LIÈGE université
Gembloux
Agro-Bio Tech

Le Corps professoral de

Gembloux Agro-Bio Tech - Université de Liège vous prie

de lui faire l'honneur d'assister à la défense publique de la dissertation originale que

Monsieur LIU Qin,

Titulaire d'un *master of ecology*,

présentera en vue de l'obtention du grade et du diplôme de

DOCTEUR EN SCIENCES AGRONOMIQUES ET INGENIERIE BIOLOGIQUE,

le 27 juin 2017, à 10h30 précises (personne ne sera admis après cette heure),

en l'auditorium TOPO 1 (Topographie, bât. 3),

Passage des Déportés, 2 à 5030 GEMBLOUX.

Cette dissertation originale a pour titre :

« Crop water productivity of winter wheat at multiple scales and its improvements over the Huang-Huai-Hai Plain, China ».

Le jury est composé comme suit :

Président: Prof. P. LEJEUNE, Président du Département BIOSE,
Membres : Prof. S. GARRE (Promoteur), Prof. C. YAN (Copromoteur – CAAS, Chine), Prof. B. TYCHON, Prof. A. DEGRE, Prof. B. MERCATORIS, Prof. M. XU (CAAS, Chine), Prof. R. LIU (CAAS, Chine).

Summary

Droughts and water shortage are amongst the most critical problems faced by worldwide agriculture, and it is so especially in China where agricultural production and prosperity are largely dependent on the timely, adequate and proper distribution of rainfall. The analysis of water productivity is becoming very critical in light of population growth, food security and increasing pressure on water resources. However, there is limited understanding of the spatio-temporal variation of crop water productivity (CWP) from the rotation system and its key influencing factors in Huang-Huai-Hai Plain (3H Plain) in which there is an over-exploitation of groundwater region and where future warmer and drought conditions will intensify crop water demand. As the largest water user, agricultural sector is facing a challenge to produce more crops with less water. Consequently, 3H Plain faced the double threat of both making contributions of high and stable yield to government and improving CWP of winter wheat through reducing water consumption. The overall ambition of this thesis was to investigate to what extent the grain yield and crop water productivity for winter wheat can respond to climate change and drought across the 3H Plain.

In our study, a combined dataset composed of a historical 54-year time series and the RCP 8.5 scenario from 40 meteorological stations was provided by the China Meteorological Administration. Among these 40 stations we selected 12 stations with more detailed information available. The minimal data sets required for model operation include daily climatic variables, soil information and management information collected from the China Soil Scientific Database. Finally, we also used satellite data to estimate water productivity mainly involved in MODIS products including MOD11A1 (land surface temperature/surface emissivity), MOD13A2 (NDVI) and MCD43B3 (surface albedo). We used SPEI-PM method, DSSAT-CERES-Wheat model and SEBAL model to explore the characteristics in grain yield and crop water productivity for winter wheat in response to climate change and drought associated with their improvements across the 3H Plain.

Our work demonstrated the investigation that an increase of ET_0 was predicted leading to subsequent drought rise in frequency, duration, severity and intensity under the RCP 8.5 scenario. The cumulative probability of the simulated yield reduction was detected to be higher during jointing to heading stage in northern than southern region due to water stress and changes in the management inputs. The lower CWP was mainly situated in the low plain-hydropenia irrigable land and dry land (zone2) and the hill-wet hot paddy field (zone6), which suggests that it is an important issue and opportunity for improving agricultural water management in the water-scarce 3H Plain. The spatial increase of yield principally controlled increase of water productivity in north agricultural sub-regions and the spatial increase of water productivity was more governed by increment of yield than the reduction of ET_a in other agricultural sub-regions. It will be adopted to develop feasible straw mulching, regulated deficit irrigation, and soil water storage and preservation to reduce pressure on groundwater over-exploitation, especially for winter wheat in the 3H Plain.

In our work, major agronomic consequences have been drawn regarding the reform of the common agricultural policy in Huang-Huai-Hai Plain, China. Researchers are encouraged to further investigations into how to implement these practices with emphasis of improving the sustainability of these agro-ecosystems.