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Introductory Chapter: Irrigation after Millennia - Still One of the Most Effective Strategies for Sustainable Management of Water Footprint in Agricultural Crops

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1. Introduction

Water is an essential component of the Earth's (agro) ecosystems with direct influence on global food production. As a renewable resource, water fluctuates over its phases in the global water cycle and replenishes the root zones (rhizospheres) of cultivated croplands in agroecosystems. Agroecosystem can be defined as a very complex functional unit of biotic (agricultural crops/varieties, animal breeds, uncultivated weeds and accompanied macro/micro biota) and abiotic (minerals, organics, fluids, gasses, water) components with the primary goal of food/feed production. Agroecosystems orientated to cultivated crop production have the major contribution in human food supply given that about 80% of human nutrition represent plant-derived foodstuffs (cereals, vegetables, fruits), while the rest are those of animal origin. Therefore, agroecosystems are the world's principal food supplier, as well as the predominant user of renewable freshwater (*blue water*) resources, consuming globally per year ~7 trillion m³ of water, either in rain-fed (~60%) or irrigated (~40%) conditions. Thus, water resources and their management in agroecosystems are of crucial importance for stability and security of global food production.

However, from the last several decades, water resources exploited in (agro) ecosystems have been started to be overexposed to different human-induced pressures (pollution by modern in/organic contaminants) and non-sustainable management practices (uncontrolled water abstractions, lacking of purification, recycling and/or reusing of *grey waters*). Such pressures accompanied with ongoing global climate changes and processes (more frequent and intensive droughts, deruralisation, human growth in water-stressed areas) imbalance water cycling and reduce availability of fresh hydro-resources for increased food demands.

Agroecosystems, especially those rain-feed, are experiencing more frequent and pronounced water imbalances (water stress) on the soil-plant-atmosphere route. Besides the substantial reduction in yield and quality, water stress in arable areas often additionally underpins numerous other environmental constraints such as salinisation, desertification, soil organic matter depletion, biodiversity reduction, eutrophication, etc. Thus, ensuring a stable and balanced water relationship in the soil-crop route is important for the sustainability and stability of the whole (agro) ecosystem.

Implementation of irrigation practice in agroecosystem is one of the most effective approaches to overcome crop water stress and ensure stable and quality food supply. It was confirmed that application of irrigation systems can substantially reduce the *water footprint* (i.e. a measure for the water volume needed for the realisation of goods and/or services), notably in horticultural and fruit crops more responsive to irrigation. Irrigated agroecosystems are overspread at nearly 20% of cultivated land areas but they generate even ~40% of global food supplies. For more than 50 years (1961–2009), irrigation was one of the widely accepted and fast-growing global strategies for overcoming water stress in agroecosystems and generator of continuous stable crop yields. In the same period, irrigated areas grew almost linearly by 120% and occupied about 300 Mha worldwide. However, due to increasing demands and continuous competition for high-quality water resources in the agricultural-industrial-domestic triangle, it is quite unrealistic to expect further expansion of agricultural irrigation on the expanse of rain-feed cropping. Adaptations to modern challenges of irrigated agroecosystem (e.g. more frequent and pronounced draughts and extreme heat strikes) aim to improve water use efficiency (WUE), and are therefore more likely. Namely, most of the modern sustainable irrigation (agricultural) management strategies are focused on using hydro-/land-resources more effectively (avoiding/reducing losses and quality deterioration) and more efficiently (maximally increasing food production) which are encompassed by the concept of WUE.

Among traditional irrigation methods and systems (which dominate at nearly 95% of irrigated area) and modern ones (distributed at nearly 5% of irrigated land) existing many significant differences in WUE along with their different operational (technological) and environmentally related characteristics. For instance, traditional surface gravity-flow irrigation systems (furrows, basins, contours, *muang fai*) in comparison to modern ones (drip irrigation, low-energised/-pressurised sprinklers) can obtain and up to two-fold lower WUE. Consequently, there is a significant potential for improvement of WUE in irrigated agroecosystems over shifting from traditional to modern irrigation systems and/or upgrading particular sections and their elements (from the water source over conveyance system to the irrigated paddocks) of traditional systems.

Finally, improved irrigation management (scheduling, timing, frequency, depth) was confirmed as one of the most feasible approach of achieving large increases in WUE. Current soil-water regime, detected either on real-time *in situ* approach (with precise sensors, probes) or calculated based on nearby weather recordings (to obtain reference evapotranspiration, crop coefficients, effective rainfalls), may significantly optimise irrigation timing and consequently improve WUE. Processing of such instantly collected data over modern information technologies (smartphone/PC applications) represents some of the most novel approaches in irrigation agroecosystems management.

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