teams in 10 countries across different climatic zones. Generalized Additive regression Models (GAMs), are selected over other statistical and machine learning methods because of their flexibility in modelling non-linear relationships and to identify the most limiting factors of yield. The outputs from GAMs are used to map climatically suitable growing regions for potato. This suitability map is then coupled with business impact modelling to tailor business case adaptation recommendations for each country. Detailed steps for the agri-climatic modelling approach for direct crops are described in Section II of this document.

For crops usually sourced indirectly through suppliers, no detailed plot-level grower data is available to inform an agri-climatic modelling approach. Instead, the study on supplier sourced crops leverages public data from scientific literature and expert interviews to give a global view on more than 8 crops in over 50 countries. Harnessing the knowledge in the vast amount of scientific literature published on these crops globally, this proves to be a robust option in the absence of field data direct from growers' plots. As peer review literature for each crop and growing regions is gathered, relevant information on growing calendars, climate-crop sensitivities, best climate models, and adaptation practices is extracted and organized. This helps associate crop performance with specific types of climate risk and provides a case for adaptation priorities. Detailed steps for the climate risk assessment for supplier sourced crop approach are described in Section III of this document.

Climate data

Climate data can be separated into baseline (current) and future.

Baseline (current) climate data: Gridded climate data are acquired from the fifth generation of the European ReAnalysis, hereafter ERA5-Land (Muñoz-Sabater et al. 2021). Gridded climate data gives us access to daily high-resolution climatological data based on direct observations and over long time periods. The reason this is used is that there are not enough weather stations worldwide to cover every point on the earth. Gridded climate data solve this issue. These data describe the evolution of the water and energy cycles over land globally, at a 9km resolution. This is achieved through global high-resolution numerical modelling of the European Centre for Medium-Range Weather Forecasts (ECMWF) land surface model, which is driven by the downscaled meteorological forcing from the ERA5-Land climate reanalysis. Due to the scarcity of equally distributed on-the-ground weather stations, as well as the limitations point data incurs, ERA5-Land provides the best representation of high-resolution and reliable climate data source covering the globe. There are alternative gridded climate products providing similar data such as Worldclim and TerraClimate (Fick and Hijmans 2017; Abatzoglou et al. 2018), however these are only at monthly resolution.

Future climate data: Future daily climate are extracted from CMIP6 (Eyring et al. 2016). CMIP6 data (Coupled Model Intercomparison Project Phase 6 data) refers to a comprehensive set of climate model simulations that are designed to simulate the Earth's climate system and predict future climate change.

CMIP6 consists of 134 models from 53 modelling centers (Durack [2016] 2020). The scientific analyses from CMIP6 are used extensively in the Intergovernmental Panel on Climate Change 6th Assessment Report and are the most trusted source on future climate projections. These scenarios are highly flexible and allow for assessment of climate change impacts on crop production in an interpretable way while accounting for the uncertainty that is implicitly part of climate model projections and emission scenarios. The Climate Model Intercomparison Project (CMIP) was established in 1995 by the World Climate Research Program to provide climate scientists with a database of coupled Global Circulation Model (GCM) simulations. CMIP6 is the sixth and latest iteration of the leading international effort to bring together climate modelers from around the world to improve our understanding of past, present, and future climate change.

II. Direct crops

Process overview

For crops sourced directly (e.g., potato) we are able to leverage insights from plot-level grower data in the PepsiCo-CGIAR partnership to complete three major steps that result in:

1) determining the major climate drivers and limiting factors of potato crop yield/production in each country at high resolution;
2) mapping the suitability based on these major climate drivers and limiting factors both under baseline (1970-2000) as well as the future (2030) climate change scenarios, and;
3) modelling the business impacts of the cascading effects of climate change risk.

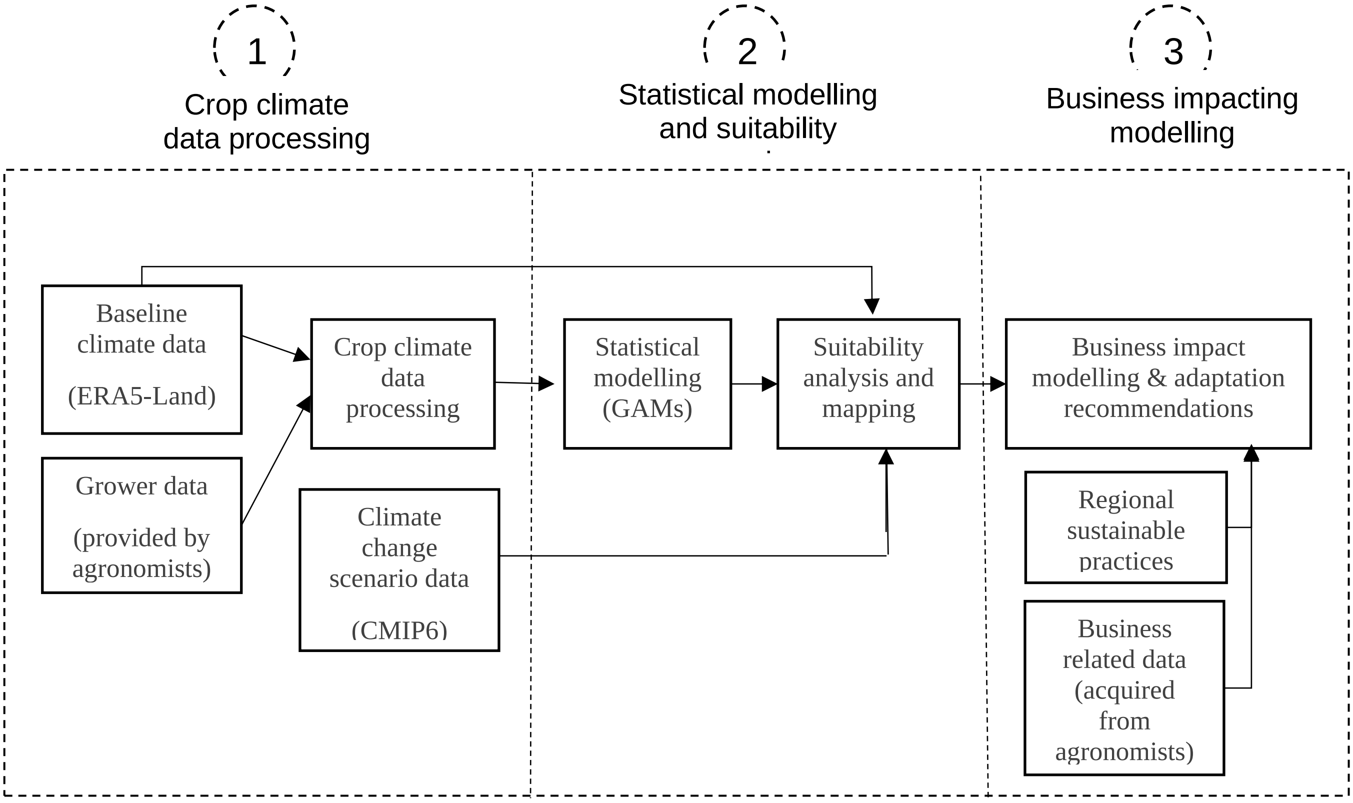

Figure 1. Agri-climatic modelling approach

1. Climate data processing for potato crop

Climate variables considered for the analysis are rainfall, air temperature (minimum, mean, maximum), diurnal temperature range, soil moisture, relative humidity, solar radiation, and other derived variables. These variables are extracted and aggregated for each country based on each of the grower location coordinates and corresponding planting and harvesting dates. Climate variables are calculated for both the whole growing season as well as each phenological phase. The phenological phases are vegetative, reproductive, and bulking. This process is replicated for both the baseline and future climate data. This is done in order to account for the more “sensitive” growth stages in the season.

2. Statistical modelling and suitability mapping

2.1 Statistical modelling

Generalized Additive regression Models (GAMs) (Hastie and Tibshirani 1986) are used together with multi-model selection (Fisher et al. 2018) to identify the key climate drivers for each country and regions potato production while accounting for all available grower variables such as supplier, variety etc. The value and reason for selecting these models are outlined in the introduction. All analyses are carried out in R (R Core Team 2021). The GAM has the following equation, where:

$$\log(y_{ij}) = \beta_o + f_{(x_{ij})} + z_i\varphi + \epsilon_{ij}$$

$$\epsilon_{ij} \sim Gamma(\gamma)$$

$$\varphi \sim N(0, ב)$$

Yields (y) are modelled as a non-linear (f) function of predictor variables (x) for each country (i) and year (j) using a Gaussian distribution with an Identity link. A random effect (φ) for each country (Zi) is included to account for the repeat measurements for each year at the country level. Random-effects control for non-independence by constraining non-independent observations to have the same intercept. For example, yield observations from a particular country or region, may be more similar (e.g., higher on average if soils and management techniques are better) relative to yield observations from other regions or countries. To account for temporal autocorrelation, ‘year’ is modelled as an autocorrelation structure of order. There are 24 climate variables (maximum temperature, minimum temperature, total rainfall, total soil moisture, diurnal temperature range and solar radiation for both the vegetative, reproductive, and bulking seasons) in the initial model selection. Model selection also accounts for multi-collinearity by ensuring no models included variables with a Pearson coefficient r > |0.5|. Model selection then ranks candidate models based on both Akaike information criterion (AIC) and Bayesian information criterion (BIC). The final GAM model is selected based on AIC and BIC and captures statistically significant climatic trends and drivers of potato yield. Results from the GAM are presented as smooth curves, where firstly the height of the response curve of each predictor provides an indication of the total amount of yield drive associated with a specific climate gradient/variable. Secondly, the slope of the smooth curve at a specific point provides an indication of how the rate of yield varies along the climate gradient/variable concerned.

2.2 Suitability mapping

From evaluating fitted GAM smooths and outcome statistics, a range-based approach is then used to classify crop-climate suitability into four categories: suitable, marginal, stressed, and unsuitable growing conditions. Suitability thresholds vary by country as the statistical modeling is done at the country level.

Based on the sensitivity of potato to climate variables from GAM modeling, we create suitability maps for both baseline (1970-2000) as well as the future (2030) scenarios. The change in suitability between baseline and future scenarios is also calculated to determine areas of opportunity and risk. These suitability maps are then created in an html format for them to be explored in a dynamic dashboard.

3. Business Impact modelling

The Business Impact Model uses scenario analysis to investigate the cascading effects of climate change risk on the performance of business. The impact is first assessed under a “business as usual” or reference-case scenario, in which no changes to farm management are introduced to cope with the risk. This is compared to a “climate resilience” or adaptation scenario in which reduced yield losses are estimated based on yield loss buffering effects documented in the literature or business data (e.g. from demo farm records). Recommended practices such as drip irrigation and improved varieties are taken into account in Climate Positive scenario. The process includes comprehensive and quantitative estimates of adaptation options and their costs, and benefits, potential opportunities given climate change. A main advantage of the model is an in-depth examination of various scenarios, allowing business leaders to test decisions and understand the scale of the potential impact with the most up-to-date information. A major limitation of the model is the difficulty to gather data for adaptation scenarios. Values are taken from a variety of sources, including literature, interviews with management, and interviews with subject matter experts.

Inputs:
Business data such as procurement volume, cost of production, and projected distribution of volumes across regions and seasons are required inputs for inferring the impact of climate risks to the business.

Suitability maps resulting from the climate analysis are used to assess regional and local climate risks, then prioritize site-specific adaptation practices and make long-term adaptation strategies. This approach involves understanding possible regional patterns of climate change and socioeconomic factors that drive or limit adoptability of the practices.

III. Supplier sourced crops

Process overview

Climate variability and change have significant implications for crop production, affecting crop yield and quality worldwide. With the Earth's climate continuously evolving, understanding the effects of climate extremes, such as droughts, floods, heatwaves, and frost, on crop yields has become increasingly crucial. The sensitivity of different crop types to environmental factors can result in varying extents of impacts of climate extremes on crop production. Therefore, understanding the unique sensitivities of different crop types to climate extremes as well as how these impact crops in the future is crucial for developing effective strategies to mitigate the negative impacts of climate change on agriculture.

To achieve this, a three-step approach is applied. In the first step, existing literature is compiled to understand the main growing seasons of each crop in each focal country and the extent of positive and negative impacts of climate factors on each specific crop yield. Then, the best climate models are identified to represent different countries' baseline and future (2030) climate. Finally, the compiled data and selected climate models are used to project the impact and adaptation practices on crop yields in each of the crops main growing season, which is visualized on an interactive dashboard. This approach enables stakeholders to better understand the impacts of climate extremes on crop yields and identify effective adaptation strategies to ensure food security and sustainable agriculture in the future.

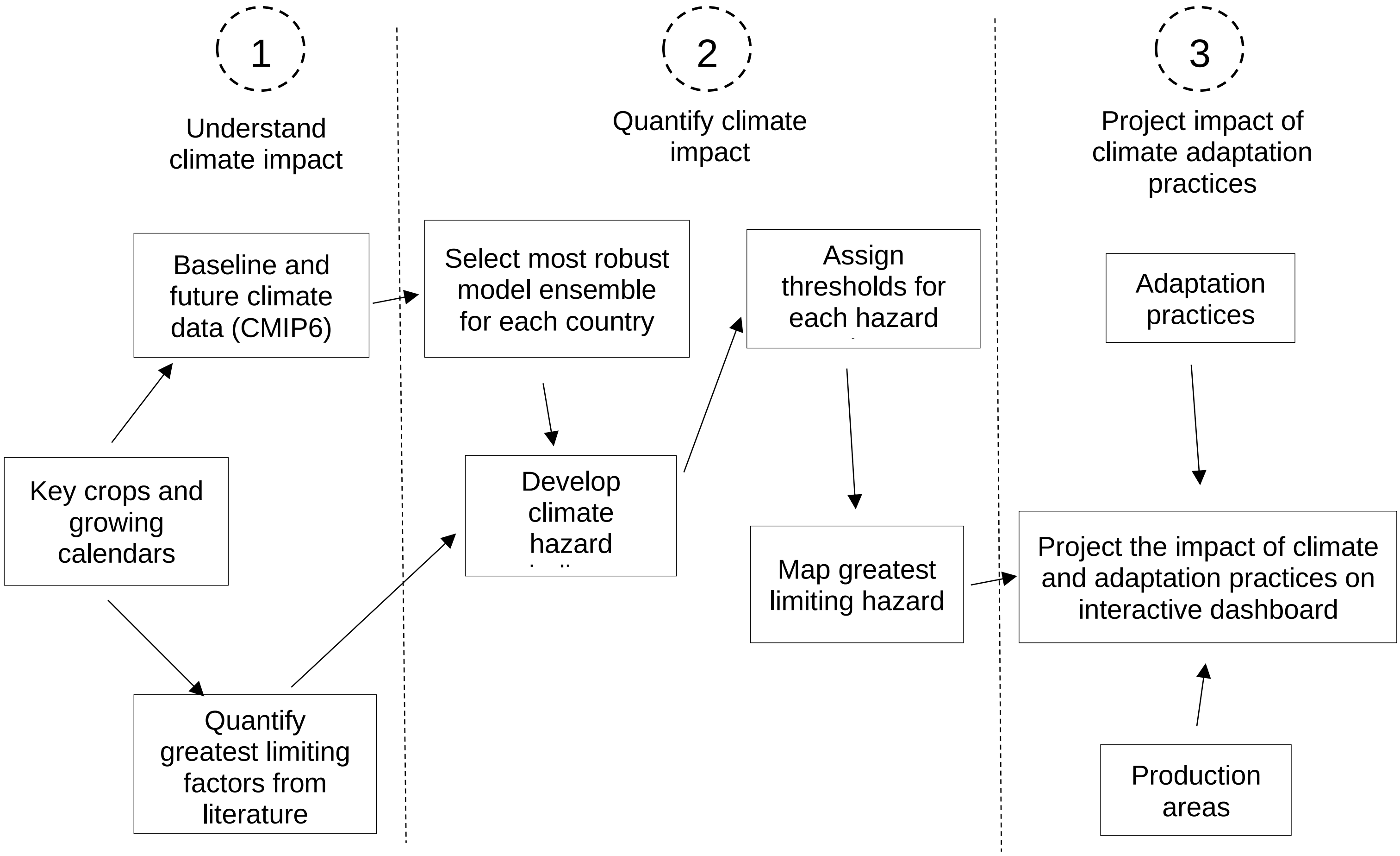

Figure 2. Climate risk and opportunity assessment methodology

1. Understand climate impact

Daily climate data are extracted for each crop per country. These data cover both the baseline (current climate) as well as future. The baseline period is considered the period from 1980-2000. The reason an average of 20 years is taken is to ensure that no biases are included by selecting a particular year which may be unrepresentatively hot, dry, cold or wet. The future climate period is also based on a 20 year span covering the years 2020-2040, which is typically used for a 2030 climate. Certain GCM's are more powerful than others depending on the geographic region. Therefore, we selected a different subset of GCM's for each region depending on the performance for that country or region. The selection is expanded on below in "Quantify climate impact". This data is used to produce four indices representing climate extremes that result in the largest net yield gain or loss risk for each jurisdiction during the growing season: heat, frost, flood, and drought. These risks are defined and calculated as follows:

Table 1. Climate risk definition

Climate risk	Definition
Heat stress	Heat stress is a climate extreme index which accounts for the number of days during the growing season that temperatures rise above the thermal limit for each crop type.
Frost risk	Frost risk is a climate extreme index which accounts for the number of days during the growing season that conditions drop below freezing.
Flood risk	Flood risk is a climate extreme index which accounts for the total amount of precipitation accumulated within a consecutive 5-day period during the growing season.
Drought risk	Drought risk is a climate extreme index that accounts for both precipitation and evapotranspiration during the growing season.

