# Spring frost and drought risk for perennial crops under changing climate conditions

**Anna Schmid**[1], Esther Bravine[2]

[1] Department of Econmics and Oeschger Centre for Climate Change Research, University of Bern
[2] Agroscope, Swiss Centre of Excellence for Agricultural Research

b UNIVERSITÄT BERN

OESCHGER CENTRE CLIMATE CHANGE RESEARCH

## OBJECTIVES

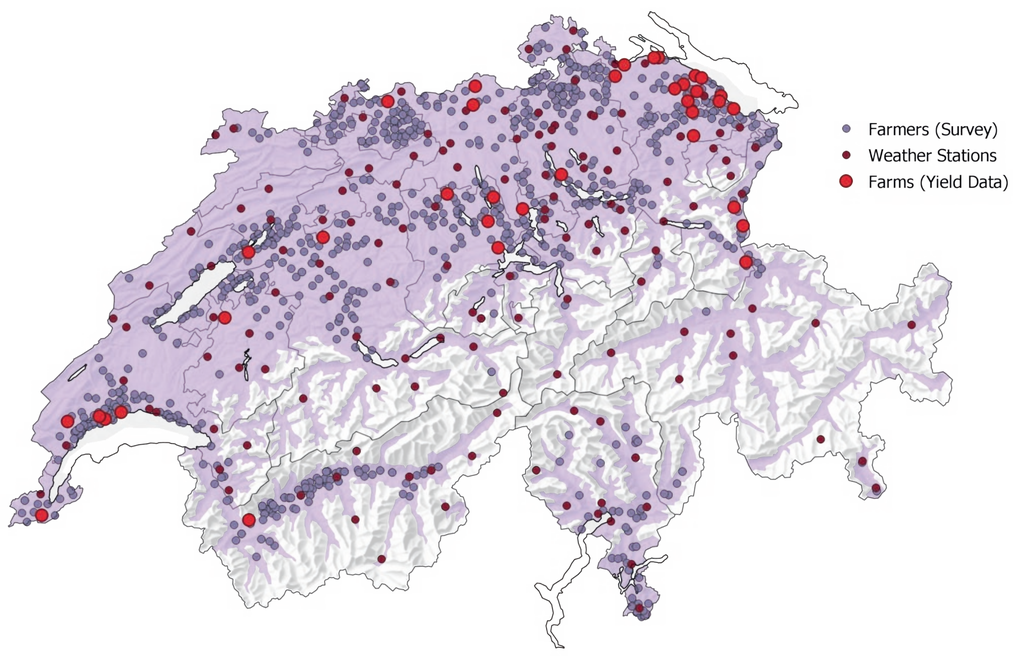
Assessing the impact of current and future frost and drought risk for Swiss apple orchards using a unique longitudinal microlevel dataset

## INTRODUCTION

- The future consequences of climate change on global agricultural production are well recognized
- Estimate the impact of different weather measurements (frost/drought) on perennial crops using fixed-effects regressions
- Scenario analysis of climate change using Swiss climate change scenarios CH2018

## DATA

- 505 orchards (variety specific) in approx. 40 farms across ten cantons, 55 apple varieties: yields [kg/ha], revenues, farm-gate prices, municipality, organic dummy, 1997-2019
- Ground station and gridded past weather data
- Swiss climate scenarios CH2018




## METHODS

Panel data model: $Y_{it} = X'_{it}\beta + _i + _t + \varepsilon_{it}$ , $i = 1, ..., n \quad t = 1, ...., T$

$Y_{it}$ : Agricultural yields (kg/ha)
$X'_{it}$ : Climate regressor matrix
$_{i,t}$ : Year and orchard fixed effects
$\varepsilon_{it}$ : Error term

- Construct own frost indices (based on apple phenology)
- Use growing degree days to estimate the temperature effect
- Control for all time-invariant unobserved heterogeneity
- Control for perennial specific dynamics (biennial bearing)

## PHENOLOGY

Silver tip ▸ Green tip ▸ Half-inch green ▸ Right cluster ▸ Pink ▸ First bloom ▸ Full bloom ▸ Post bloom

BBCH51 ▸ BBCH53 ▸ BBCH54 ▸ BBCH56 ▸ BBCH59 ▸ BBCH61 ▸ BBCH65 ▸ BBCH69

## DATA FOR PRELIMINARY ANALYSIS

Regional (WEST, LO, VS, EAST) pre- and postharvest estimates (kg/ha) 1995-2019 (SOV), precipitation and temperature for 37 ground stations (MeteoSwiss), Swiss climate scenarios CH2018 (MeteoSwiss)

## PRELIMINARY RESULTS

## PRELIMINARY RESULTS

- Large and significant negative effect of our frost indicator
- Biennial bearing: significant positive effect of one-year lagged frost variable (around 2/3 of the frost impact effectsize in the previous year)
- Positive effect of growing degree days (however rather small effect)
- Hot degree days have a significant negative effect on agricultural yield (trees can fall into “survival mode”)
- The climate change scenarios reveal regional differences, with some regions being more affected by frost and heat

## RESEARCH OUTLOOK

## NEXT STEPS

Using the new data: Incorporate winter chills and winter warming, construct precipitation indices, incorporate past/future shifts in blooming period, use different measures of frost and drought (cumulative wet, dry and frost days), further scenarios analyses, and inclusion of adaptation trends, potential inclusion of infrastucture and pests

## REFERENCES

CH2018 (2018): “Climate scenarios for Switzerland,” Techreport, National Centre for Climate Services, Zurich.
Dalhaus, T., W. Schlenker, M. M. Blanke, E. Bravin, and R. Finger (2020): “The effects of extreme weather on apple quality,” Scientific reports, 10, 1–7.
Schlenker, W. and M. J. Roberts (2008): “Estimating the impact of climate change on crop yields: The importance of nonlinear temperature effects,” Tech. rep., National Bureau of Economic Research.

POSTER PDF:

CONTACT: