IJASD
ISSN:2618-1193

Improving Rice Yield Through Insufficient Water

Hania Arif[1]*, Mamoona Midhat Kazmi[2] , Aamer Amin[3]
[1]*Centre for Integrated Mountain Research (CIMR),Universityof the Punjab, Lahore
[2,3,]Department of Space Science,University of the Punjab, Lahore
* HaniaArifEmail: dr.haniaarif@gmail.com

Citation | Hania Arif, Mamoona Midhat Kazmi, Anam Munawar, and Aamer Amin, "Improving Rice Yield Through Insufficient Water", IJASD, vol. 3, no. 2, pp. 33–38, May 2021

Received | April 14, 2021; **Revised |** May 16, 2021; **Accepted |** May 20, 2021; **Published |** May 24, 2021.

Pakistan's most important crops are rice, grown on 2.83 million hectares and producing 6.9 million tonnes annually. Exporting rice from Pakistan is a major source of foreign currency for the country because of its widespread use as a staple food. While other cereal crops require less water, rice is a considerably more water-intensive crop. Agricultural water management includes all technologies and practices that promote water production to meet the increasing demand for irrigation water and the restricted availability due to climate change. Laser land leveling was first used in Pakistan in the 1980s. For the first time, the International Rice Research Institute (IRRI) has created an alternate wetting and drying method. Farmers in rice fields utilized laser land leveling technology to determine how much irrigation water they used as a result. To make this idea a reality, 17 local farmers from various countries were chosen. The data collected were analyzed using the Excel spreadsheet application. There was a lot of water at the canal's head, but only 20% of it was available at its tail. Tube well operations fulfilled the final 20% of irrigation water needs at the head, 50% in the middle, and 80% at the tail. Before introducing AWD and laser land leveling technologies, tube well operating time was decreased by 25.49 percent, 20.3 percent, and 22.5 percent. Reducing the number of hours a tube well is run has two benefits: it reduces irrigation water extraction, which is important in light of climate change, and it reduces energy costs for tube well operation, which increases farmer profitability. These findings are consistent with previous research. Because this survey did not isolate yield and AWD technology and laser land leveling from other characteristics that may be investigated in future research studies, responding farmers also claimed a rise in paddy output to contribute to yield improvement. AWD technology has not been prioritized despite the government's investment in laser land leveling. Because of this, it is advised that the use of AWD technology be increased in agriculture.

Keywords; AWD Technique, IRRI, Water Scarcity, Sustainable Farming.

Introduction

The most important crop in Pakistan is rice. Second, only the country's wheat production was planted 2.69 million hectares in 2018 with 6.702 million metric tonnes, production of 2018's rice crop set new records [1][2]. Rice growing accounts for 66 percent of Punjab province in Pakistan. Exporting rice from Pakistan is a major source of foreign currency for the country because of its widespread use as a staple food. Between 2015 and 2018, rice exports generated more than 1426 million in revenue[3][4][5]. On the other hand, Rice needs a lot of water to thrive. Pakistan already has a serious problem with water scarcity, thus increasing water productivity becomes even more important. Increasing agricultural water output is one way to help ensure food security. Water productivity refers to the amount of value or advantage that can be generated by using water[6][7][8]. In a normal rice field, one kilogram of rice requires 300 to 500 gallons of irrigation water [9][10]. It doesn't matter how much water researchers [11][12] claim rice cultivation requires because rice is generally a water-intensive crop. There are approximately 1448 liters of evapotranspiration needed to produce one kilogram of rice according to the International Rice Research Institute [13][14]. Irrigation systems require 500-1,000 liters of water for every kg of rice produced [13].[15] When it comes to producing one kilogram of rice, a rice field requires approximately 2,500 liters of water. All evapotranspiration, seepage, and percolation fluxes are contained in this 2,500-liter container. Several field tests conducted throughout Asia helped researchers arrive at an average quantity. This average might be anywhere from 800 to over 5,500 liters depending on the individual. Crop management, weather, and soil conditions may all play a part in crop failures and failure rates. Rice fields use two to three times as much water as the other major cereal crops on the farm[16].

Most rice-growing regions in Asia now demand a significant amount of irrigation water due to contemporary rice-growing techniques. According to the Philippines and India, a kilogram of rice needs around 3,000 gallons of water for irrigation purposes. In irrigated areas, there are no water conservation strategies utilized, and water is needed in these and other non-agricultural sectors. Current rice crop farming techniques must be upgraded to maximize irrigation water efficiency. Farming practices that conserve water are critical to reducing greenhouse gas emissions[17][9]. Climate changes need a shift from existing agricultural practices to more sustainable and ecologically friendly practices, with an emphasis on climate-smart production techniques," [18]. By 2020, farmers in India must produce 50% more grain to meet demand, [19][6]. Agricultural water management must incorporate innovative technologies and practices that provide optimal soil moisture conditions for plant growth to deal with increased irrigation water demand and decreasing water availability [3][20]. Crop patterns can be used to swap one crop for another, like dried rice [20]. The Alternate Wetting and Drying (AWD) approach developed by IRRI in 2004 was requested by irrigated rice producers in Bangladesh to meet their needs for conserving water, energy, and fuel. AWD, a water-saving technology for rice growers, can be used to reduce irrigation water use in rice fields. It is only after the ponds have been drained that irrigation water is used to saturate the rice fields. AWD irrigation cycles can last anything from one to ten days. 15 cm of water depth is considered a "Safe AWD" threshold as long as irrigation does not influence yield. About 15-30 percent of water consumption can be saved if you use a safe all-wheel drive vehicle.