In addition, the growing season, or the period between planting dates and harvesting dates, varied for each crop and country. This information is gathered from peer-review papers and databases from official sources. The list of reference sources for growing season is detailed in Annex D.

2. Quantify climate impact

A systematic review methodology is applied to assess all existing literature on crop limits and limiting factors to quantify the greatest limiting factors and ranges on crop yield. To achieve this, a comprehensive search of scientific databases is carried out, including peer-reviewed articles, conference proceedings, and scientific reports. The retrieved articles are then screened for relevance and quality and selected those that met our inclusion criteria. Specific data on crop types, yield, and limiting factors are extracted from the selected articles and synthesized using meta-analysis techniques. This approach enables the quantitative estimation of the relative importance of different climate risks (heat, frost, flood, drought) and their ranges on crop yield across different crop types, utilizing the vast amount of published literature on these crops. All crops and countries are shown below in Table 1. The list of literature on limiting factors is detailed in Annex E.

Table 2. List of crops and countries included in the scope thus far

Sector	Corn	Oats	Wheat	Sugar beet	Canol a	Soy	Sugar-cane	Sun-flower	Table grape
North America	x	x	x	x	x	x	x	x	
Europe & Russia	x	x	x	x	x	x		x	
South Africa	x	x	x						x
Egypt	x			x					
Brazil	x		x			x	x		
India	x								
Australia	x	x	x		x				

The accuracy of GCMs in predicting climate conditions in different countries depends on a complex interplay of data quality, model assumptions and emission scenarios. Using all available academic literature, GCMs are gathered according to their accuracy per country, per region and all selected GCMs are averaged to produce an ensemble frost, drought, heat, and flood risk index per country. This ensures that only the best models are selected to better capture the complexity of the Earth's climate system and improves the ability to predict future climate change. The list of literature for GCMs assessment is detailed in Annex F.

3. Project impact of climate adaptation practices

Based on the criteria established in the "Quantify climate impact" section above, the crop yield of each crop is calculated for specific administrative levels, using categories of extremely high yield loss, high yield loss, moderate yield loss, no change, moderate yield gain, high yield gain, and extremely high yield gain. This process is conducted for both the projected climate conditions and a hypothetical simulation of a scenario that visualizes the potential adaptation impact of regenerative agriculture practices, referred to as a resilient scenario.

The resilient scenario is created based on a systematic literature review. For each location, a search is conducted to identify a range of options that can reduce the risk and enhance farm resilience. These options include changes in agricultural practices such as drip irrigation, cover cropping, or pest & disease scouting, etc. With the literature review, current adoption rates are assessed to determine the practices' feasibility and opportunity to increase climate resilience. The process also involves assessing the potential benefits and limitations of each option with regards to their impact on livelihoods, greenhouse gas reduction and biodiversity. Based on previous assessments, a list of adaptation options is generated and prioritized with multiple factors across their feasibility, sustainability, and constraints to develop implementation plan. After identifying adaptation measures for each specific region, adaptation options are integrated into the base map with their yield benefits. Adaptation scenarios are then overlayed to see how effectively packages of adaptation options would reduce climate risks. The list of literature used for the resilient pathway development is detailed in Annex C.

Subsequently, these maps are also overlayed by production volume (Monfreda, Ramankutty, and Foley 2008) to visualize the magnitude of the impact as well as the simulation of a potential resilient scenario. The results are integrated into an interactive dashboard. Within the dashboard each admin level is mapped according to its greatest limiting factor.

References:

Annex A – Climate data

Durack, PJ. (2016) 2020. "CMIP6_CVs." Python. WCRP-CMIP. https://github.com/WCRP-CMIP/CMIP6_CVs.

Muñoz-Sabater, Joaquín, Emanuel Dutra, Anna Agustí-Panareda, Clément Albergel, Gabriele Arduini, Gianpaolo Balsamo, Souhail Boussetta, et al. 2021. "ERA5-Land: A State-of-the-Art Global Reanalysis Dataset for Land Applications." *Earth System Science Data* 13 (9): 4349–83. https://doi.org/10.5194/essd-13-4349-2021.

Eyring, Veronika, Sandrine Bony, Gerald A. Meehl, Catherine A. Senior, Bjorn Stevens, Ronald J. Stouffer, and Karl E. Taylor. 2016. "Overview of the Coupled Model Intercomparison Project Phase 6 (CMIP6) Experimental Design and Organization." *Geoscientific Model Development* 9 (5): 1937–58. https://doi.org/10.5194/gmd-9-1937-2016.

Fick, Stephen E., and Robert J. Hijmans. 2017. "WorldClim 2: New 1-Km Spatial Resolution Climate Surfaces for Global Land Areas." *International Journal of Climatology* 37 (12): 4302–15. https://doi.org/10.1002/joc.5086.

Abatzoglou, John T., Solomon Z. Dobrowski, Sean A. Parks, and Katherine C. Hegewisch. 2018. "TerraClimate, a High-Resolution Global Dataset of Monthly Climate and Climatic Water Balance from 1958–2015." *Scientific Data* 5 (1): 170191. https://doi.org/10.1038/sdata.2017.191.

Annex B – Statistical modelling

Durack, PJ. (2016) 2020. “CMIP6_CVs.” Python. WCRP-CMIP. https://github.com/WCRP-CMIP/CMIP6_CVs.

Eyring, Veronika, Sandrine Bony, Gerald A. Meehl, Catherine A. Senior, Bjorn Stevens, Ronald J. Stouffer, and Karl E. Taylor. 2016. “Overview of the Coupled Model Intercomparison Project Phase 6 (CMIP6) Experimental Design and Organization.” *Geoscientific Model Development* 9 (5): 1937–58. https://doi.org/10.5194/gmd-9-1937-2016.

Fisher, Rebecca, Shaun K. Wilson, Tsai M. Sin, Ai C. Lee, and Tim J. Langlois. 2018. “A Simple Function for Full-Subsets Multiple Regression in Ecology with R.” *Ecology and Evolution* 8 (12): 6104–13. https://doi.org/10.1002/ece3.4134.

Hastie, Trevor, and Robert Tibshirani. 1986. “Generalized Additive Models.” *Statistical Science* 1 (3): 297–310.

Lobell, David B., Marianne Bänziger, Cosmos Magorokosho, and Bindiganavile Vivek. 2011. “Nonlinear Heat Effects on African Maize as Evidenced by Historical Yield Trials.” *Nature Climate Change* 1 (1): 42–45. https://doi.org/10.1038/nclimate1043.

Lobell, David B., and Marshall B. Burke. 2010. “On the Use of Statistical Models to Predict Crop Yield Responses to Climate Change.” *Agricultural and Forest Meteorology* 150 (11): 1443–52. https://doi.org/10.1016/j.agrformet.2010.07.008.

Monfreda, Chad, Navin Ramankutty, and Jonathan A. Foley. 2008. “Farming the Planet: 2. Geographic Distribution of Crop Areas, Yields, Physiological Types, and Net Primary Production in the Year 2000.” *Global Biogeochemical Cycles* 22 (1). https://doi.org/10.1029/2007GB002947.

Moore, Frances C., and David B. Lobell. 2014. “Adaptation Potential of European Agriculture in Response to Climate Change.” *Nature Climate Change* 4 (7): 610–14. https://doi.org/10.1038/nclimate2228.

Muñoz-Sabater, Joaquín, Emanuel Dutra, Anna Agustí-Panareda, Clément Albergel, Gabriele Arduini, Gianpaolo Balsamo, Souhail Boussetta, et al. 2021. “ERA5-Land: A State-of-the-Art Global Reanalysis Dataset for Land Applications.” *Earth System Science Data* 13 (9): 4349–83. https://doi.org/10.5194/essd-13-4349-2021.

Osborne, T M, and T R Wheeler. 2013. “Evidence for a Climate Signal in Trends of Global Crop Yield Variability over the Past 50 Years.” *Environmental Research Letters* 8 (2): 024001. https://doi.org/10.1088/1748-9326/8/2/024001.

R Core Team. 2021. “R: A Language and Environment for Statistical Computing.” Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

Ray, Deepak K., James S. Gerber, Graham K. MacDonald, and Paul C. West. 2015. “Climate Variation Explains a Third of Global Crop Yield Variability.” *Nature Communications* 6 (1): 5989. https://doi.org/10.1038/ncomms6989.

Schlenker, Wolfram, and Michael J. Roberts. 2009. “Nonlinear Temperature Effects Indicate Severe Damages to U.S. Crop Yields under Climate Change.” *Proceedings of the National Academy of Sciences* 106 (37): 15594–98. https://doi.org/10.1073/pnas.0906865106.

Urban, Daniel, Michael J. Roberts, Wolfram Schlenker, and David B. Lobell. 2012. “Projected Temperature Changes Indicate Significant Increase in Interannual Variability of U.S. Maize Yields: A Letter.” *Climatic Change* 112 (2): 525–33. https://doi.org/10.1007/s10584-012-0428-2.

Annex C – Business impact and adaptations

Agri-climatic modelling

Potato

Alam, Mohammed Z., Derek H. Lynch, Mehdi Sharifi, David L. Burton, and Andrew M. Hammermeister. 2016. "The Effect of Green Manure and Organic Amendments on Potato Yield, Nitrogen Uptake and Soil Mineral Nitrogen." *Biological Agriculture & Horticulture* 32 (4): 221–36. https://doi.org/10.1080/01448765.2015.1133319.

Autrique, A., and M. J. Potts. 1987. "The Influence of Mixed Cropping on the Control of Potato Bacterial Wilt (Pseudomonas Solanacearum)." *Annals of Applied Biology* 111 (1): 125–33. https://doi.org/10.1111/j.1744-7348.1987.tb01439.x.

Badr, M. A., S. D. Abou Hussein, W. A. El-Tohamy, and N. Gruda. 2010. "Efficiency of Subsurface Drip Irrigation for Potato Production Under Different Dry Stress Conditions." *Gesunde Pflanzen* 62 (2): 63–70. https://doi.org/10.1007/s10343-010-0222-x.

Battilani, A., C.R. Jensen, F. Liu, F. Plauborg, M.N. Andersen, and D. Solimando. 2014. "Partial Root-Zone Drying (PRD) Feasibility on Potato in a Sub-Humid Climate." *VII International Symposium on Irrigation of Horticultural Crops* 1038: 495–502. https://doi.org/10.17660/ActaHortic.2014.1038.61.

Brar, A. S., G. S. Buttar, H. S. Thind, and K. B. Singh. 2019. "Improvement of Water Productivity, Economics and Energetics of Potato through Straw Mulching and Irrigation Scheduling in Indian Punjab." *Potato Research* 62 (4): 465–84. https://doi.org/10.1007/s11540-019-9423-6.

Burgers, M. S., and P. C. Nel. 1984. "Potato Irrigation Scheduling and Straw Mulching." *South African Journal of Plant and Soil* 1 (4): 111–16. https://doi.org/10.1080/02571862.1984.10634123.

Campos, Hugo, and Oscar Ortiz, eds. 2020. *The Potato Crop: Its Agricultural, Nutritional and Social Contribution to Humankind*. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-28683-5.

Chang, Lei, Fanxiang Han, Shouxi Chai, Hongbo Cheng, Delong Yang, and Yuzhang Chen. 2020. "Straw Strip Mulching Affects Soil Moisture and Temperature for Potato Yield in Semiarid Regions." *Agronomy Journal* 112 (2): 1126–39. https://doi.org/10.1002/agj2.20103.

Department of Agricultural Economics and Management, Faculty of Agriculture University of Swaziland, Kibirige Douglas, Chiguware Tendai, and Masika J Patrick. 2014. "Estimating Enterprise Budgets of Selected Vegetable Grown by Small-Scale Commercial and Subsistence Farms in the Eastern Cape Province of South Africa." *IOSR Journal of Agriculture and Veterinary Science* 7 (12): 60–70. https://doi.org/10.9790/2380-071226070.

Dvořák, Petr, Jaroslav Tomášek, Perla Kuchtová, Karel Hamouz, Jana Hajšlová, and Věra Schulzová. 2012. "Effect of Mulching Materials on Potato Production in Different Soil-Climatic Conditions." *Romanian Agricultural Research* 29 (201–209).

Erdem, Tolga, Yesim Erdem, Halim Orta, and Hakan Okursoy. 2006. "Water-Yield Relationships of Potato under Different Irrigation Methods and Regimens." *Scientia Agricola* 63 (June): 226–31. https://doi.org/10.1590/S0103-90162006000300003.

Haverkort, A. J., A. C. Franke, F. A. Engelbrecht, and J. M. Steyn. 2013. "Climate Change and Potato Production in Contrasting South African Agro-Ecosystems 1. Effects on Land and Water Use Efficiencies." *Potato Research* 56 (1): 31–50. https://doi.org/10.1007/s11540-013-9230-4.

Hu, Qi, Ning Yang, Feifei Pan, Xuebiao Pan, Xiaoxiao Wang, and Pengyu Yang. 2017. "Adjusting Sowing Dates Improved Potato Adaptation to Climate Change in Semiarid Region, China." *Sustainability* 9 (4): 615. https://doi.org/10.3390/su9040615.

Hue, D.T., P.J. Batt, I. McPharlin, and P. Dawson. 2009. "The Economic Impact on Smallholder Potato Farmers in the Red River Delta, Vietnam, from the Use of Superior Quality Seed." *Acta Horticulturae*, no. 809 (January): 171–80. https://doi.org/10.17660/ActaHortic.2009.809.16.

Jindo, Keiji, Albartus Evenhuis, Corné Kempenaar, Cláudia Pombo Sudré, Xiaoxiu Zhan, Misghina Goitom Teklu, and Geert Kessel. 2021. "Review: Holistic Pest Management against Early Blight Disease towards Sustainable Agriculture." *Pest Management Science* 77 (9): 3871–80. https://doi.org/10.1002/ps.6320.

Jovanovic, Zorica, Radmila Stikic, Biljana Vucelic-Radovic, Milena Paukovic, Zoran Brocic, Gordana Matovic, Sead Rovcanin, and Mirjana Mojevic. 2010. "Partial Root-Zone Drying Increases WUE, N and Antioxidant Content in Field Potatoes." *European Journal of Agronomy* 33 (2): 124–31. https://doi.org/10.1016/j.eja.2010.04.003.

Kibirige, Douglas, Chiguware Tendai, and Patrick Masika. 2014. "Estimating Enterprise Budgets of Selected Vegetable Grown by Small-Scale Commercial and Subsistence Farms in the Eastern Cape Province of Egypt." *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)* 7: 60–70. https://doi.org/10.9790/2380-071226070.

Kittipadakul, Piya, Boonsri Jaipeng, Anthony Slater, Walter Stevenson, and Shelley Jansky. 2016. "Potato Production in Thailand." *American Journal of Potato Research* 93 (4): 380–85. https://doi.org/10.1007/s12230-016-9511-y.

Knight, FH, J Conrad, and N Helme. 2007. "Biodiversity Best Practice Guidelines for Potato Production in the Sandveld." Report submitted to Potato South Africa and CapeNature.

Kromann, Peter, Willmer G. Pérez, Arturo Taipe, Elmar Schulte-Geldermann, Buddhi Prakash Sharma, Jorge L. Andrade-Piedra, and Gregory A. Forbes. 2012. "Use of Phosphonate to Manage Foliar Potato Late Blight in Developing Countries." *Plant Disease* 96 (7): 1008–15. https://doi.org/10.1094/PDIS-12-11-1029-RE.

Lacey, Lawrence A., Jürgen Kroschel, Steven P. Arthurs, and Francisco De La Rosa. 2010. "Microbial Control of the Potato Tuber Moth Phthorimaea Operculella (Lepidoptera: Gelechiidae)." *Revista Colombiana de Entomología* 36 (2): 181–89.

Larraín S, Patricia, Michel Guillon, Julio Kalazich, Fernando Graña, and Claudia Vásquez. 2009. "Effect of Pheromone Trap Density on Mass Trapping of Male Potato Tuber Moth Phthorimaea Operculella (Zeller) (Lepidoptera: Gelechiidae), and Level of Damage on Potato Tubers." *Chilean Journal of Agricultural Research* 69 (2): 281–85. https://doi.org/10.4067/S0718-58392009000200018.

