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Prospects of Using Tree-Ring Earlywood and Latewood Width for Reconstruction of Crops Yield on Example of South Siberia

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Abstract: Improvement of dendrochronological crops yield reconstruction by separate application of earlywood and latewood width chronologies succeeded in rain-fed semiarid region. (1) Background: Tree-ring width chronologies have been successfully applied for crops yield reconstruction models. We propose application of separated earlywood and latewood width chronologies as possible predictors improving the fitness of reconstruction models. (2) Methods: The generalized yield series of main crops (spring wheat, spring barley, oats) were investigated in rain-fed and irrigated areas in semiarid steppes of South Siberia. Chronologies of earlywood, latewood, and total ring width of Siberian larch (*Larix sibirica* Ledeb.) growing in forest-steppe in the middle of the study area were tested as predictors of yield reconstruction models. (3) Results: In the rain-fed territory, separation of earlywood and latewood allowed increasing variation of yield explained by reconstruction model from 17.4 to 20.5%, whereas total climatic-driven component of variation was 41.5%. However, both tree-ring based models explained only 7.7% of yield variation in the irrigated territory (climate inclusion increased it to 34.8%). Low temperature sensitivity of larch growth was the main limitation of the model. A 240-year (1780–2019) history of crop failures and yield variation dynamics were estimated from the actual data and the best reconstruction model. (4) Conclusions: Presently in the study region, breeding of the environment-resistant crops varieties compensates the increase of temperature in the yield dynamics, preventing severe harvest losses. Tree-ring based reconstructions may help to understand and forecast response of the crops to the climatic variability, and also the probability of crop failures, particularly in the rain-fed territories.

Keywords: Siberian larch; tree-ring chronologies; earlywood width; latewood width; small grain crops; semiarid conditions; crops failures; reconstruction model

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1. Introduction

Long- and short-term climatic variations affect the growth and productivity of both natural vegetation and agricultural crops in a fundamentally similar way [1,2]. Global warming has led to shifts in productivity maxima and distribution areas towards higher latitudes [3,4]. Studies of long-term crops yield dynamics can provide important information on the vulnerability of agroecosystems to climate change and future risks to food security [2,5–7]. However, this field of research is limited by insufficient availability