Expanded Production of Irrigated Wheat

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Summary

Grain yields of wheat strongly decrease when the crop is exposed to high diurnal temperatures at any point during its growth cycle and this occurs frequently in the hot rainy seasons when wheat is traditionally cultivated by farmers across the dry lowlands of Sub-Saharan Africa. Heat events in this time of year have become more regular and more intense because of global climate change, whereby exacerbating the risk of yield losses and crop failure for farmers. Growing wheat during the cool season in African dryland belts, referred to as winter production, avoids that the crop gets exposed to the adverse effects of heat stress. The cooler weather during this time of year however makes that limited amounts of precipitation are received and consequently irrigation systems need to be in place for wheat crops to grown up to their full potential. Investments for water lifting and drip feed infrastructure are profitable in the short term because winter production ensures stable high levels of wheat grain yield and quality. This way the innovation allows to build a food value chain that is resilient to climate shocks and to expand the cultivation of wheat across non-traditional growing areas of drylands. The success of irrigated wheat production in several breadbasket regions of Africa is advancing self-sufficiency and reducing expensive importation.

Technical Description

Farmers in Africa traditionally cultivate wheat during the wet season because adequate rainfall is received without investment in irrigation. However, high mean diurnal temperatures of 33-36°C and extreme heat events with temperatures above 45°C may occur during the growing season that acutely reduce the performance of wheat, even for improved varieties bred to withstand heat stress. By cultivating wheat in the cooler, dry season, the risk of heat-related yield loss is reduced as temperature spikes above 35°C are uncommon. To compensate the lack of rainfall during the dry season, wheat crops must be provided between 300 to 500 mm of water through irrigation. The advantageous growing conditions under irrigation also lower the risks of pests and diseases. Irrigated winter production of wheat also enables farmers to practice crop rotation, particularly with legumes that serve to protect soil quality.

Uses

There is very large potential for irrigated winter production of wheat in the dry sub-humid and semi-arid belts across the lowlands of Western Africa, Horn of Africa and

Southern Africa since these regions face high temperatures and regular heatwaves during summer season. Wheat farmers in the Eastern African low-altitude and mid-altitude highlands where the hot rainy season sporadically experiences above normal temperatures and heat events can also eliminate weather-related risks by cultivating the crop during the dry cool time of year. Strategic planning and deployment of irrigated wheat production in the cool seasons of Africa’s breadbasket areas is of great importance to achieve wheat self-sufficiency under rapidly warming conditions and more frequent heat.

Composition

Winter production of wheat in Africa can be performed with spring bread varieties if more than 450 mm of water in supplied through irrigation and rainfall, whereas spring durum cultivars need to be used when the supply of water is 250 to 450 mm. Heat-tolerant wheat varieties can be used in years when elevated temperatures and heat waves are predicted to occur during the cold season, while common spring wheat cultivars may be grown under normal weather conditions. The type of irrigation that farmers will put in place for winter production of wheat depends on the available water sources and topographic position of fields. In broad terms, they have a choice between passive gravity-based systems that divert rivers via canals and dams, or active levitation systems that draw from surface and underground reservoirs through water pumping systems. Overhead water delivery requires higher water pressures, while furrows and floods may be supplied through gravitational flow.

Means of application

The window for growing wheat during the dry season of African drylands may be rather narrow since cooler temperatures last only 2-3 months and because of delays in cultivation and harvesting before and following the rainy season. In that case, it is necessary to use early maturing wheat varieties with production cycles of 90 to 100 days. Before tillage and sowing can take place the land has to be irrigated, which can either be done by opening a dam that collected water during the rainy season or by pumping it from nearby rivers. Seed must be planted into moist beds using water from dams or nearby rivers. Soils are ploughed and levelled by hand, animal or tractor at which stage farmyard manure or other organic resources should also be incorporated. Seed is planted in lines to allow effective control of weeds and more even distribution of water.

Agroecologies	Dryland area, Highlands, Moist savanna.
Regions	Africa South of Sahara.
Developed in Countries	Burkina Faso, Zimbabwe, Zambia, Sudan, Senegal, Nigeria, Niger, Mozambique, Mali, Malawi, Ethiopia.

Available in	Burkina Faso, Zimbabwe, Zambia, Sudan, Senegal, Nigeria, Niger, Mozambique, Mali, Malawi, Ethiopia.
Solution Forms	Management.
Solution Applications	Soil/land conservation.
Agricultural Commodities	Wheat.
Target Beneficiaries	Small-scale farmers, Commercial farmers.

Commercialization

Commercialization Category

Commercially available

Startup Requirements

Wheat production may be greatly expanded across Africa if the following conditions are met: 1) Educate farmers and investors about the advantages and costs of crop irrigation, 2) Provide access to quality seed of improved varieties, affordable irrigation systems and technical advisory services on their use, 3) Link producers with markets and food processors through prices allowing fair profits and 4) Consider wheat value chains within public sector water infrastructure development projects.

Production Costs

The main expenses for winter production of wheat in dryland farming systems include the installation and maintenance of irrigation systems, the purchase of improved seed, mineral fertilizers, animal manure and chemical control agents, and the labour for land preparation, planting, weed management and harvesting. Farmers may also incur costs for the construction of reservoirs to store unused water in summer time, and also for the payment of licenses and fees to extract surface water or groundwater. High prices of irrigation water and low use efficiencies are substantially driving up the cost of winter production and can make it financially unsustainable. Winter production using surface irrigation in the Nile river delta of Sudan has been shown to bear a total cost of US $373 per hectare, with 19% going to irrigation. Infrastructure investments to constructing dams, reservoirs and pumping stations are covered as public sector agricultural investments.

Customer Segmentation

Irrigated dry season production of wheat can be practiced by small-scale and commercial wheat farmers in all major growing areas of Sub-Saharan Africa.

Potential Profitability

Irrigated winter production of wheat in the dry lowlands and highlands of Africa is known to realize grain yields of 4 to 6 ton/ha, while rainfed summer production reaps only 3-4 ton/ha during favourable years and less than 2 ton/ha in case heatwaves and drought spells occur. The technique also makes it possible to expand wheat production into untapped irrigable land, with a potential of 330,000 hectare along the Senegal and Niger River in Mali, and 108,000 hectare in Mauritania alone. Irrigated winter production of wheat in Senegal could displace the US $55 million annual durum imports. Cultivating wheat in the dry cool season under irrigation can replace the traditional unproductive fallow period on 7.2 million ha of rice paddies across West African countries.

Licensing Requirements

In some cases, farmers enjoy traditional water rights and may develop their own unlicensed small-scale irrigation schemes. In other cases, access to irrigation water is regulated and requires licenses and the payment of fees, even by farmers living alongside surface waters. Approvals from national and local regulatory agencies have to be obtained for installing irrigation equipment and extracting water from rivers or groundwater so that winter production of wheat can take place. Irrigation equipment and supplies often enter countries duty-free to encourage investment in agriculture.

Innovation as Public Good

Techniques for winter production of wheat in drylands are a Regional Public Good, and ICARDA and the International Water Management Institute have responsibility of developing and disseminating knowhow about appropriate varieties and irrigation systems. The intellectual property of irrigation systems that are commercially marketed is owned by manufacturers.

Solution Images

Water delivery to borders of planting basins

Irrigated wheat field in El Gezira, Sudan

Institutions

ICARDA
Science for resilient livelihoods in dry areas

Accompanying Solutions

Furrow Irrigated Raised Bed Wheat Production

Heat and Drought Tolerant Wheat Varieties