Lemaga, Berga, R. Kanzikwera, R. Kakuhenzire, J. J. Hakiza, and G. Manzi. 2001. "The Effect of Crop Rotation on Bacterial Wilt Incidence and Potato Tuber Yield." *African Crop Science Journal* 9 (1). https://doi.org/10.4314/acsj.v9i1.27647.

Li, Qiang, Hongbing Li, Li Zhang, Suiqi Zhang, and Yinglong Chen. 2018. "Mulching Improves Yield and Water-Use Efficiency of Potato Cropping in China: A Meta-Analysis." *Field Crops Research* 221 (May): 50–60. https://doi.org/10.1016/j.fcr.2018.02.017.

Lindi, Samuel. 2018. "Integrated Effect of Different Mulching and Furrow Irrigation Techniques on Potato (Solanum Tuberosum L) Yield and Water Productivity at Kulumsa, Ethiopia." *Irrigation Water Management*, January. https://www.academia.edu/40161265/Integrated_Effect_of_Different_Mulching_and_Furrow_Irrigation_Techniques_on_Potato_Solanum_tuberosum_L_Yield_and_Water_Productivity_at_Kulumsa_Ethiopia.

Mujica, Norma, and Jürgen Kroschel. 2019. "Ecological, Economic, and Environmental Assessments of Integrated Pest Management in Potato: A Case Study from the Cañete Valley, Peru." *Food and Energy Security* 8 (1): e00153. https://doi.org/10.1002/fes3.153.

Nyankanga, R., M. Njogu, J. Muthomi, and M. Olanya. 2012. "Efficacy of Fungicide Combinations, Phosphoric Acid and Plant Extract from Stinging Nettle on Potato Late Blight Management and Tuber Yield." *Archives of Phytopathology and Plant Protection* 45 (12): 1449–63. https://doi.org/10.1080/03235408.2012.676818.

"Promoting Risk Mitigation Measures for Climate Change Adaptation (Surokkha)." 2020. Syngenta Foundation for Sustainable Agriculture (SFSA Bangladesh).

Ridoutt, Bradley, Peerasak Sanguansri, Lawrence Bonney, Steven Crimp, Gemma Lewis, and Lilly Lim-Camacho. 2016. "Climate Change Adaptation Strategy in the Food Industry—Insights from Product Carbon and Water Footprints." *Climate* 4 (2): 26. https://doi.org/10.3390/cli4020026.

sagrainmag.co.za. 2022. "Finding the Best Cropping Sequences for the Eastern Free State - SA Grain." August 2, 2022. https://sagrainmag.co.za/2022/08/02/finding-the-best-cropping-sequences-for-the-eastern-free-state/, https://sagrainmag.co.za/2022/08/02/finding-the-best-cropping-sequences-for-the-eastern-free-state/.

Sarangi, Sukanta K., B. Maji, P. C. Sharma, S. Digar, K. K. Mahanta, D. Burman, U. K. Mandal, S. Mandal, and M. Mainuddin. 2021. "Potato (Solanum Tuberosum L.) Cultivation by Zero Tillage and Paddy Straw Mulching in the Saline Soils of the Ganges Delta." *Potato Research* 64 (2): 277–305. https://doi.org/10.1007/s11540-020-09478-6.

Scott, G. J., and V. Suarez. 2012. "The Rise of Asia as the Centre of Global Potato Production and Some Implications for Industry." *Potato Journal*. https://cgspace.cgiar.org/handle/10568/66527.

Singh, B. P., R. K. Rana, and M. Kumar. 2011. "Technology Infusion through Contact Farming : Success Story of Potato." *Indian Horticulture*, 49–51.

Uwamahoro, Florence, Anna Berlin, Charles Bucagu, Helena Bylund, and Jonathan Yuen. 2018. "Potato Bacterial Wilt in Rwanda: Occurrence, Risk Factors, Farmers' Knowledge and Attitudes." *Food Security* 10 (5): 1221–35. https://doi.org/10.1007/s12571-018-0834-z.

Vaibhav K. Singh, Shailbala, and V.S. Pundhir. 2012. "Forecasting Models: An Effective Tool for Potato Late Blight Management." https://doi.org/10.13140/RG.2.1.1856.9369.

Wang, Chun-ling, Shuang-he Shen, Shu-yu Zhang, Qiao-zhen Li, and Yu-bi Yao. 2015. "Adaptation of Potato Production to Climate Change by Optimizing Sowing Date in the Loess Plateau of Central Gansu, China." *Journal of Integrative Agriculture* 14 (2): 398–409. https://doi.org/10.1016/S2095-3119(14)60783-8.

Wasilewska-Nascimento, Beata, Dominika Boguszewska-Mańkowska, and Krystyna Zarzyńska. 2020. "Challenges in the Production of High-Quality Seed Potatoes (Solanum Tuberosum L.) in the Tropics and Subtropics." *Agronomy* 10 (2): 260. https://doi.org/10.3390/agronomy10020260.

Weintraub, Phyllis G., and A. Rami Horowitz. 1996. "Spatial and Diel Activity of the Pea Leafminer (Diptera: Agromyzidae) in Potatoes, Solanum Tuberosum." *Environmental Entomology* 25 (4): 722–26. https://doi.org/10.1093/ee/25.4.722.

Wustman, Romke, Anton Haverkort, Xiaoyong Zhang, and Geetika Rathee. 2011. "An Overview of the Potato Sector in India and Prospects of Indo&Dutch Cooperation." Praktijkonderzoek Plant & Omgeving (Applied Plant Research), part of Wageningen UR Business Unit Arable Farming, Multifunctional Agriculture and Field Production of Vegetables.

Yuliar, Yanetri Asi Nion, and Koki Toyota. 2015. "Recent Trends in Control Methods for Bacterial Wilt Diseases Caused by Ralstonia Solanacearum." *Microbes and Environments* 30 (1): 1–11. https://doi.org/10.1264/jsme2.ME14144.

Supplier sourced crops

Oats

Chinnici, M.F. and Peterson, D.M. (1979) 'Temperature and Drought Effects on Blast and Other Characteristics in Developing Oats 1', *Crop Science*, 19(6), pp. 893–897.

Djaman, K. *et al.* (2018) 'Evapotranspiration, Grain Yield, and Water Productivity of Spring Oat (Avena sativa L.) under Semiarid Climate', *Agricultural Sciences*, 09(09). Available at: https://doi.org/10.4236/as.2018.99083.

Elarab, M. *et al.* (2015) 'Estimating chlorophyll with thermal and broadband multispectral high resolution imagery from an unmanned aerial system using relevance vector machines for precision agriculture', *International Journal of Applied Earth Observation and Geoinformation*, 43, pp. 32–42. Available at: https://doi.org/10.1016/j.jag.2015.03.017.

Farkas, Z. *et al.* (2021) 'CO2 Responses of Winter Wheat, Barley and Oat Cultivars under Optimum and Limited Irrigation', *Sustainability*, 13(17). Available at: https://doi.org/10.3390/su13179931.

Flores-Juárez, D.J. *et al.* (2020) 'Inoculation of forage oats with arbuscular mycorrhizal fungi', *Revista Mexicana de Ciencias Agrícolas*, 11(SPE24), pp. 191–199. Available at: https://doi.org/10.29312/remexca.v0i24.2369.

Fonteyne, S. *et al.* (2019) 'Conservation agriculture improves long-term yield and soil quality in irrigated maize-oats rotation', *Agronomy*, 9(12), p. 845.

Gusta, L.V. and O'connor, B.J. (1987) 'Frost tolerance of wheat, oats, barley, canola and mustard and the role of ice-nucleating bacteria', *Canadian Journal of Plant Science*, 67(4), pp. 1155–1165.

Hetherington, S.D. and Auld, B.A. (2001) 'Host range of Drechslera avenacea, a fungus with potential for use as a biological control agent of Avena fatua', *Australasian Plant Pathology*, 30(3), p. 205. Available at: https://doi.org/10.1071/AP01020.

Ivanovna, M.K. *et al.* (2018) 'Moisture content of oats in different methods of soil processing and irrigation treatment on the frozen soils of Yakutia of the Russian Federation', *International Agricultural Journal*, 3, Article 3.

Khairullina, A. *et al.* (2023) 'Biocontrol Effect of Clonostachys rosea on Fusarium graminearum Infection and Mycotoxin Detoxification in Oat (Avena sativa', *Plants*, 12(3), p. 500.

Macedo-Cruz, A. *et al.* (2011) 'Digital image sensor-based assessment of the status of oat (Avena sativa L.) crops after frost damage', *Sensors*, 11(6), pp. 6015–6036.

Martínez-López, J.A. *et al.* (2022) 'Improving the Sustainability and Profitability of Oat and Garlic Crops in a Mediterranean Agro-Ecosystem under Water-Scarce Conditions', *Agronomy*, 12(8).

McCosh J. *et al.* (2017) *Upscaling of rainwater harvesting and conservation on communal crop and rangeland through integrated crop and livestock production for increased water use productivity*. Available at: https://www.wrc.org.za/Wp-Content/Uploads/Mdocs/Tt%20712-17%20web.Pdf.

Mushtaq, A. and Mehfuza, H. (2014) 'A review on oat (Avena sativa L.) as a dual-purpose crop', *Scientific Research and Essays*, 9(4), pp. 52–59.

Mut, Z., Akay, H. and Erbaş Köse, Ö.D. (2018) 'Grain yield, quality traits and grain yield stability of local oat cultivars', *Journal of soil science and plant nutrition*, 18(1), pp. 269–281.

Neumann, A., Schmidtke, K. and Rauber, R. (2007) 'Effects of crop density and tillage system on grain yield and N uptake from soil and atmosphere of sole and intercropped pea and oat', *Field Crops Research*, 100(2–3), pp. 285–293. Available at: https://doi.org/10.1016/j.fcr.2006.08.001.

Oats Production in the Summer Rainfall Region (no date) *Sensako*. Available at: https://www.sensako.co.za/NewsArticle.aspx?id=32 (Accessed: 7 April 2023).

Reynolds, S.G. and Suttie, J.M. (eds) (2004) *Fodder Oats: a world overview*. Food and Agriculture Organization of the United Nations.

Sánchez-Martín, J. *et al.* (2016) 'Higher rust resistance and similar yield of oat landraces versus cultivars under high temperature and drought', *Agronomy for Sustainable Development*, 37(1), p. 3. Available at: https://doi.org/10.1007/s13593-016-0407-5.

Söderström, M. *et al.* (2015) 'Modelling within-field variations in deoxynivalenol (DON) content in oats using proximal and remote sensing', *Precision Agriculture*, 16(1), pp. 1–14. Available at: https://doi.org/10.1007/s11119-014-9373-6.

Sojka, R.E. *et al.* (1997) 'Subsoiling and surface tillage effects on soil physical properties and forage oat stand and yield', *Soil and Tillage Research*, 40(3–4), pp. 125–144. Available at: https://doi.org/10.1016/S0167-1987(96)01075-6.

Solano-Sosa, M.Z. *et al.* (2022) 'Forage evaluation based on oat on scenarios of intercrop and organic nutrition', *Agro Productividad* [Preprint]. Available at: https://doi.org/10.32854/agrop.v15i7.2313.

Tian, L. *et al.* (2022) 'Effects of strip cropping with reducing row spacing and super absorbent polymer on yield and water productivity of oat (Avena sativa L.) under drip irrigation in Inner Mongolia, China', *Scientific Reports*, 12, p. 10 1038 41598-022-15418-.

V., H. *et al.* (2016) *Oat forage. Feedipedia, a programme by INRAE, CIRAD, AFZ and FAO*. Available at: https://www.feedipedia.org/node/500.

Xie, H. *et al.* (2021) 'Important physiological changes due to drought stress on oat', *Frontiers in Ecology and Evolution*, 271(oats).

Xie, Hongying *et al.* (2021) 'Important Physiological Changes Due to Drought Stress on Oat', *Frontiers in Ecology and Evolution*, 9. 644726, p. 10 3389 2021 644726.

Xu, C. (2012) 'A study on growth characteristics of different cultivars of oat (Avena sativa) in alpine region', *Acta Prataculturae Sinica*, 21(2), pp. 280–285.

Zhang, Y. *et al.* (2019) 'Optimized sowing time windows mitigate climate risks for oats production under cool semi-arid growing conditions', *Agricultural and Forest Meteorology*, 266, pp. 184–197.

Zorovski, P. (2021) 'Development, Productivity and Quality of Naked Oat Grain After Treatment with Biofertilizer in the Conditions of Organic Agriculture', *Scientific Papers Agronomy*, 64(1).

Corn

Abreu, V.M. de *et al.* (2014) 'Physiological performance and expression of isozymes in maize seeds subjected to water stress', *Journal of Seed Science*, 36, pp. 40–47.

Abreu, V.M. de *et al.* (2019) 'Combining Ability and Heterosis of Maize Genotypes under Water Stress during Seed Germination and Seedling Emergence', *Crop Science*, 59(1), pp. 33–43. Available at: https://doi.org/10.2135/cropsci2018.03.0161.

Abreu, V.M.D. *et al.* (2017) 'Indirect Selection for Drought Tolerance in Maize Through Agronomic and Seeds Traits', *Revista Brasileira de Milho e Sorgo*, 16(2). Available at: https://doi.org/10.18512/1980-6477/rbms.v16n2p287-296.

Altieri, M.A., Funes-Monzote, F.R. and Petersen, P. (2012) 'Agroecologically efficient agricultural systems for smallholder farmers: Contributions to food sovereignty', *Agronomy for Sustainable Development*, 32(1), pp. 1–13. Available at: https://doi.org/10.1007/s13593-011-0065-6.

Ananthi, T. and Amanullah, M.M. (2017) 'A Review On Maize- Legume Intercropping For Enhancing The Productivity And Soil Fertility For Sustainable Agriculture', *Advances in Environmental Biology*, 11(5), pp. 49–63.

Araus, J.L., Serret, M.D. and Edmeades, G. (2012) 'Phenotyping maize for adaptation to drought', *Frontiers in Physiology*, 3. Available at: https://www.frontiersin.org/articles/10.3389/fphys.2012.00305.

Awika, J.M. (2011) 'Major cereal grains production and use around the world', in *Advances in cereal science: implications to food processing and health promotion*. American Chemical Society, pp. 1–13.

Balusamy, A., Udayasoorian, C. and Jayabalakrishnan, R. (2019) 'Effect of Subsurface Drainage System on Maize Growth, Yield and Soil Quality', *International Journal of Current Microbiology and Applied Sciences*, 8(02), pp. 1206–1215. Available at: https://doi.org/10.20546/ijcmas.2019.802.140.

Barutcular, C. *et al.* (2016) 'Evaluation of maize hybrids to terminal drought stress tolerance by defining drought indices', *Journal of Experimental Biology and Agricultural Sciences*, 4(6), pp. 610–616. Available at: https://doi.org/10.18006/2016.4(Issue6).610.616.

Baum, M.E., Archontoulis, S.V. and Licht, M.A. (2019) 'Planting Date, Hybrid Maturity, and Weather Effects on Maize Yield and Crop Stage', *Agronomy Journal*, 111(1), pp. 303–313. Available at: https://doi.org/10.2134/agronj2018.04.0297.

Bolaños, J. and Edmeades, G.O. (1993) 'Eight cycles of selection for drought tolerance in lowland tropical maize. I. Responses in grain yield, biomass, and radiation utilization', *Field Crops Research*, 31(3–4), pp. 233–252.

Botha, J. *et al.* (2015) 'Rainwater harvesting and conservation tillage increase maize yields in South Africa', *Water Resources and Rural Development*, 6, p. 10 1016 2015 04 001.

Bowles, T.M. *et al.* (2020) 'Long-Term Evidence Shows that Crop-Rotation Diversification Increases Agricultural Resilience to Adverse Growing Conditions in North America', *One Earth*, 2(3), pp. 284–293. Available at: https://doi.org/10.1016/j.oneear.2020.02.007.

Butler, E.E., Mueller, N.D. and Huybers, P. (2018) 'Peculiarly pleasant weather for US maize', *Proceedings of the National Academy of Sciences*, 115(47), pp. 11935–11940.

Camp, C.R. *et al.* (2001) 'Irrigation and nitrogen management with a site-specific center pivot', in *Proc. of the Third Europ. Conf. on Prec. Agric*. Montpellier, France, Agro Montpellier.

Camp, C.R., Bauer, P.J. and Busscher, W.J. (1999) 'Evaluation of no-tillage crop production with subsurface drip irrigation on soils with compacted layers', *Transactions of the ASAE*, 42(4), p. 911.

