Mekonnen. M. M and Hoekstra. A. Y (2016) Four billion people facing severe water scarcity. *Sci Adv* [ONLINE] **12 2**(2) e1500323. doi: 10.1126/sciadv.1500323. [Accessed 12/03/2019] Available from: <https://www.ncbi.nlm.nih.gov/pubmed/?term=Four+billion+people+facing+severe+water+scarcity>

* Taking account into seasonal fluctuation in water availability, more than half of the global population face at least one month of water scarcity per year since the period 1996-2005.
* 1.8-2.9 billion face water scarcity for 4-6 months per year.
* Half of those 4 billion populations reside in China and Indian, countries with heavy cultivation of Oryza sativa. With China harvesting mainly japonica variety of rice.
* A cause of scarcity being water consumption leading to drying river and lakes e.g. Yellow River in North China, Aral Sea in Central Asia, Chad Lake in Africa.

Liu. H. Zheng M. *et al* (2015) Dry direct-seeded rice as an alternative to transplanted-flooded rice in Central China. *Agron. Sustain. Dev.* [ONLINE] **35**:285–294. DOI 10.1007/s13593-014-0239-0. [Accessed 19/03/2019] Available from: <https://link.springer.com/article/10.1007/s13593-014-0239-0>

* According to FAO Statistical databses. Food and Agriculture Organisation. China’s production of rice plays a key role in food security of Asian Region.
* WP = agricultural water productivity. A measure of the efficiency of water use in farming.
* Under a study period from 2012 to 2013. Where rainfall and temperature was consistent within the 10 year average window. Dry direct seeding rice of the Lavitica variety was shown to have consumed 15.3% less water than transplanted-flooded rice.

Farooq. M, Siddique. K.H.M., (2010) Rice direct seeding: Experiences, challenges and opportunities.*Soil & Tillage Research* [ONLINE] **111** (2011) 87–98 DOI: 10.1016/j.still.2010.10.008[Accessed 19/03/2019] Available from: <https://www.researchgate.net/profile/Tariq_Aziz23/publication/229396674_Rice_direct_seeding_Experiences_challenges_and_opportunities/links/5c6dcde592851c1c9df12ec3/Rice-direct-seeding-Experiences-challenges-and-opportunities.pdf>

In transplant-flooding method, rice seedlings are grown in an anaerobic nursery then transplanted to a continuously flooded soil created by puddling. The puddling process itself leads to water loss which is increased further by surface evaporation. The Dry-directed seeding rice seedling are grown in aerobic conditions, the seedlings are sown in rows without the need for puddling.

Knetminer database contains

Mahender. A, Anandan A and Pradhan S K. (2015) Early seedling vigour, an imperative trait for direct-seeded rice: an overview on physio-morphological parameters and molecular markers. *Planta* [ONLINE] **241**(5) pp1027-1050. [Accessed 19/03/2019] Available from: <https://link.springer.com/article/10.1007%2Fs00425-015-2273-9>

* ESV. Early Seedling Virgour is a criteria assessing the success of DSR crops through measuring seedling germination, development and tolerance under various field conditions.
* Traits both morphological and physiological include

coleoptile length

mesocotyl length

root length

seminal root length

Germination rate.

Seedling growth.

* Many QTL have been found for these ESV traits from recombinant inbred lines, biparental segregating populations.