# PROFITABILITY OF IRRIGATION UNDER THE EFFECTS OF CLIMATE CHANGE – A SITE AND CROP SPECIFIC ASSESSMENT AT THE EXAMPLE OF BRANDENBURG

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# PROFITABILITY OF IRRIGATION UNDER THE EFFECTS OF CLIMATE CHANGE – A SITE AND CROP SPECIFIC ASSESSMENT AT THE EXAMPLE OF BRANDENBURG


## Abstract

Irrigation is seen as an appropriate adaptation measure to the effects of climate change. However, the costs of irrigation are not always covered by the additional revenue. Based on simulated yields using the crop growth model HERMES for different climate scenarios we estimate the profitability for three typical agricultural crops for different soil quality levels in the federal state of Brandenburg. The results show that not in all cases irrigation can be profitably applied. Medium quality soils are in general the sites that turn irrigation into a profitable revenue. Future crop price increases could turn irrigation more profitable, but the increasing irrigation water demands need to be met by water availability which is already a concern in some regions of Germany.



## Keywords

Irrigation, climate change, profitability, economic assessment, water availability.


## 1 Introduction

Irrigation is regarded as a promising measure for farmers to increase yield, stabilize its variability and improve nutrient uptake especially under the effects of climate change, which is particularly important on marginal soils (LFULG 2014). The objective of this study is to evaluate irrigated production activities on 5 different soil quality types in the federal state of Brandenburg for different crops and climate scenarios.

## 2 Methods and data

Based on detailed process-based crop yield modelling for different climate change scenarios adjusted for the regional soil and weather conditions in Brandenburg, we calculate the crop specific profitability of irrigation for a number of crops and discuss advantages and disadvantages of future irrigation activities. In Brandenburg, agricultural production is challenged by dominant sandy soils with a low water storage capacity and precipitation reaching hardly 600mm per year (LISCHEID 2010).

Yields are simulated by the process-oriented crop-growth model HERMES (KERSEBAUM 1995) for five different soil qualities in combination with historical weather of the base line and six scenarios of climatic change in Brandenburg on a 25x25 km grid. The climate scenarios differ in terms of the assumed greenhouse gas emissions according to the Representative Concentration Pathways (RCP) and the climate models used (Max Planck Institute for Meteorology - MPI, Met Office Hadley Centre - HAD). The model can derive automatic irrigation and nitrogen fertilization depending on daily soil and crop status.

A comparative economic assessment of the irrigation effects was carried out on the basis of the difference between additional revenue and additional costs for irrigation. In order to calculate the additional revenue (AR) from irrigation, the additional yield (AY) of the crop calculated with the HERMES model was multiplied by the average producer prices (PP) of the respective crop (c) in Brandenburg in the years 2011-2015 (LELF 2016), depending on the region (r) and climate scenario (s). The additional costs were represented by irrigation costs (fixed and variable costs) and additional fertilization costs. Fixed irrigation costs (ICF) were assumed to be 146 €/ha (LFULG 2014), and variable irrigation costs (ICV) per mm of irrigation quantity

(IQ) were estimated at 1.23 €/mm (LFULG 2014) and additional fertilization costs were assumed to be 0.99 € per kg of nitrogen fertilization quantity (AFQ) calculated from the 5-year average (2011-2015) of costs per kg N for KAS 27 % N (LELF 2016). The equation (1) below shows the calculation.

(1) ARcrs= AYcrs (dt) * PPc (€/dt) – ICF– IQcrs (mm)* 1.23 €/mm –AFQcrs (kg) * 0.99 €/kg N

## 3 Results and discussion

Depending on the soil quality and the climate scenario, the simulated yields of the irrigated crops showed different levels of profitability for irrigation (see Figure 1). Simulated yields of the baseline fit current levels in Brandenburg.

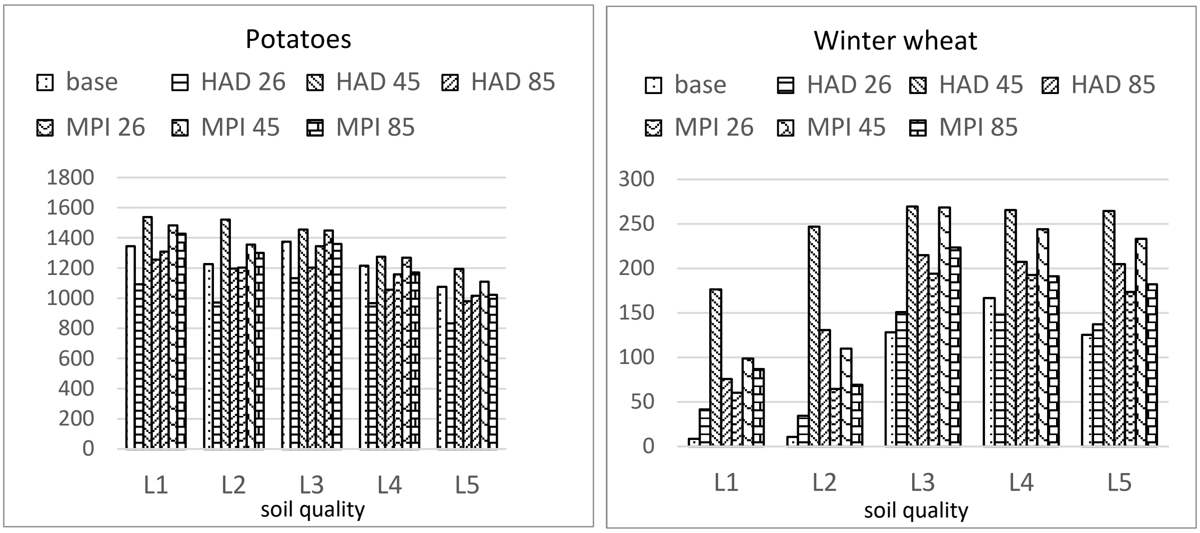


**Figure 1: Net additional revenue from irrigation for different soil qualities (L1-L5) and climate scenarios (examples: potatoes, winter wheat)**

The revenue of the additional yield for potatoes is positive for all sites and climate scenarios. The irrigation of winter wheat is less profitable as compared to potatoes, but less fertile soils can benefit from irrigation. The calculated variation coefficients for the yields of both crops underline that irrigation does stabilize yields (e.g. 0.28 for rainfed, 0.04 for irrigated potatoes on better soils (L1), not shown in figure).

## 4 Conclusions

Our results show that for most crops irrigation can be profitable, but the margins remain small for many crops (e.g. winter wheat). Investment in irrigation needs to carefully consider the trends in crop prices and the local and regional availability of irrigation water. At current prices, investment in irrigation is only rational if at least one high profit crop is grown (e.g. potatoes) or as an insurance against climate hazards – especially important for livestock and biogas producers that have to ensure the availability of feed and substrate. In all climate scenarios and for most soil qualities irrigation becomes more profitable as compared to current conditions.

## 5 References

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