Cardozo, N.P., Oliveira Bordonal, R. and Scala, N. (2018) 'Sustainable intensification of sugarcane production under irrigation systems, considering climate interactions and agricultural efficiency', *Journal of Cleaner Production*, 204, pp. 861–871. Available at: https://doi.org/10.1016/j.jclepro.2018.09.004.

Chen, B., Gramig, B.M. and Yun, S.D. (2021) 'Conservation tillage mitigates drought-induced soybean yield losses in the US Corn Belt', *Q Open*, 1(1), p. qoab007. Available at: https://doi.org/10.1093/qopen/qoab007.

Chen, G. and Weil, R.R. (2011) 'Root growth and yield of maize as affected by soil compaction and cover crops', *Soil and Tillage Research*, 117, pp. 17–27.

Coughenour, C.M. and Chamala, S. (eds) (2000) *Conservation Tillage and Cropping Innovation*. Iowa State University Press. Available at: https://doi.org/10.1002/9780470290149.

Dahal, S. *et al.* (2020) 'Degradability of biodegradable soil moisture sensor components and their effect on maize (Zea mays L.) growth', *Sensors*, 20(21), p. 6154.

Easson, D.L. and Fearnehough, W. (2000) 'Effects of plastic mulch, sowing date and cultivar on the yield and maturity of forage maize grown under marginal climatic conditions in Northern Ireland', *Grass and Forage Science*, 55(3), pp. 221–231.

El-Husseini, M.M., El-Heneidy, A.H. and Awadallah, K.T. (2018) 'Natural enemies associated with some economic pests in Egyptian agro-ecosystems', *Egyptian Journal of Biological Pest Control*, 28(1), p. 78. Available at: https://doi.org/10.1186/s41938-018-0081-9.

Elmetwalli, A.M.H. (2008) 'Remote Sensing as a Precision Farming Tool in the Nile Valley', *Egypt* [Preprint]. Available at: http://dspace.stir.ac.uk/handle/1893/844.

El-Sappagh, I.A., Khalil, A.E.H. and EL-AMIR, S. (2022) 'Efficacy of Some Synthetic Insecticides and Botanical oils against Fall Armyworm, Spodoptera frugiperda (Lepidoptera: Noctuidae', *on Maize in Egypt. Egyptian Academic Journal of Biological Sciences, F. Toxicology & Pest Control*, 14(1), pp. 99–107.

Eneji, A.E. *et al.* (2008) 'Growth and Nutrient Use in Four Grasses Under Drought Stress as Mediated by Silicon Fertilizers', *Journal of Plant Nutrition*, 31(2), pp. 355–365. Available at: https://doi.org/10.1080/01904160801894913.

Ferreira, F. (no date) *Change in cropping practices under centre pivot irrigation*, *Change in cropping practices under centre pivot irrigation*. Available at: https://www.grainsa.co.za/change-in-cropping-practices-under-centre-pivot-irrigation (Accessed: 5 April 2023).

Filintas, A. (2021) 'Soil moisture depletion modelling using a TDR multi-sensor system, GIS, soil analyzes, precision agriculture and remote sensing on maize for improved irrigation-fertilization decisions', *Engineering Proceedings*, 9(1), p. 36.

Flores-Sanchez, D. *et al.* (2013) 'Exploring maize-legume intercropping systems in Southwest Mexico', *Agroecology and Sustainable Food Systems*, 37(7), pp. 739–761.

Goswami, J. *et al.* (2019) 'RAPID IDENTIFICATION OF ABIOTIC STRESS (FROST) IN *IN-FILED* MAIZE CROP USING UAV REMOTE SENSING', *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, XLII-3-W6, pp. 467–471. Available at: https://doi.org/10.5194/isprs-archives-XLII-3-W6-467-2019.

Grainsa and RhinoReloaded (no date) *Low-cost drought and low nitrogen-tolerant maize hybrids for food security in South Africa*, *Low-cost drought and low nitrogen-tolerant maize hybrids for food security in South Africa*. Available at: https://www.grainsa.co.za/low-cost-drought-and-low-nitrogen-tolerant-maize-hybrids-for-food-security-in-south-africa (Accessed: 7 April 2023).

Grewal, S.S. *et al.* (1989) 'Rainwater harvesting for the management of agricultural droughts in the foothills of northern India', *Agricultural Water Management*, 16(4), pp. 309–322. Available at: https://doi.org/10.1016/0378-3774(89)90028-0.

Hallauer, A.R. and Carena, M.J. (2009) 'Maize', in *Cereals*. New York, NY: Springer, pp. 3–98.

Hillnhütter, C. *et al.* (2011) 'Remote sensing to detect plant stress induced by Heterodera schachtii and Rhizoctonia solani in sugar beet fields', *Field Crops Research*, 122(1), pp. 70–77. Available at: https://doi.org/10.1016/j.fcr.2011.02.007.

Hörbe, T.A.N. *et al.* (2013) 'Optimization of corn plant population according to management zones in Southern Brazil', *Precision Agriculture*, 14(4), pp. 450–465. Available at: https://doi.org/10.1007/s11119-013-9308-7.

Huynh, H.T. *et al.* (2019) 'Influences of soil tillage, irrigation and crop rotation on maize biomass yield in a 9-year field study in Müncheberg, Germany', *Field Crops Research*, 241, p. 107565. Available at: https://doi.org/10.1016/j.fcr.2019.107565.

Idowu, O.J. *et al.* (2019) 'Short-term conservation tillage effects on corn silage yield and soil quality in an irrigated, arid agroecosystem', *Agronomy*, 9(8), p. 455.

Jat, H.S. *et al.* (2019) 'Re-designing irrigated intensive cereal systems through bundling precision agronomic innovations for transitioning towards agricultural sustainability in North-West India', *Scientific Reports*, 9(1). Available at: https://doi.org/10.1038/s41598-019-54086-1.

Jat, R.S. and Ahlawat, I.P.S. (2006) 'Direct and Residual Effect of Vermicompost, Biofertilizers and Phosphorus on Soil Nutrient Dynamics and Productivity of Chickpea-Fodder Maize Sequence', *Journal of Sustainable Agriculture*, 28(1), pp. 41–54. Available at: https://doi.org/10.1300/J064v28n01_05.

Jeffries, G.R. *et al.* (2020) 'Mapping sub-field maize yields in Nebraska, USA by combining remote sensing imagery, crop simulation models, and machine learning', *Precision Agriculture*, 21(3), pp. 678–694.

Jug, D. *et al.* (2007) 'Influence of different soil tillage systems on yield of maize', *Cereal Research Communications*, 35(2), pp. 557–560.

Lamm, F.R. and Trooien, T.P. (2003) 'Subsurface drip irrigation for corn production: A review of 10 years of research in Kansas', *Irrigation Science*, 22(3–4), pp. 195–200. Available at: https://doi.org/10.1007/s00271-003-0085-3.

Linker, R. and Kisekka, I. (2017) 'Model-Based Deficit Irrigation of Maize in Kansas', *Transactions of the ASABE*, 60(6), pp. 2011–2022. Available at: https://doi.org/10.13031/trans.12341.

Lobell, D.B. and Asner, G.P. (2003) 'Climate and management contributions to recent trends in US agricultural yields', *Science*, 299(5609), pp. 1032–1032.

Lobell, D.B., Deines, J.M. and Tommaso, S.D. (2020) 'Changes in the drought sensitivity of US maize yields', *Nature Food*, 1(11), pp. 729–735.

Lourdes Corrêa Figueiredo, M. *et al.* (2015) 'Biological control with Trichogramma pretiosum increases organic maize productivity by 19.4%', *Agronomy for Sustainable Development*, 35(3), pp. 1175–1183. Available at: https://doi.org/10.1007/s13593-015-0312-3.

Maia, S.M.F. *et al.* (2019) 'Combined effect of intercropping and minimum tillage on soil carbon sequestration and organic matter pools in the semiarid region of Brazil', *Soil Research*, 57(3), pp. 266–275. Available at: https://doi.org/10.1071/SR17336.

Maitra, S. *et al.* (2020) *Potential and Advantages of Maize-Legume Intercropping System*, *Maize - Production and Use*. IntechOpen. Available at: https://doi.org/10.5772/intechopen.91722.

Martins, M.A. *et al.* (2018) 'Improving drought management in the Brazilian semiarid through crop forecasting', *Agricultural Systems*, 160, pp. 21–30. Available at: https://doi.org/10.1016/j.agsy.2017.11.002.

Martins, M.A., Tomasella, J. and Dias, C.G. (2019) 'Maize yield under a changing climate in the Brazilian Northeast: Impacts and adaptation', *Agricultural Water Management*, 216, pp. 339–350. Available at: https://doi.org/10.1016/j.agwat.2019.02.011.

Midwest Cover Crop tool has been updated to better help farmers (2020) *Cover Crops*. Available at: https://www.canr.msu.edu/news/midwest-cover-crop-tool-has-been-updated-to-better-help-farmers (Accessed: 7 April 2023).

Moeletsi, M. (2017) 'Mapping of Maize Growing Period over the Free State Province of South Africa: Heat Units Approach', *Advances in Meteorology*, pp. 1–11.

Mohammed, A.T. and Irmak, S. (2022) 'Maize response to irrigation and nitrogen under center pivot, subsurface drip and furrow irrigation: Water productivity, basal evapotranspiration and yield response factors', *Agricultural Water Management*, 271, p. 107795. Available at: https://doi.org/10.1016/j.agwat.2022.107795.

Moitzi, G., Sattler, E. and Wagentristl, H. (2021) 'Effect of cover crop, slurry application with different loads and tire inflation pressures on tire track depth, soil penetration resistance and maize yield', *Agriculture*, 11(7), p. 641.

Moscardini, V.F. *et al.* (2020) 'Efficacy of Bacillus thuringiensis (Bt) maize expressing Cry1F, Cry1A.105, Cry2Ab2 and Vip3Aa20 proteins to manage the fall armyworm (Lepidoptera: Noctuidae) in Brazil', *Crop Protection*, 137, p. 105269. Available at: https://doi.org/10.1016/j.cropro.2020.105269.

Muhumed, M. *et al.* (2014) 'Effects of drip irrigation frequency, fertilizer sources and their interaction on the dry matter and yield components of sweet corn', *AJCS, [online*, 8(2), pp. 223–231.

Musokwa, M., Mafongoya, P. and Chirwa, P. (2020) 'Monitoring of Soil Water Content in Maize Rotated with Pigeonpea Fallows in South Africa', *Water*, 12, p. 2761 10 3390 12102761.

Naghavi, M., Pour-Aboughadareh, A. and Marouf, K. (2013) 'Evaluation of Drought Tolerance Indices for Screening Some of Corn (Zea mays L.) Cultivars under Environmental Conditions', *Notulae Scientia Biologicae*, 5, pp. 388–393. Available at: https://doi.org/10.15835/nsb.5.3.9049.

Nemadodzi, E. (2021) *Better results with legumes in rotation with maize*. Available at: https://sagrainmag.co.za/2021/07/12/better-results-with-legumes-in-rotation-with-maize/.

Nóia Júnior, R. de S. and Sentelhas, P.C. (2019) 'Soybean-maize succession in Brazil: Impacts of sowing dates on climate variability, yields and economic profitability', *European Journal of Agronomy*, 103, pp. 140–151. Available at: https://doi.org/10.1016/j.eja.2018.12.008.

Oliver, M.A. (2013) 'Precision agriculture and geostatistics: How to manage agriculture more exactly', *Significance*, 10(2), pp. 17–22. Available at: https://doi.org/10.1111/j.1740-9713.2013.00646.x.

Ouda, S. and Zohry, A.E.-H. (2015) 'Crop Rotation: An Approach to Save Irrigation Water under Water Scarcity in Egypt'.

Parr, M. *et al.* (2011) 'Nitrogen Delivery from Legume Cover Crops in No-Till Organic Corn Production', *Agronomy Journal*, 103(6), pp. 1578–1590. Available at: https://doi.org/10.2134/agronj2011.0007.

Pelzer, E. *et al.* (2012) 'Assessing innovative cropping systems with DEXiPM, a qualitative multi-criteria assessment tool derived from DEXi', *Ecological Indicators*, 18, pp. 171–182. Available at: https://doi.org/10.1016/j.ecolind.2011.11.019.

Penagos, D.I. *et al.* (2003) 'Effect of weeds on insect pests of maize and their natural enemies in Southern Mexico', *International Journal of Pest Management*, 49(2), pp. 155–161. Available at: https://doi.org/10.1080/0967087021000043111.

Pierre, J.F. *et al.* (2022) 'Maize legume intercropping systems in southern Mexico: A review of benefits and challenges', *Ciência Rural*, 52(11), p. 20210409. Available at: https://doi.org/10.1590/0103-8478cr20210409.

Raddy, G. *et al.* (2022) 'Effect of Precision Irrigation and Nutrient Management on Growth and Yield of Baby Corn (Zea mays L.)', *Biological Forum – An International Journal*, 14(3), pp. 1622–1629.

Ramadoss, M. *et al.* (2004) 'Water and high temperature stress effects on maize production', in *Proceedings of the 4th International Crop Science Congress*. Brisbane, Australia, pp. 45–49.

Robertson, M.J. *et al.* (2011) 'Adoption of variable rate fertiliser application in the Australian grains industry: status, issues and prospects', *Precision Agriculture*, 13(2), pp. 181–199. Available at: https://doi.org/10.1007/s11119-011-9236-3.

Salem, E.M. *et al.* (2021) 'Soil mulching and deficit irrigation effect on sustainability of nutrients availability and uptake, and productivity of maize grown in calcareous soils', *Communications in Soil Science and Plant Analysis*, 52(15), pp. 1745–1761. Available at: https://doi.org/10.1080/00103624.2021.1892733.

Samie, A.-E. *et al.* (2022) 'Effect of foliar spray by different ascorbic acid and zinc concentration on yield and yield components of maize under heat stress', *Fayoum Journal of Agricultural Research and Development*, 36(1), pp. 21–33.

Sandhu, D. and Irmak, S. (2019) 'Performance of AquaCrop model in simulating maize growth, yield, and evapotranspiration under rainfed, limited and full irrigation', *Agricultural Water Management*, 223, p. 105687. Available at: https://doi.org/10.1016/j.agwat.2019.105687.

Schlenker, W. and Roberts, M.J. (2009) 'Nonlinear temperature effects indicate severe damages to US crop yields under climate change', *Proceedings of the National Academy of sciences*, 106(37), pp. 15594–15598.

Scopel, E. *et al.* (2005) 'Impact of direct sowing mulch-based cropping systems on soil carbon, soil erosion and maize yield', *Agronomy for Sustainable Development*, 25(4), pp. 425–432. Available at: https://doi.org/10.1051/agro:2005041.

Selim, M. (2018) 'Potential role of cropping system and integrated nutrient management on nutrients uptake and utilization by maize grown in calcareous soil', *Egyptian Journal of Agronomy*, 40(3), pp. 297–312.

Shabir, M.A. *et al.* (2020) 'Egyptian Clover Green Manuring Improved Grain Nutritional Contents, Productivity and Soil Health of Spring Maize with Different Nitrogen Rates', *Communications in Soil Science and Plant Analysis*, 51(15), pp. 1969–1978. Available at: https://doi.org/10.1080/00103624.2020.1813753.

Shah, N.A. *et al.* (2012) 'Morphological and yield responses of maize (Zea mays L.) genotypes subjected to root zone excess soil moisture stress', *Plant Stress*, 6(1), pp. 59–72.

Shelton, A.M. (2012) 'Genetically engineered vegetables expressing proteins from Bacillus thuringiensis for insect resistance: Successes, disappointments, challenges and ways to move forward', *GM Crops & Food*, 3(3), pp. 175–183. Available at: https://doi.org/10.4161/gmcr.19762.

Sheoran, S. *et al.* (2022) 'Recent Advances for Drought Stress Tolerance in Maize (Zea mays L.): Present Status and Future Prospects', *Frontiers in Plant Science*, 13, p. 872566. Available at: https://doi.org/10.3389/fpls.2022.872566.

Singh, B.P. *et al.* (2020) 'Physiological characterization of maize inbred lines under moisture deficit condition', *Journal of Pharmacognosy and Phytochemistry*, 9(1), pp. 112–114.

Singh, G. *et al.* (1990) 'Effect of sowing date on requirement of growing degree days, heliothermal units and photothermal units, and phenology of winter maize (Zea mays', *Indian Journal of Agricultural Sciences*, 60(11), pp. 723–731.

Srinivasan, G. *et al.* (2004) 'Increasing productivity through genetic improvement for tolerance to drought and excess-moisture stress in maize (Zea mays L', *Water in Agriculture*, 116, pp. 227–239.

Stepanovic, S. *et al.* (2016) 'Effectiveness of flame weeding and cultivation for weed control in organic maize', *Biological Agriculture & Horticulture*, 32(1), pp. 47–62. Available at: https://doi.org/10.1080/01448765.2015.1028443.

‘The role of some agricultural practices and fertilizer type on both the incidence of stem borers infestation and corn yield in Egypt’ (2002) *Mededelingen (Rijksuniversiteit Te Gent Fakulteit van de Landbouwkundige En Toegepaste Biologische Wetenschappen*, 67(3), pp. 575–589.

Thenmozhi, S. *et al.* (2022) ‘Studies on growth, yield and water use efficiency of maize as influenced by irrigation methods and fertilizer application’, *The Pharma Innovation Journal*, p. 5.

Tolk, J.A., Howell, T.A. and Evett, S.R. (1999) ‘Effect of mulch, irrigation, and soil type on water use and yield of maize’, *Soil and Tillage Research*, 50(2), pp. 137–147.

Tsadilas, C.D. and Vakalis, P.S. (2003) ‘Economic benefit from irrigation of cotton and corn with treated wastewater’, *Water Supply*, 3(4), pp. 223–229. Available at: https://doi.org/10.2166/ws.2003.0066.

Valentín, F. *et al.* (2020) ‘Comparing evapotranspiration and yield performance of maize under sprinkler, superficial and subsurface drip irrigation in a semi-arid environment’, *Irrigation Science*, 38(1), pp. 105–115. Available at: https://doi.org/10.1007/s00271-019-00657-z.

Videnović, Ž. *et al.* (2011) ‘Long term effects of different soil tillage systems on maize (Zea mays L.) yields’, *Plant, Soil and Environment*, 57(No. 4), pp. 186–192. Available at: https://doi.org/10.17221/443/2010-PSE.

Wani, S.P. *et al.* (2001) ‘Minimizing land degradation and sustaining productivity by integrated watershed management: Adarsha Watershed, Kothapally, India’, in *Integrated Watershed Management for Land and Water Conservation and Sustainable Agricultural Production in Asia: Proceedings of the ADB-ICRISAT-IWMI Project Review and Planning Meeting*.

Wilson, D.R., Johnstone, J.V. and Salinger, M.J. (1994) ‘Maize production potential and climatic risk in the South Island of New Zealand’, *New Zealand Journal of Crop and Horticultural Science*, 22(3), pp. 321–334.

Yin, Y. *et al.* (2021) ‘Mapping the Global-Scale Maize Drought Risk Under Climate Change Based on the GEPIC-Vulnerability-Risk Model’, *International Journal of Disaster Risk Science*, 12(3), pp. 428–442. Available at: https://doi.org/10.1007/s13753-021-00349-3.

Zuhri, A.-H.A. (2005) ‘Effect of preceding winter crops and intercropping on yield, yield components and associated weeds in maize’, *Annals of Agricultural Science, Moshtohor* [Preprint].

Sugarbeet

Abd El-Mageed, T.A. *et al.* (2019) ‘A novel compost alleviate drought stress for sugar beet production grown in Cd-contaminated saline soil’, *Agricultural Water Management*, 226, p. 105831.

Abou-Elwafa, S.F., Amin, A.E.-E.A. and Eujayl, I. (2020) ‘Genetic diversity of sugar beet under heat stress and deficit irrigation’, *Agronomy Journal*, 112(5), pp. 3579–3590.

Ali, A.M., Ibrahim, S.M. and Abou-Amer, I. (2019) ‘Water deficit stress mitigation by foliar application of potassium silicate for sugar beet grown in a saline calcareous soil’, *Egyptian Journal of Soil Science*, 59(1), pp. 15–23.

Aljabri, M. *et al.* (2021) ‘Recycling of beet sugar byproducts and wastes enhances sugar beet productivity and salt redistribution in saline soils’, *Environmental Science and Pollution Research*, 28(33), pp. 45745–45755. Available at: https://doi.org/10.1007/s11356-021-13860-3.

Bardin, S.D., Huang, H.C. and Moyer, J.R. (2004) ‘Control of Pythium damping-off of sugar beet by seed treatment with crop straw powders and a biocontrol agent’, *Biological Control*, 29(3), pp. 453–460. Available at: https://doi.org/10.1016/j.biocontrol.2003.09.001.

Bargabus, R.L. *et al.* (2002) ‘Characterisation of systemic resistance in sugar beet elicited by a non-pathogenic, phyllosphere-colonizing Bacillus mycoides, biological control agent’, *Physiological and Molecular Plant Pathology*, 61(5), pp. 289–298. Available at: https://doi.org/10.1006/pmpp.2003.0443.

Bažok, R. *et al.* (2016) ‘Comparative efficacy of classical and biorational insecticides on sugar beet weevil, Bothynoderes punctiventris Germar (Coleoptera: Curculionidae’, *Plant Protection Science*, 52(2), pp. 134–141. Available at: https://doi.org/10.17221/86/2015-PPS.

Britt-Louise, L. (2006) ‘Molecular breeding for resistance to rhizomania in sugar beets’, *Acta Universitatis Agriculturae Sueciae* [Preprint], (2006:106). Available at: https://res.slu.se/id/publ/13841 (Accessed: 7 April 2023).

Clarke, N.A.H.H. *et al.* (1993) ‘Identification of stress tolerance traits in sugar beet’, in *Interacting stresses on plants in a changing climate*. Berlin, Heidelberg: Springer, pp. 511–524.

Ehler, L.E. *et al.* (1997) ‘Potential for augmentative biological control of black bean aphid in California sugarbeet’, *Entomophaga*, 42(1), p. 241. Available at: https://doi.org/10.1007/BF02769901.

El-All, A. and Makhlouf, B. (2017) ‘Response of Sugar Beet to Continuous Deficit Irrigation and Foliar Application of some Micronutrients under Sandy Soil Conditions’, *Journal of Soil Sciences and Agricultural Engineering*, 8(12), pp. 749–760.

Eldefrawy, B.M. and Mashaal, R.E. (2022) ‘The Larval-Pupal Parasitoid, Enicospilus repentinus (Hol.) and Resistant Varieties as Bio-Agents for Regulating Populations of Scrobipalpa ocellatella Boyd. In the Egyptian Sugar Beet Fields’, *Egyptian Academic Journal of Biological Sciences, F. Toxicology & Pest Control*, 14(1), pp. 55–62.

El-Fakharany, S.K.M. *et al.* (2012) ‘Effect of intercropping of maize, bean, cabbage and toxicants on the population levels of some insect pests and associated predators in sugar beet plantations’, *The Journal of Basic & Applied Zoology*, 65(1), pp. 21–28. Available at: https://doi.org/10.1016/j.jobaz.2012.02.002.

Gobarah, M.E. *et al.* (2019) ‘Effect of different sowing dates on quantity and quality of some promising sugar beet (Beta vulgaris L.) varieties under North Delta, condition’, *Egyptian Journal of Agronomy*, 41(3), pp. 343–354.

Götze, P. *et al.* (2017) ‘Crop rotation effects on yield, technological quality and yield stability of sugar beet after 45 trial years’, *European Journal of Agronomy*, 82, pp. 50–59. Available at: https://doi.org/10.1016/j.eja.2016.10.003.

Hoffmann, C.M. (2010) ‘Sucrose accumulation in sugar beet under drought stress’, *Journal of agronomy and crop science*, 196(4), pp. 243–252.

Hoffmann, C.M. and Kluge-Severin, S. (2011) ‘Growth analysis of autumn and spring sown sugar beet’, *European journal of agronomy*, 34(1), pp. 1–9.

Hussein, H.-A.A. *et al.* (2019) ‘Effect of L-Ornithine application on improving drought tolerance in sugar beet plants’, *Heliyon*, 5(10), p. 02631.

Jaggard, K.W., Dewar, A.M. and Pidgeon, J.D. (1998) ‘The relative effects of drought stress and virus yellows on the yield of sugarbeet in the UK, 1980–95’, *The Journal of Agricultural Science*, 130(3), pp. 337–343.

Jakienė, E. and Liakas, V. (2013) ‘Effect of the biological preparations Azofit and Amalgerol on sugar beet seeding’, *RURAL DEVELOPMENT*, p. 106.

King, B., Tarkalson, D. and Bjorneberg, D. (2019) ‘Soil Water Extraction Patterns and Water Use Efficiency of Irrigated Sugarbeet under Full and Limited Irrigation in an Arid Climate’, *Journal of Sugar Beet Research*, 56(3 & 4), pp. 23–53. Available at: https://doi.org/10.5274/Jsbr.56.3.23.

Laurent, A. *et al.* (2023) 'Assessment of non-neonicotinoid treatments against aphids on sugar beets', *Crop Protection*, 164, p. 106140. Available at: https://doi.org/10.1016/j.cropro.2022.106140.

Maios, C. (2006) *Expression of defence-related genes in sugar beet plants infected with Rhizoctonia solani and treated with benzo-(1,2,3)-thiadiazole-7-carbothioic acid S-methyl ester (BTH*. Master of Science, McGill University. Available at: https://escholarship.mcgill.ca/concern/theses/jm214p34s.

Makhlouf, B.S.I., Khalil, S.R.A.E. and Saudy, H.S. (2022) 'Efficacy of humic acids and chitosan for enhancing yield and sugar quality of sugar beet under moderate and severe drought', *Journal of Soil Science and Plant Nutrition*, 1–16.

Martínez, J. *et al.* (2017) 'A cost-effective canopy temperature measurement system for precision agriculture: A case study on sugar beet', *Precision Agriculture*, 18(1), pp. 95–110. Available at: https://doi.org/10.1007/s11119-016-9470-9.

Moliterni, V.M.C. *et al.* (2015) 'Early transcriptional changes in Beta vulgaris in response to low temperature', *Planta*, 242(1), pp. 187–201.

Montazar, A. (2021) 'A Viability Assessment of Subsurface Drip Irrigation in the Desert Southwest', *1* [Preprint]. Available at: https://doi.org/10.13031/irrig.2020-040.

Osman, H.S. *et al.* (2022) 'Improving the antioxidants system, growth, and sugar beet quality subjected to long-term osmotic stress by phosphate solubilizing bacteria and compost tea', *International Journal of Plant Production*, 16(1), pp. 119–135.

Petkeviciene, B. (2009) 'The effects of climate factors on sugar beet early sowing timing', *Agron. Res*, 7, pp. 436–443.

Pidgeon, J.D. *et al.* (2006) 'Using multi-environment sugar beet variety trials to screen for drought tolerance', *Field crops research*, 95(2–3), pp. 268–279.

Pretorius, R.J. *et al.* (2018) 'Comparing the Effects of Two Tillage Operations on Beneficial Epigeal Arthropod Communities and Their Associated Ecosystem Services in Sugar Beets', *Journal of Economic Entomology*, 111(6), pp. 2617–2631. Available at: https://doi.org/10.1093/jee/toy285.

Reinsdorf, E., Koch, H.J. and Märländer, B. (2013) 'Phenotype related differences in frost tolerance of winter sugar beet (Beta vulgaris L', *Field Crops Research*, 151, pp. 27–34.

Sakellariou-Makrantonaki, M., Kalfountzos, D. and Vyrlas, P. (2002) 'Water saving and yield increase of sugar beet with subsurface drip irrigation', *Global Nest: The International Journal*, 4(2–3), pp. 85–91.

Salama, H., El-Karamity, D.E.-S. and Nawar, A.I. (2016) 'Additive intercropping of wheat, barley, and faba bean with sugar beet: Impact on yield, quality and land use efficiency', *Egyptian Journal of Agronomy*, 38(3), pp. 413–430.

Sonbol, H.A. *et al.* (2010) 'Effect of different surface and drip irrigation systems on sugar beet yield, irrigation performances and soil salinity at north delta', *Journal of Soil Sciences and Agricultural Engineering*, 1(4), pp. 407–420.

Strausbaugh, C.A. and Eujayl, I. (2012) 'Influence of Sugarbeet Tillage Systems on the Rhizoctonia-Bacterial Root Rot Complex', *Journal of Sugarbeet Research*, 49(3), pp. 57–77. Available at: https://doi.org/10.5274/jsbr.49.3.57.

Stricevic, R. *et al.* (2011) 'Assessment of the FAO AquaCrop model in the simulation of rainfed and supplementally irrigated maize, sugar beet and sunflower', *Agricultural Water*

Management, 98(10), pp. 1615–1621. Available at: https://doi.org/10.1016/j.agwat.2011.05.011.

Taleghani, D. *et al.* (2022) 'Improvement and selection for drought-tolerant sugar beet (Beta vulgaris L.) pollinator lines', *Results in Engineering*, 13, p. 100367.

Tarkalson, D.D. *et al.* (2014) 'Drought Tolerance Selection of Sugarbeet Hybrids', *Journal of Sugarbeet Research*, 51(1), pp. 14–30. Available at: https://doi.org/10.5274/jsbr.51.1.14.

Tarkalson, D.D., Bjorneberg, D.L. and Moore, A. (2012) 'Effects of Tillage System and Nitrogen Supply on Sugarbeet Production', *Journal of Sugarbeet Research*, 49(3), pp. 79–102. Available at: https://doi.org/10.5274/jsbr.49.3.79.

Weeden, B.R. (2000) *Potential of sugar beet on the Atherton Tableland: a report for the Rural Industries Research and Development Corporation*. Barton, A.C.T: RIRDC (RIRDC publication, no. 00/167).

Yolcu, S. *et al.* (2021) 'An insight into the abiotic stress responses of cultivated beets (Beta vulgaris L', *Plants*, 11(1), p. 12.

Zaki, M.S. *et al.* (2018) 'Using Different Types of Fertilization For Increasing Sugar Beet Growth Under Sandy Soil Conditions', *Journal of Plant Genetics and Crop Research*, 1(1), p. 19.

Zewail, R.M.Y. *et al.* (2020) 'Micronutrients through foliar application enhance growth, yield and quality of sugar beet (Beta vulgaris L', *Journal of Plant Nutrition*, 43(15), pp. 2275–2285.

Wheat

Ali, A.H., Said, E.M. and Abdelgawad, Z.A. (2022) 'The role of seaweed extract on improvement drought tolerance of wheat revealed by osmoprotectants and DNA (cpDNA) markers', *Brazilian Journal of Botany*, 45(3), pp. 857–867. Available at: https://doi.org/10.1007/s40415-022-00820-5.

Al-Zubade, A. *et al.* (2021) 'Effect of Biofertilizer in Organic and Conventional Systems on Growth', *Yield and Baking Quality of Hard Red Winter Wheat. Sustainability*, 13(24), p. 13861.

Bahçeci, İ. *et al.* (2017) 'A new drainpipe–envelope concept for subsurface drainage systems in irrigated agriculture', *Irrigation and Drainage*, 67, p. 10 1002 2247.

Barlow, K.M. *et al.* (2015) 'Simulating the impact of extreme heat and frost events on wheat crop production: A review', *Field crops research*, 171, pp. 109–119.

Calzarano, F. *et al.* (2018) 'Durum Wheat Quality, Yield and Sanitary Status under Conservation Agriculture', *Agriculture*, 8(9). Available at: https://doi.org/10.3390/agriculture8090140.

Delfine, S. *et al.* (2005) 'Effect of foliar application of N and humic acids on growth and yield of durum wheat', *Agronomy for Sustainable Development*, 25(2), pp. 183–191. Available at: https://doi.org/10.1051/agro:2005017.

FAO, F. (2018) 'The impact of disasters and crises on agriculture and food security', *Report* [Preprint].

Faria, J.M.S. *et al.* (2020) 'Arbuscular Mycorrhiza Inoculum Type Influences Phosphorus Subcellular Distribution in Shoots of Wheat Grown in Acidic Soil under Sustainable Agricultural Practices', *Biology and Life Sciences Forum*, 4(1). Available at: https://doi.org/10.3390/IECPS2020-08596.

Farooq, M. *et al.* (2011) 'Heat stress in wheat during reproductive and grain-filling phases', *Critical Reviews in Plant Sciences*, 30(6), pp. 491–507.

Fieuzal, R. *et al.* (2011) 'Combined use of optical and radar satellite data for the monitoring of irrigation and soil moisture of wheat crops', *Hydrology and Earth System Sciences*, 15(4), pp. 1117–1129. Available at: https://doi.org/10.5194/hess-15-1117-2011.

Freebairn, D.M. *et al.* (1986) 'Research and development of reduced tillage systems for vertisols in Queensland, Australia', *Soil and Tillage Research*, 8, pp. 211–229. Available at: https://doi.org/10.1016/0167-1987(86)90335-1.

Gou, F. *et al.* (2016) 'Yield and yield components of wheat and maize in wheat–maize intercropping in the Netherlands', *European Journal of Agronomy*, 76, pp. 17–27.

Hank, T.B., Bach, H. and Mauser, W. (2015) 'Using a Remote Sensing-Supported Hydro-Agroecological Model for Field-Scale Simulation of Heterogeneous Crop Growth and Yield: Application for Wheat in Central Europe', *Remote Sensing*, 7(4). Available at: https://doi.org/10.3390/rs70403934.

Horváth, E. *et al.* (2007) 'Exogenous 4-hydroxybenzoic acid and salicylic acid modulate the effect of short-term drought and freezing stress on wheat plants', *Biologia Plantarum*, 51(3), pp. 480–487. Available at: https://doi.org/10.1007/s10535-007-0101-1.

Jensen, K.J.S. *et al.* (2021) 'Yield and development of winter wheat (Triticum aestivum L.) and spring barley (Hordeum vulgare) in field experiments with variable weather and drainage conditions', *European Journal of Agronomy*, 122, p. 126075. Available at: https://doi.org/10.1016/j.eja.2020.126075.

Karthikeyan, N. *et al.* (2007) 'Evaluating the potential of plant growth promoting cyanobacteria as inoculants for wheat', *European Journal of Soil Biology*, 43(1), pp. 23–30. Available at: https://doi.org/10.1016/j.ejsobi.2006.11.001.

Lehnert, H. *et al.* (2017) 'Genetics of mycorrhizal symbiosis in winter wheat (Triticum aestivum', *New Phytologist*, 215(2), pp. 779–791. Available at: https://doi.org/10.1111/nph.14595.

Lenssen, A.W., Johnson, G.D. and Carlson, G.R. (2007) 'Cropping sequence and tillage system influences annual crop production and water use in semiarid Montana, USA', *Field Crops Research*, 100(1), pp. 32–43. Available at: https://doi.org/10.1016/j.fcr.2006.05.004.

Li, P.H. (ed.) (2012) *Plant cold hardiness and freezing stress: Mechanisms and crop implications*. Elsevier.

Lobell, D.B. *et al.* (2002) 'Soil, climate, and management impacts on regional wheat productivity in Mexico from remote sensing', *Agricultural and Forest Meteorology*, 114(1–2), pp. 31–43. Available at: https://doi.org/10.1016/S0168-1923(02)00138-7.

Marček, T. *et al.* (2019) 'Metabolic response to drought in six winter wheat genotypes', *PLoS one*, 14(2), p. 0212411.

Marcellos, H. and Single, W.V. (1972) 'The influence of cultivar, temperature and photoperiod on post-flowering development of wheat', *Australian Journal of Agricultural Research*, 23(4), pp. 533–540.

Martre, P. *et al.* (2015) 'Multimodel ensembles of wheat growth: many models are better than one', *Global change biology*, 21(2), pp. 911–925.

Mayfield, A.H. and Trengove, S.P. (2009) 'Grain yield and protein responses in wheat using the N-Sensor for variable rate N application', *Crop and Pasture Science, [online*, 60(9), p. 818. Available at: https://doi.org/10.1071/cp08344.

McNee, M.E. *et al.* (2022) 'Effects of dryland summer cover crops and a weedy fallow on soil water, disease levels, wheat growth and grain yield in a Mediterranean-type environment', *Field Crops Research*, 280, p. 108472. Available at: https://doi.org/10.1016/j.fcr.2022.108472.

Mehring, G.H. *et al.* (2015) ‘Spring Wheat Response to Disease Control and Subsurface Drainage Management in the Red River of the North Valley, USA’, *Agricultural Sciences*, 06(10), pp. 1220–1231. Available at: https://doi.org/10.4236/as.2015.610117.

Mehta, Y.R. *et al.* (1992) ‘Integrated management of major wheat diseases in Brazil: An example for the Southern Cone region of Latin America’, *Crop Protection*, 11(6), pp. 517–524. Available at: https://doi.org/10.1016/0261-2194(92)90168-5.

Modarresi, M. *et al.* (2010) ‘Response of wheat yield and yield related traits to high temperature’, *Cereal Research Communications*, 38(1), pp. 23–31.

Mousavi, H. *et al.* (2022) ‘Effects of Increasing Salinity by Drip Irrigation on Total Grain Weight Show High Yield Potential of Putative Salt-Tolerant Mutagenized Wheat Lines’, *Sustainability*, 14(9). Available at: https://doi.org/10.3390/su14095061.

Pačuta, V. *et al.* (2021) ‘Grain yield and quality traits of durum wheat (Triticum durum Desf.) treated with seaweed-and humic acid-based biostimulants’, *Agronomy*, 11(7).

Pankhurst, C.E., McDonald, H.J. and Hawke, B.G. (1995) ‘Influence of tillage and crop rotation on the epidemiology of Pythium infections of wheat in a red-brown earth of South Australia’, *Soil Biology and Biochemistry, [online*, 27(8), pp. 1065–1073. Available at: https://doi.org/10.1016/0038-0717(95)00009-4.

Peake, A.S. *et al.* (2016) ‘An alternative approach to whole-farm deficit irrigation analysis: Evaluating the risk-efficiency of wheat irrigation strategies in sub-tropical Australia’, *Agricultural Water Management*, 169, pp. 61–76. Available at: https://doi.org/10.1016/j.agwat.2016.02.013.

Pereira, J.F., Cunha, G.R. da and Moresco, E.R. (2019) ‘Improved drought tolerance in wheat is required to unlock the production potential of the Brazilian Cerrado’, *Crop Breeding and Applied Biotechnology*, 19, pp. 217–225. Available at: https://doi.org/10.1590/1984-70332019v19n2r30.

Pradhan, G.P. *et al.* (2012) ‘Effects of drought and high temperature stress on synthetic hexaploid wheat’, *Functional Plant Biology*, 39(3), pp. 190–198.

Reynolds, M.P., Sayre, K.D. and Vivar, H.E. (1994) ‘Intercropping wheat and barley with N-fixing legume species: A method for improving ground cover, N-use efficiency and productivity in low input systems’, *The Journal of Agricultural Science*, 123(2), pp. 175–183.

Richards, R. *et al.* (2014) ‘Yield improvement and adaptation of wheat to water-limited environments in Australia - A case study’, *Crop and Pasture Science*, 65, pp. 676–689.

Ross, I.L. *et al.* (2000) ‘Genetic Diversity and Biological Control Activity of Novel Species of Closely Related Pseudomonads Isolated from Wheat Field Soils in South Australia’, *Applied and Environmental Microbiology*, 66(4), pp. 1609–1616. Available at: https://doi.org/10.1128/aem.66.4.1609-1616.2000.

Saad, A. *et al.* (2015) ‘Sustainable safe reuse of drainage water in agriculture at North delta soils, Egypt’, *Journal of Chemical and Pharmaceutical Research*, 7(5), pp. 1033–1043.

Sarto, M.V.M. *et al.* (2017) ‘Wheat phenology and yield under drought: a review’, *Australian Journal of Crop Science*, 11(8), pp. 941–946.

Schjønning, P., Høy, J.J. and Munkholm, L.J. (2010) ‘Soil tillage effects on the development of winter wheat yields in Denmark’, in *Causes of Yield Stagnation in Winter Wheat in Denmark*, p. 105.

Seddaiu, G. *et al.* (2016) ‘Long term effects of tillage practices and N fertilization in rainfed Mediterranean cropping systems: Durum wheat, sunflower and maize grain yield’, *European Journal of Agronomy*, 77, pp. 166–178. Available at: https://doi.org/10.1016/j.eja.2016.02.008.

Seymour, M. *et al.* (2012) 'Break-crop benefits to wheat in Western Australia – insights from over three decades of research', *Crop and Pasture Science*, 63(1), p. 1. Available at: https://doi.org/10.1071/cp11320.

Sharma, P., Abrol, V. and Sharma, R.K. (2011) 'Impact of tillage and mulch management on economics, energy requirement and crop performance in maize–wheat rotation in rainfed subhumid inceptisols, India', *European Journal of Agronomy*, 34(1), pp. 46–51. Available at: https://doi.org/10.1016/j.eja.2010.10.003.

Shew, A. *et al.* (2020) 'Yield reduction under climate warming varies among wheat cultivars in South Africa', *Nature Communications*, 11. 1234567890, p. 10 1038 41467-020-18317–8.

Silva, S.R. *et al.* (2021) 'Long-term effects of tillage systems on liming efficiency, soil chemical properties and wheat yield in Southern Brazil', *Soil Research*, 60(6), pp. 497–510. Available at: https://doi.org/10.1071/SR21023.

Silva, W.M. da *et al.* (2022) 'Soil Efflux of Carbon Dioxide in Brazilian Cerrado Wheat (Triticum aestivum L.) under Variable Soil Preparation and Irrigation', *Agriculture*, 12(2). Available at: https://doi.org/10.3390/agriculture12020163.

Tadesse, W., Bishaw, Z. and Assefa, S. (2018) 'Wheat production and breeding in Sub-Saharan Africa: Challenges and opportunities in the face of climate change', *International Journal of Climate Change Strategies and Management*, 11, p. 10 1108-02-2018–0015.

Taha, A. (2012) *Effect of climate change on maize and wheat grown under fertigation treatments in newly reclaimed soil*. Egypt: Doctorial Dessertation, Tanta University.

Theron, S. *et al.* (2022) 'The effect of crop rotation and tillage practice on Fusarium crown rot and agronomic parameters of wheat in South Africa', *Crop Protection*, 166. 106175, p. 10 1016 2022 106175.

Tm, F., Jt, C. and Ak, B. (2008) 'Low temperature adaption of wheat post head-emergence in northern Australia', in. Sydney University Press. Available at: https://ses.library.usyd.edu.au/handle/2123/3295 (Accessed: 7 April 2023).

Verhulst, N. *et al.* (2011) 'Conservation agriculture for wheat-based cropping systems under gravity irrigation: Increasing resilience through improved soil quality', *Plant and Soil*, 340(1–2), pp. 467–479. Available at: https://doi.org/10.1007/s11104-010-0620-y.

Wheeler, T.R. *et al.* (1996) 'Growth and yield of winter wheat (Triticum aestivum) crops in response to CO2 and temperature', *The Journal of Agricultural Science*, 127(1), pp. 37–48.

Sugarcane

Adami, M. *et al.* (2012) 'Remote sensing time series to evaluate direct land use change of recent expanded sugarcane crop in Brazil', *Sustainability*, 4(4), pp. 574–585.

Amarasingam, N. *et al.* (2022) 'A review of UAV platforms, sensors, and applications for monitoring of sugarcane crops', *Remote Sensing Applications: Society and Environment*, 26, p. 100712. Available at: https://doi.org/10.1016/j.rsase.2022.100712.

Ambrosano, E.J. *et al.* (2013) 'Crop rotation biomass and effects on sugarcane yield in Brazil', *InTech Open Minds*, 2, pp. 1–40.

Ballal, C.R. and Verghese, A. (2015) 'Role of Parasitoids and Predators in the Management of Insect Pests', in A.K. Chakravarthy (ed.) *New Horizons in Insect Science: Towards Sustainable Pest Management*. New Delhi: Springer India, pp. 307–326. Available at: https://doi.org/10.1007/978-81-322-2089-3_28.

Camargo, M.S. de *et al.* (2017) 'Silicon fertilization reduces the deleterious effects of water deficit in sugarcane', *Journal of Soil Science and Plant Nutrition*, 17(1), pp. 99–111. Available at: https://doi.org/10.4067/S0718-95162017005000008.

Carvalho, A.L. *et al.* (2015) 'Impact of climate changes on potential sugarcane yield in Pernambuco, northeastern region of Brazil', *Renewable Energy*, 78, pp. 26–34.

Carvalho, J.L.N. *et al.* (2019) 'Multilocation Straw Removal Effects on Sugarcane Yield in South-Central Brazil', *BioEnergy Research*, 12(4), pp. 813–829. Available at: https://doi.org/10.1007/s12155-019-10007-8.

Dal-Bianco, M. *et al.* (2012) 'Sugarcane improvement: How far can we go?', *Current Opinion in Biotechnology*, 23(2), pp. 265–270. Available at: https://doi.org/10.1016/j.copbio.2011.09.002.

Flack-Prain, S. *et al.* (2021) 'The impact of climate change and climate extremes on sugarcane production', *GCB Bioenergy*, 13(3), pp. 408–424.

Li, Y.R. and Yang, L.T. (2015) 'Sugarcane agriculture and sugar industry in China', *Sugar Tech*, 17(1), pp. 1–8.

Matos Pires, R. *et al.* (2014) 'Effects of Subsurface Drip Irrigation and Different Planting Arrangements on the Yields and Technological Quality of Sugarcane', *Journal of Irrigation and Drainage Engineering*, 140(9), p. 5014001. Available at: https://doi.org/10.1061/(ASCE)IR.1943-4774.0000710.

Matovic, M.D. (2013) *Biomass Now - Cultivation and Utilization*. Available at: https://doi.org/10.5772/3437.

Narayanamoorthy, A. (2005) 'Economics of drip irrigation in sugarcane cultivation: Case study of a farmer from Tamil Nadu', *Indian Journal of Agricultural Economics*, 60(902-2016–66811).

Ribeiro, R.V. *et al.* (2013) 'Revealing drought-resistance and productive patterns in sugarcane genotypes by evaluating both physiological responses and stalk yield', *Experimental Agriculture*, 49(2), pp. 212–224.

Santos, D.L.D. and Sentelhas, P.C. (2012) 'Climate change scenarios and their impact on the water balance of sugarcane production areas in the State of São Paulo, Brazil', *Revista Ambiente & Água*, 7, pp. 07–17.

Shabbir, R. *et al.* (2021) 'Modern Biotechnologies: Innovative and Sustainable Approaches for the Improvement of Sugarcane Tolerance to Environmental Stresses', *Agronomy*, 11(6). Available at: https://doi.org/10.3390/agronomy11061042.

Viator, R.P., Kovar, J.L. and Hallmark, W.B. (2002) 'Gypsum and Compost Effects on Sugarcane Root Growth, Yield, and Plant Nutrients', *Agronomy Journal*, 94(6), pp. 1332–1336. Available at: https://doi.org/10.2134/agronj2002.1332.

Zhao, D. and Li, Y.-R. (2015) 'Climate Change and Sugarcane Production: Potential Impact and Mitigation Strategies', *International Journal of Agronomy*, p. 547386. Available at: https://doi.org/10.1155/2015/547386.

Zhao, D. and Li, Y.R. (2015) 'Climate change and sugarcane production: potential impact and mitigation strategies', *International Journal of Agronomy* [Preprint].

Canola

Ahmed, H.U. *et al.* (2014) 'Crop residue affects Rhizoctonia solani population dynamics and seedling blight of canola', *Plant Pathology Journal (Faisalabad*, 13(1), pp. 50–55.

Aksouh-Harradj, N.M., Campbell, L.C. and Mailer, R.J. (2006) 'Canola response to high and moderately high temperature stresses during seed maturation', *Canadian journal of plant science*, 86(4), pp. 967–980.

Arrouays, D. *et al.* (2002) *Stocker du Carbone dans les Sols Agricoles de France? Contribution a` la Lutte Contre l'Effet de Serre*. Paris, France: Expertise Collective INRA.

Assefa, Y. *et al.* (2018) 'Major management factors determining spring and winter canola yield in North America', *Crop Science*, 58(1), pp. 1–16.

Bushong, J.A. *et al.* (2012) 'Continuous winter wheat versus a winter canola–winter wheat rotation', *Agronomy Journal*, 104(2), pp. 324–330.

Cárcamo, H.A. *et al.* (2007) 'Managing cabbage seedpod weevil in canola using a trap crop—A commercial field scale study in western Canada', *Crop Protection*, 26(8), pp. 1325–1334. Available at: https://doi.org/10.1016/j.cropro.2006.11.007.

Cárcamo, H.A. *et al.* (2008) 'Effects of seeding date and canola species on seedling damage by flea beetles in three ecoregions', *Journal of Applied Entomology*, 132(8), pp. 623–631. Available at: https://doi.org/10.1111/j.1439-0418.2008.01298.x.

Champolivier, L. and Merrien, A. (1996) 'Effects of water stress applied at different growth stages to Brassica napus L. var. oleifera on yield, yield components and seed quality', *European Journal of Agronomy*, 5(3–4), pp. 153–160.

Cheng, Z., Park, E. and Glick, B.R. (2007) '1-Aminocyclopropane-1-carboxylate deaminase from Pseudomonas putida UW4 facilitates the growth of canola in the presence of salt', *Canadian Journal of Microbiology*, 53(7), pp. 912–918. Available at: https://doi.org/10.1139/W07-050.

Coquil, B. and Bordes, J.P. (2005) 'FARMSTAR: An efficient decision support tool for near real time crop management from satellite images', in *Precision Agriculture '05. Papers Presented at the 5th European Conference on Precision Agriculture*. Uppsala, Sweden, pp. 873–880.

Din, J. *et al.* (2011) 'Physiological and agronomic response of canola varieties to drought stress', *J Anim Plant Sci*, 21(1), pp. 78–82.

Djaman, K. *et al.* (2018) 'Seed yield and water productivity of irrigated winter canola (Brassica napus L.) under semiarid climate and high elevation', *Agronomy*, 8(6), p. 90.

Elferjani, R. and Soolanayakanahally, R. (2018) 'Canola responses to drought, heat, and combined stress: shared and specific effects on carbon assimilation, seed yield, and oil composition', *Frontiers in plant science*, 9, p. 1224.

Elliott, R.H., Franke, C. and Rakow, G.F.W. (2008) 'Effects of seed size and seed weight on seedling establishment, vigour and tolerance of Argentine canola (Brassica napus) to flea beetles, Phyllotreta spp', *Canadian Journal of Plant Science*, 88(1), pp. 207–217. Available at: https://doi.org/10.4141/CJPS07059.

Fernando, W.G.D. *et al.* (2007) 'Biological control of Sclerotinia sclerotiorum (Lib.) de Bary by Pseudomonas and Bacillus species on canola petals', *Crop Protection*, 26(2), pp. 100–107. Available at: https://doi.org/10.1016/j.cropro.2006.04.007.

Hokkanen, H.M.T. (2008) 'Biological control methods of pest insects in oilseed rape', *EPPO Bulletin*, 38(1), pp. 104–109. Available at: https://doi.org/10.1111/j.1365-2338.2008.01191.x.

Katuwal, K.B. *et al.* (2020) 'Soil water extraction pattern and water use efficiency of spring canola under growth-stage-based irrigation management', *Agricultural Water Management*, 239, p. 106232. Available at: https://doi.org/10.1016/j.agwat.2020.106232.

Kumar, S., Bishnoi, U.R. and Cebert, E. (2007) 'Impact of rotation on yield and economic performance of summer crops-winter canola cropping systems', *American-Eurasian Journal of Sustainable Agriculture*, pp. 68–77.

Kutcher, H.R. and Malhi, S.S. (2010) 'Residue burning and tillage effects on diseases and yield of barley (Hordeum vulgare) and canola (Brassica napus', *Soil and Tillage Research*, 109(2), pp. 153–160. Available at: https://doi.org/10.1016/j.still.2010.06.001.

Nguyen, L.H., Robinson, S. and Galpern, P. (2022) 'Medium-resolution multispectral satellite imagery in precision agriculture: Mapping precision canola (Brassica napus L.) yield using Sentinel-2 time series', *Precision Agriculture*, 23(3), pp. 1051–1071. Available at: https://doi.org/10.1007/s11119-022-09874-7.

Niedbała, G. (2019) 'Application of Artificial Neural Networks for Multi-Criteria Yield Prediction of Winter Rapeseed', *Sustainability*, 11(2), p. 2. Available at: https://doi.org/10.3390/su11020533.

Peng, G. *et al.* (2011) 'Potential biological control of clubroot on canola and crucifer vegetable crops', *Plant Pathology*, 60(3), pp. 566–574. Available at: https://doi.org/10.1111/j.1365-3059.2010.02400.x.

Raymer, P.L. (2002) 'Canola: an emerging oilseed crop', *Trends in new crops and new uses*, 1, pp. 122–126.

Reddy, G.V.P. (2017) *Integrated Management of Insect Pests on Canola and Other Brassica Oilseed Crops*. CABI.

Riethmuller, G.P., Carmody, P.C. and Walton, G.H. (1998) 'Improved canola establishment, yield and oil with large seed on sandplain soil in Western Australia', in. Available at: http://www.australianoilseeds.com/__data/assets/pdf_file/0014/4550/Improved_canola_establishment,_yield_and_oil_with_large_seed_in_WA.pdf.

Sharma, A. and Reddy, G.V.P. (2020) 'IPM and Pollinator Protection in Canola Production in the USA', in Y. Gao, H.M.T. Hokkanen, and I. Menzler-Hokkanen (eds) *Integrative Biological Control: Ecostacking for Enhanced Ecosystem Services*. Springer International Publishing, pp. 165–176. Available at: https://doi.org/10.1007/978-3-030-44838-7_10.

Stepien, A. *et al.* (2017) 'Nutrient content, fat yield and fatty acid profile of winter rapeseed (Brassica napus L.) grown under different agricultural production systems', *Chilean Journal of Agricultural Research*, 77(3), pp. 266–272. Available at: https://doi.org/10.4067/S0718-58392017000300266.

Taylor, A.J., Smith, C.J. and Wilson, I.B. (1991) 'Effect of irrigation and nitrogen fertilizer on yield, oil content, nitrogen accumulation and water use of canola (Brassica napus L', *Fertilizer Research*, 29(3), pp. 249–260. Available at: https://doi.org/10.1007/bf01052393.

Wallace, G.E. and Huda, A. (2005) 'Using climate information to approximate the value at risk of a forward contracted canola crop', *Australian Farm Business Management Journal*, 2(1), pp. 75–83.

Williams, I.H. (2010) 'The Major Insect Pests of Oilseed Rape in Europe and Their Management: An Overview', in I.H. Williams (ed.) *Biocontrol-Based Integrated Management of Oilseed Rape Pests*. Dordrecht: Springer Netherlands, pp. 1–43. Available at: https://doi.org/10.1007/978-90-481-3983-5_1.

ZELEKE, K.T., LUCKETT, D.J. and COWLEY, R.B. (2014) 'RESPONSE OF CANOLA (Brassica napus L.) AND MUSTARD (B. juncea L.) TO DIFFERENT WATERING REGIMES', *Experimental Agriculture, [online*, 50(4), pp. 573–590. Available at: https://doi.org/10.1017/s0014479714000064.

Sunflower

Agüera, E. and Haba, P. (2021) 'Climate Change Impacts on Sunflower (Helianthus annus L.) Plants', *Plants*, 10(12), p. 2646.

Csüllög, K., Rácz, D.E. and Tarcali, G. (2019) 'The Charcoal rot disease (Macrophomina phaseolina (Tassi) Goid.) on sunflower in Hungary', in. Available at: https://doi.org/10.13140/RG.2.2.21598.18246.

Debaeke, P. *et al.* (2017) 'Sunflower crop and climate change: vulnerability, adaptation, and mitigation potential from case-studies in Europe', *OCL Oilseeds and fats crops and lipids*, 24(1), pp. 15-.

García-Vila, M. *et al.* (2012) 'Sunflower', in *Crop yield response to water FAO Irrigation and Drainage, Paper*, p. 66.

Gurkan, H. *et al.* (2020) 'Possible impacts of climate change on sunflower yield in Turkey', in *Agronomy-Climate Change & Food Security. IntechOpen*.

Hulke, B. *et al.* (2019) 'Phomopsis Stem Canker of Sunflower in North America: Correlation with Climate and Solutions Through Breeding and Management', *OCL*, 26(Article 13). Available at: https://openprairie.sdstate.edu/plant_faculty_pubs/296.

Krauss, M. *et al.* (2020) 'Enhanced soil quality with reduced tillage and solid manures in organic farming – a synthesis of 15 years', *Scientific Reports*, 10(1). Available at: https://doi.org/10.1038/s41598-020-61320-8.

Liu, R. *et al.* (2018) 'Deficit irrigation: A viable option for sustainable confection sunflower (Helianthus annuus L.) production in the semi-arid US', *Irrigation Science*, 36(6), pp. 319–328. Available at: https://doi.org/10.1007/s00271-018-0588-6.

Reddy, G.V.P. *et al.* (2014) 'Sustainable Management Tactics for Control of Phyllotreta cruciferae (Coleoptera: Chrysomelidae) on Canola in Montana', *Journal of Economic Entomology*, 107(2), pp. 661–666. Available at: https://doi.org/10.1603/EC13503.

Rosner, K. *et al.* (2018) 'Long-term Soil Tillage and Cover Cropping Affected Arbuscular Mycorrhizal Fungi, Nutrient Concentrations, and Yield in Sunflower', *Agronomy Journal*, 110(6), pp. 2664–2672. Available at: https://doi.org/10.2134/agronj2018.03.0177.

Waqas, M. *et al.* (2015) 'Endophytic infection alleviates biotic stress in sunflower through regulation of defence hormones, antioxidants and functional amino acids', *European Journal of Plant Pathology*, 141(4), pp. 803–824. Available at: https://doi.org/10.1007/s10658-014-0581-8.

Wasaya, A. *et al.* (2021) 'Mitigating Drought Stress in Sunflower (Helianthus annuus L.) Through Exogenous Application of β-Aminobutyric Acid', *Journal of Soil Science and Plant Nutrition*, 21(2), pp. 936–948. Available at: https://doi.org/10.1007/s42729-021-00412-4.

Soybean

Antoneli, V. *et al.* (2019) 'Effects of Applying Liquid Swine Manure on Soil Quality and Yield Production in Tropical Soybean Crops (Paraná, Brazil', *Sustainability*, 11(14). Available at: https://doi.org/10.3390/su11143898.

Bhardwaj, S.F. (1986) 'Consumptive use and water requirement of soybeans', *Journal of irrigation and drainage engineering*, 112(2), pp. 157–163.

Calonego, J.C. and Rosolem, C.A. (2010) 'Soybean root growth and yield in rotation with cover crops under chiseling and no-till', *European Journal of Agronomy*, 33(3), pp. 242–249. Available at: https://doi.org/10.1016/j.eja.2010.06.002.

Carvalho, M.Â.C.C. de *et al.* (2020) 'Drought Monitoring Based on Remote Sensing in a Grain-Producing Region in the Cerrado–Amazon Transition, Brazil', *Water*, 12(12). Available at: https://doi.org/10.3390/w12123366.

Colussi, J. *et al.* (2022) 'How Communication Affects the Adoption of Digital Technologies in Soybean Production: A Survey in Brazil', *Agriculture*, 12(5). Available at: https://doi.org/10.3390/agriculture12050611.

Cotrim, M.F. *et al.* (2021) 'Physiological performance of soybean genotypes grown under irrigated and rainfed conditions', *Journal of Agronomy and Crop Science*, 207(1), pp. 34–43.

Dros, J.M. (2004) *Managing the Soy Boom: Two scenarios of soy production*. Amsterdam: AIDEnvironment.

Franchini, J.C. *et al.* (2009) 'Soil management to reduce yield losses from drought', *Documentos - Embrapa Soja, No.314* [Preprint]. Available at: https://www.cabdirect.org/cabdirect/abstract/20103093384.

Hamayun, M. *et al.* (2021) 'Aspergillus foetidus regulated the biochemical characteristics of soybean and sunflower under heat stress condition: Role in sustainability', *Sustainability*, 13(13), p. 7159.

Hungria, M., Nogueira, M.A. and Araujo, R.S. (2015) 'Soybean Seed Co-Inoculation with Bradyrhizobium spp. and Azospirillum brasilense: A New Biotechnological Tool to Improve Yield and Sustainability', *American Journal of Plant Sciences*, 6(6). Available at: https://doi.org/10.4236/ajps.2015.66087.

Jin, Z. *et al.* (2017) 'The combined and separate impacts of climate extremes on the current and future US rainfed maize and soybean production under elevated CO2', *Global change biology*, 23(7), pp. 2687–2704.

Mallarino, A.P. (no date) 'Efficacy of Variable-Rate Application Technology for Phosphorus, Potassium, and Lime Management', in. *Industry Soil Fertility Conf*. Available at: https://www.agronext.iastate.edu/soilfertility/info/Mallarino%20Variable-Rate%20Proceed%20NC%20Soil%20Fert%20Conf%202019.pdf.

Nielsen, R.L. and Christmas, E. (2002) 'Early season frost & low temperature damage to corn and soybean', *Corny News Netw* [Preprint].

Sabagh, A.E. *et al.* (2020) *Consequences and Mitigation Strategies of Heat Stress for Sustainability of Soybean (Glycine max L. Merr.) Production under the Changing Climate*, *Plant Stress Physiology*. IntechOpen. Available at: https://doi.org/10.5772/intechopen.92098.

Salassi, M.E. *et al.* (1984) 'An economic analysis of soybean yield response to irrigation of Mississippi River Delta soils'.

Sentelhas, P.C. *et al.* (2015) 'The soybean yield gap in Brazil – magnitude, causes and possible solutions for sustainable production', *The Journal of Agricultural Science*, 153(8), pp. 1394–1411. Available at: https://doi.org/10.1017/S0021859615000313.

Soybean aphid biological control in North America | Heimpel Lab (no date). Available at: https://heimpellab.cfans.umn.edu/projects/soybean-aphid-biological-control-north-america (Accessed: 7 April 2023).

Specht, J.E. *et al.* (2001) 'Soybean response to water: a QTL analysis of drought tolerance', *Crop science*, 41(2), pp. 493–509.

Weber, J. *et al.* (2017) 'Weed Control Using Conventional Tillage, Reduced Tillage, No-Tillage, and Cover Crops in Organic Soybean', *Agriculture*, 7(5), p. 43. Available at: https://doi.org/10.3390/agriculture7050043.

Wei, Y. *et al.* (2018) 'Quantitative response of soybean development and yield to drought stress during different growth stages in the Huaibei Plain, China', *Agronomy*, 8(7), p. 97.

Annex D – Crop calendars and data sources

<table>
<tr><th>Country</th><th>Growing period</th><th>Crop</th><th>Data sources</th></tr>
<tr><td>South Africa</td><td>November-May</td><td>Maize</td><td rowspan="29">https://ipad.fas.usda.gov/ogamaps/cropcalendar.aspx

https://www.fao.org/giews/countrybrief/

https://www.nda.agric.za/docs/Brochures/Oats.pdf

https://americansugarbeet.org/who-we-are/what-is-sugarbeet/

https://www.actascientific.com/ASAG/pdf/ASAG-06-1090.pdf

https://www.uscanola.com/crop-production/spring-and-winter-canola/

https://www.ifastat.org

https://api.ifastat.org/reports/download/13300

Sacks, W.J., D. Deryng, J.A. Foley, and N. Ramankutty (2010). Crop planting dates: an analysis of global patterns. Global Ecology and Biogeography 19, 607-620. DOI: 10.1111/j.1466-8238.2010.00551.x.</td></tr>
<tr><td>South Africa</td><td>May-December</td><td>Oats</td></tr>
<tr><td>South Africa</td><td>May-November</td><td>Wheat</td></tr>
<tr><td>Europe and Russia</td><td>April-October</td><td>Maize, Oats, Sugar beet, Soy, Sunflower</td></tr>
<tr><td>Europe and Russia</td><td>Jan-December</td><td>Wheat, Canola</td></tr>
<tr><td>Egypt</td><td>May-November</td><td>Maize</td></tr>
<tr><td>Egypt</td><td>September-April</td><td>Sugar beet</td></tr>
<tr><td>Brazil</td><td>October-August</td><td>Maize</td></tr>
<tr><td>Brazil</td><td>April-December</td><td>Wheat</td></tr>
<tr><td>Brazil</td><td>October-May</td><td>Soybean</td></tr>
<tr><td>Brazil</td><td>Jan-December</td><td>Sugarcane</td></tr>
<tr><td>India (Kharif)</td><td>March-December</td><td>Maize</td></tr>
<tr><td>Australia</td><td>October-June</td><td>Maize</td></tr>
<tr><td>Australia</td><td>April-December</td><td>Canola, Oats</td></tr>
<tr><td>Australia</td><td>April-January</td><td>Wheat</td></tr>
<tr><td>US</td><td>April-November</td><td>Maize</td></tr>
<tr><td>US</td><td>Jan-December</td><td>Oats, Wheat, Sugarcane</td></tr>
<tr><td>US</td><td>September-June</td><td>Canola</td></tr>
<tr><td>US</td><td>April-October</td><td>Sunflower, Sugar beet</td></tr>
<tr><td>US</td><td>May-October</td><td>Soybean</td></tr>
<tr><td>Canada</td><td>May- November</td><td>Maize, Soybean</td></tr>
<tr><td>Canada</td><td>May- October</td><td>Oats, Canola, Sunflower</td></tr>
<tr><td>Canada</td><td>Jan- December</td><td>Wheat, Sugarcane</td></tr>
<tr><td>Canada</td><td>April-September</td><td>Sugar beet</td></tr>
<tr><td>Mexico</td><td>Jan-December</td><td>Maize, Sugarcane, Oats</td></tr>
<tr><td>Mexico</td><td>September-July</td><td>Wheat</td></tr>
<tr><td>Mexico</td><td>April-September</td><td>Sugar beet</td></tr>
<tr><td>Mexico</td><td>November-June</td><td>Canola</td></tr>
<tr><td>Mexico</td><td>April-December</td><td>Soybean, Sunflower</td></tr>
</table>

Annex E – Climate impacts on supplier sourced crops' performance

Oats

Chinnici, M. F., & Peterson, D. M. (1979). Temperature and Drought Effects on Blast and Other Characteristics in Developing Oats 1. *Crop Science*, *19*(6), 893-897.

Department of Agriculture, Forestry and Fisheries. (2010). Oats Production guideline. https://www.nda.agric.za/docs/Brochures/Oats.pdf.

Gusta, L. V., & O'connor, B. J. (1987). Frost tolerance of wheat, oats, barley, canola and mustard and the role of ice-nucleating bacteria. Canadian Journal of Plant Science, 67(4), 1155-1165.

Heuzé V., Tran G., Boudon A., Lebas F., 2016. Oat forage. Feedipedia, a programme by INRAE, CIRAD, AFZ and FAO. https://www.feedipedia.org/node/500 Last updated on April 13, 2016, 16:26

Mushtaq, A., & Mehfuza, H. (2014). A review on oat (Avena sativa L.) as a dual-purpose crop. Scientific Research and Essays, 9(4), 52-59.

Mut, Z., Akay, H., & Erbaş Köse, Ö. D. (2018). Grain yield, quality traits and grain yield stability of local oat cultivars. Journal of soil science and plant nutrition, 18(1), 269-281.

Reynolds, S. G., & Suttie, J. M. (Eds.). (2004). *Fodder Oats: a world overview*. Food and Agriculture Organization of the United Nations.

Xie, H., Li, M., Chen, Y., Zhou, Q., Liu, W., Liang, G., & Jia, Z. (2021). Important physiological changes due to drought stress on oat. *Frontiers in Ecology and Evolution*, 271.oats

Xu, C. (2012). A study on growth characteristics of different cultivars of oat (Avena sativa) in alpine region. Acta Prataculturae Sinica, 21(2), 280-285.

Corn

Awika, J. M. (2011). Major cereal grains production and use around the world. In *Advances in cereal science: implications to food processing and health promotion* (pp. 1-13). American Chemical Society.

Butler, E. E., Mueller, N. D., & Huybers, P. (2018). Peculiarly pleasant weather for US maize. *Proceedings of the National Academy of Sciences*, *115*(47), 11935-11940.

Hallauer, A. R., & Carena, M. J. (2009). Maize. In Cereals (pp. 3-98). Springer, New York, NY.

Lobell, D. B., & Asner, G. P. (2003). Climate and management contributions to recent trends in US agricultural yields. *Science*, *299*(5609), 1032-1032.

Lobell, D. B., Deines, J. M., & Tommaso, S. D. (2020). Changes in the drought sensitivity of US maize yields. *Nature Food*, *1*(11), 729-735.

Ramadoss, M., Birch, C. J., Carberry, P. S., & Robertson, M. (2004). Water and high temperature stress effects on maize production. In Proceedings of the 4th International Crop Science Congress, Brisbane, Australia (Vol. 26, pp. 45-49).

Schlenker, W., & Roberts, M. J. (2009). Nonlinear temperature effects indicate severe damages to US crop yields under climate change. *Proceedings of the National Academy of sciences*, *106*(37), 15594-15598.

Wilson, D. R., Johnstone, J. V., & Salinger, M. J. (1994). Maize production potential and climatic risk in the South Island of New Zealand. *New Zealand Journal of Crop and Horticultural Science*, *22*(3), 321-334.

Sugarbeet

Clarke, N. A. H. H., Hetschkun, H., Jones, C., Boswell, E., & Marfaing, H. (1993). Identification of stress tolerance traits in sugar beet. In Interacting stresses on plants in a changing climate (pp. 511-524). Springer, Berlin, Heidelberg.

Hoffmann, C. M. (2010). Sucrose accumulation in sugar beet under drought stress. Journal of agronomy and crop science, 196(4), 243-252.

Hoffmann, C. M., & Kluge-Severin, S. (2011). Growth analysis of autumn and spring sown sugar beet. European journal of agronomy, 34(1), 1-9.

Jaggard, K. W., Dewar, A. M., & Pidgeon, J. D. (1998). The relative effects of drought stress and virus yellows on the yield of sugarbeet in the UK, 1980–95. *The Journal of Agricultural Science*, *130*(3), 337-343.

Moliterni, V. M. C., Paris, R., Onofri, C., Orrù, L., Cattivelli, L., Pacifico, D., ... & Mandolino, G. (2015). Early transcriptional changes in Beta vulgaris in response to low temperature. Planta, 242(1), 187-201.

Petkeviciene, B. (2009). The effects of climate factors on sugar beet early sowing timing. Agron. Res, 7, 436-443.

Pidgeon, J. D., Ober, E. S., Qi, A., Clark, C. J., Royal, A., & Jaggard, K. W. (2006). Using multi-environment sugar beet variety trials to screen for drought tolerance. Field crops research, 95(2-3), 268-279.

Reinsdorf, E., Koch, H. J., & Märländer, B. (2013). Phenotype related differences in frost tolerance of winter sugar beet (Beta vulgaris L.). Field Crops Research, 151, 27-34.

Taleghani, D., Rajabi, A., Hemayati, S. S., & Saremirad, A. (2022). Improvement and selection for drought-tolerant sugar beet (Beta vulgaris L.) pollinator lines. Results in Engineering, 13, 100367.

Weeden, B. R. (2000). Potential of sugar beet on the Atherton tableland. A Report for the Rural Industries Research and Development Corporation, Project No DAQ-211A.

Yolcu, S., Alavilli, H., Ganesh, P., Asif, M., Kumar, M., & Song, K. (2021). An insight into the abiotic stress responses of cultivated beets (Beta vulgaris L.). Plants, 11(1), 12.

Wheat

Barlow, K. M., Christy, B. P., O'leary, G. J., Riffkin, P. A., & Nuttall, J. G. (2015). Simulating the impact of extreme heat and frost events on wheat crop production: A review. Field crops research, 171, 109-119.

FAO, F. (2018). The impact of disasters and crises on agriculture and food security. Report.

Farooq, M., Bramley, H., Palta, J. A., & Siddique, K. H. (2011). Heat stress in wheat during reproductive and grain-filling phases. Critical Reviews in Plant Sciences, 30(6), 491-507.

Frederiks, T. M., Christopher, J. T., & Borrell, A. K. (2008). Low temperature adaption of wheat post head-emergence in northern Australia.

Kulkarni, M., Soolanayakanahally, R., Ogawa, S., Uga, Y., Selvaraj, M. G., & Kagale, S. (2017). Drought response in wheat: key genes and regulatory mechanisms controlling root system architecture and transpiration efficiency. Frontiers in chemistry, 5, 106.

Li, P. H. (Ed.). (2012). *Plant cold hardiness and freezing stress: Mechanisms and crop implications* (Vol. 2). Elsevier.

Marček, T., Hamow, K. Á., Végh, B., Janda, T., & Darko, E. (2019). Metabolic response to drought in six winter wheat genotypes. PLoS one, 14(2), e0212411.

Marcellos, H., & Single, W. V. (1972). The influence of cultivar, temperature and photoperiod on post-flowering development of wheat. Australian Journal of Agricultural Research, 23(4), 533-540.

Martre, P., Wallach, D., Asseng, S., Ewert, F., Jones, J. W., Rötter, R. P., ... & Wolf, J. (2015). Multimodel ensembles of wheat growth: many models are better than one. Global change biology, 21(2), 911-925.

Modarresi, M., Mohammadi, V., Zali, A., & Mardi, M. (2010). Response of wheat yield and yield related traits to high temperature. *Cereal Research Communications*, *38*(1), 23-31.

Pradhan, G. P., Prasad, P. V., Fritz, A. K., Kirkham, M. B., & Gill, B. S. (2012). Effects of drought and high temperature stress on synthetic hexaploid wheat. Functional Plant Biology, 39(3), 190-198.

Sarto, M. V. M., Sarto, J. R. W., Rampim, L., Rosset, J. S., Bassegio, D., da Costa, P. F., & Inagaki, A. M. (2017). Wheat phenology and yield under drought: a review. Australian Journal of Crop Science, 11(8), 941-946.

Wheeler, T. R., Batts, G. R., Ellis, R. H., Hadley, P., & Morison, J. I. L. (1996). Growth and yield of winter wheat (Triticum aestivum) crops in response to CO2 and temperature. *The Journal of Agricultural Science*, *127*(1), 37-48.

Sugarcane

Adami, M., Rudorff, B. F. T., Freitas, R. M., Aguiar, D. A., Sugawara, L. M., & Mello, M. P. (2012). Remote sensing time series to evaluate direct land use change of recent expanded sugarcane crop in Brazil. Sustainability, 4(4), 574-585.

de Carvalho, A. L., Menezes, R. S. C., Nóbrega, R. S., de Siqueira Pinto, A., Ometto, J. P. H. B., von Randow, C., & Giarolla, A. (2015). Impact of climate changes on potential sugarcane yield in Pernambuco, northeastern region of Brazil. Renewable Energy, 78, 26-34.

Flack-Prain, S., Shi, L., Zhu, P., da Rocha, H. R., Cabral, O., Hu, S., & Williams, M. (2021). The impact of climate change and climate extremes on sugarcane production. GCB Bioenergy, 13(3), 408-424.

Li, Y. R., & Yang, L. T. (2015). Sugarcane agriculture and sugar industry in China. Sugar Tech, 17(1), 1-8.

Narayanamoorthy, A. (2005). Economics of drip irrigation in sugarcane cultivation: Case study of a farmer from Tamil Nadu. Indian Journal of Agricultural Economics, 60(902-2016-66811).

Santos, D. L. D., & Sentelhas, P. C. (2012). Climate change scenarios and their impact on the water balance of sugarcane production areas in the State of São Paulo, Brazil. Revista Ambiente & Água, 7, 07-17.

Zhao, D., & Li, Y. R. (2015). Climate change and sugarcane production: potential impact and mitigation strategies. *International Journal of Agronomy*, *2015*.

Canola

Aksouh-Harradj, N. M., Campbell, L. C., & Mailer, R. J. (2006). Canola response to high and moderately high temperature stresses during seed maturation. Canadian journal of plant science, 86(4), 967-980.

Assefa, Y., Prasad, P. V., Foster, C., Wright, Y., Young, S., Bradley, P., ... & Ciampitti, I. A. (2018). Major management factors determining spring and winter canola yield in North America. Crop Science, 58(1), 1-16.

Bushong, J. A., Griffith, A. P., Peeper, T. F., & Epplin, F. M. (2012). Continuous winter wheat versus a winter canola–winter wheat rotation. Agronomy Journal, 104(2), 324-330.

Champolivier, L., & Merrien, A. (1996). Effects of water stress applied at different growth stages to Brassica napus L. var. oleifera on yield, yield components and seed quality. European Journal of Agronomy, 5(3-4), 153-160.

Din, J., Khan, S. U., Ali, I., & Gurmani, A. R. (2011). Physiological and agronomic response of canola varieties to drought stress. J Anim Plant Sci, 21(1), 78-82.

Elferjani, R., & Soolanayakanahally, R. (2018). Canola responses to drought, heat, and combined stress: shared and specific effects on carbon assimilation, seed yield, and oil composition. Frontiers in plant science, 9, 1224.

Raymer, P. L. (2002). Canola: an emerging oilseed crop. Trends in new crops and new uses, 1, 122-126.

Wallace, G. E., & Huda, A. (2005). Using climate information to approximate the value at risk of a forward contracted canola crop. Australian Farm Business Management Journal, 2(1), 75-83.

Sunflower

Agüera, E., & de la Haba, P. (2021). Climate Change Impacts on Sunflower (Helianthus annus L.) Plants. Plants, 10(12), 2646.

Debaeke, P., Casadebaig, P., Flenet, F., & Langlade, N. (2017). Sunflower crop and climate change: vulnerability, adaptation, and mitigation potential from case-studies in Europe. *OCL Oilseeds and fats crops and lipids*, *24*(1), 15-p.

García-Vila, M., Fereres, E., Prieto, M. H., Ruz, C., & Soriano, M. A. (2012). Sunflower. Crop yield response to water FAO Irrigation and Drainage, Paper, 66.

Gurkan, H., Ozgen, Y., Bayraktar, N., Bulut, H., & Yildiz, M. (2020). Possible impacts of climate change on sunflower yield in Turkey. In Agronomy-Climate Change & Food Security. IntechOpen.

Soybean

Bhardwaj, S. F. (1986). Consumptive use and water requirement of soybeans. Journal of irrigation and drainage engineering, 112(2), 157-163.

Cotrim, M. F., Gava, R., Campos, C. N. S., de David, C. H. O., Reis, I. D. A., Teodoro, L. P. R., & Teodoro, P. E. (2021). Physiological performance of soybean genotypes grown under irrigated and rainfed conditions. Journal of Agronomy and Crop Science, 207(1), 34-43.

Dros, J. M. (2004). Managing the Soy Boom: Two scenarios of soy production. Amsterdam: AIDEnvironment.

Jin, Z., Zhuang, Q., Wang, J., Archontoulis, S. V., Zobel, Z., & Kotamarthi, V. R. (2017). The combined and separate impacts of climate extremes on the current and future US rainfed maize and soybean production under elevated CO2. Global change biology, 23(7), 2687-2704.

Nielsen, R. L., & Christmas, E. (2002). Early season frost & low temperature damage to corn and soybean. Corny News Netw.

Sabagh, A. E., Hossain, A., Islam, M. S., Iqbal, M. A., Fahad, S., Ratnasekera, D., & Llanes, A. (2020). Consequences and mitigation strategies of heat stress for sustainability of soybean (Glycine max L. Merr.) production under the changing climate. Plant stress physiology.

Salassi, M. E., Musick, J. A., Heatherly, L. G., & Hamill, J. G. (1984). An economic analysis of soybean yield response to irrigation of Mississippi River Delta soils.

Specht, J. E., Chase, K., Macrander, M., Graef, G. L., Chung, J., Markwell, J. P., ... & Lark, K. G. (2001). Soybean response to water: a QTL analysis of drought tolerance. Crop science, 41(2), 493-509.

Wei, Y., Jin, J., Jiang, S., Ning, S., & Liu, L. (2018). Quantitative response of soybean development and yield to drought stress during different growth stages in the Huaibei Plain, China. Agronomy, 8(7), 97.

Annex F – Selection of climate models

Ayugi, B. *et al.* (2021) 'Evaluation and projection of mean surface temperature using CMIP6 models over East Africa', *Journal of African Earth Sciences*, 181, p. 104226. Available at: https://doi.org/10.1016/j.jafrearsci.2021.104226.

Firpo, M.Â.F. *et al.* (2022) 'Assessment of CMIP6 models' performance in simulating present-day climate in Brazil', *Frontiers in Climate*, 4. Available at: https://www.frontiersin.org/articles/10.3389/fclim.2022.948499 (Accessed: 24 November 2022).

Hamed, M.M., Nashwan, M.S. and Shahid, S. (2022) 'Inter-comparison of historical simulation and future projections of rainfall and temperature by CMIP5 and CMIP6 GCMs over Egypt', *International Journal of Climatology*, 42(8), pp. 4316–4332. Available at: https://doi.org/10.1002/joc.7468.

Kim, Y.-H. *et al.* (2020) 'Evaluation of the CMIP6 multi-model ensemble for climate extreme indices', *Weather and Climate Extremes*, 29, p. 100269. Available at: https://doi.org/10.1016/j.wace.2020.100269.

Masud, B. *et al.* (2021) 'Means and Extremes: Evaluation of a CMIP6 Multi-Model Ensemble in Reproducing Historical Climate Characteristics across Alberta, Canada', *Water*, 13(5), p. 737. Available at: https://doi.org/10.3390/w13050737.

Mesgari, E. *et al.* (2022) 'Assessment of CMIP6 models' performances and projection of precipitation based on SSP scenarios over the MENAP region', *Journal of Water and Climate Change*, 13(10), pp. 3607–3619. Available at: https://doi.org/10.2166/wcc.2022.195.

Mitra, A. (2021) 'A Comparative Study on the Skill of CMIP6 Models to Preserve Daily Spatial Patterns of Monsoon Rainfall Over India', *Frontiers in Climate*, 3. Available at: https://www.frontiersin.org/articles/10.3389/fclim.2021.654763 (Accessed: 25 November 2022).

Palmer, T.E. *et al.* (2022) 'Performance based sub-selection of CMIP6 models for impact assessments in Europe', *Earth System Dynamics Discussions*, pp. 1–45. Available at: https://doi.org/10.5194/esd-2022-31.

Papalexiou, S.M. *et al.* (2020) 'Robustness of CMIP6 Historical Global Mean Temperature Simulations: Trends, Long-Term Persistence, Autocorrelation, and Distributional Shape', *Earth's Future*, 8(10), p. e2020EF001667. Available at: https://doi.org/10.1029/2020EF001667.

Ridder, N.N., Pitman, A.J. and Ukkola, A.M. (2021) 'Do CMIP6 Climate Models Simulate Global or Regional Compound Events Skillfully?', *Geophysical Research Letters*, 48(2), p. e2020GL091152. Available at: https://doi.org/10.1029/2020GL091152.

Annex G – Production areas

Monfreda, Chad, Navin Ramankutty, and Jonathan A. Foley. 2008. "Farming the Planet: 2. Geographic Distribution of Crop Areas, Yields, Physiological Types, and Net Primary Production in the Year 2000." *Global Biogeochemical Cycles* 22 (1). https://doi.org/10.1029/2007GB002947.