Methods

Increasing water restrictions, primarily due to climate change, have necessitated the use of laser land leveling and AWD technology in Pakistan recently. Pakistan has been using laser land leveling since the 1990s, although AWD is a more recent development. Using laser land leveling, the issue of excessive irrigation was solved. Overwatering was a common problem in areas that were not level [21]. The result is a decrease in irrigation water use and an increase in water loss [22]. Drought-resistant crops may be grown on more acreage thanks to laser field leveling, which improves irrigation water distribution, increases cultivable land, and enhances crop standing. Studies conducted by scientists [23]–[25].

AWD technology in conjunction with laser land leveling the Global Program on Food Security (GPFS) of the Swiss Agency for Development and Cooperation (SDC). Swiss Intercooperation (Helvetas) in Muridke tehsil of district Sheikhupura, Punjab, Pakistan, and MARS Food (MARS) is implementing the project (MARS through Rice Partners Limited). Many stakeholders are involved in the WAPRO initiative, which attempts to increase water production. A new WAPRO Push-Pull-Policy technique can boost rice field water productivity [26][2]. Improvements in rice production and irrigation practices are highly sought after by rice producers.

This study was conducted to examine the influence of irrigation water use efficiency, including the use of laser field leveling prior to the implementation of AWD by the beneficiaries/respondent farmers. Methods and supplies are included in this section.

Findings

Using information from the channel's head, it was determined that the canal's water supply was significantly higher. The water supply at the canal's head was expected to be between 85% and 85% of the irrigation water requirement. The remaining 25% to 30% of irrigation water needs were satisfied by employing tube wells. Tube well operations at the head needed 15.13 hours per acre prior to the advent of laser field leveling. Using AWD and precision leveling technology reduced farmers' tube well operation time by nearly half.

While canal water use has remained steady, tube well water consumption has fallen by 25.90 percent when AWD technology and laser land leveling were installed. Farmers that participated in the study reported an increase in paddy yield. Other agronomic elements, such as AWD tube technology and laser land leveling, may also contribute to improved yields; however, this study did not isolate yield from other variables that may be explored in the future.

AWD technology lowered irrigation water application by 25.47 percent to 24.23 percent and boosted rice production in the places studied in his research [27]. According to Rejesus, irrigation time was reduced by 35 percent without decreasing productivity [28]. Numerous academics have observed that laser land leveling saves irrigation water[23]–[25]. Reducing the number of hours a tube well is run has two benefits: it reduces irrigation water extraction, which is important in light of climate change, and it reduces energy costs for tube well operation, which increases farmer profitability.

Mid-channel observations revealed a much higher volume of canal water than previously considered possible. Farmers in the middle of the canal were better off using canal water for irrigation since they could collect about half of their irrigation water from the canal and the other half from tube wells, which was more convenient for them. Before AWD and laser field leveling, drilling a tube well took 34.85 hours per acre. Using AWD methodologies and laser field leveling, tube well operation time was decreased from 33.81 hours per acre to 25.53 hours per acre, allowing farmers to meet their water needs.

There was a 21.9 percent reduction in tube well operation time in the central area. Following AWD methods and laser land leveling techniques, the amount of tube well water used has decreased by 19.3 percent. Both [27], [28]reported results that were indistinguishable from one another. According to the farmers who took part in the survey, the use of AWD and laser field leveling increased their paddy yields.

Data gathered from the channel's tail showed a low canal water supply. There were difficulties in collecting canal water at the end of the channel and farmers could only obtain around 19.5% of their irrigation water demands from canal water, with the remaining 89% coming through tube well operation. Tail tube wells used to take 49.76 hours per acre to operate before AWD and laser land leveling were adopted. Combining the AWD technique with laser field leveling reduced tube well operation time from 49.94 hours per acre to 39.56 hours per acre.

Even with continuous canal water application, tube well water application has decreased by 25.6% when using AWD and laser land leveling procedures. Both [27], [28]reported results that were indistinguishable from one another. Respondent farmers claimed that their paddy yield had increased, even if other agronomic factors such as those previously discussed may have contributed to the increase.

Conclusions

Rice is not only a staple food in Pakistan, but it is also a major export that generates a large amount of revenue. While other cereal crops require less water, rice is a considerably more water-intensive crop. Traditional rice farming in irrigated settings in most Asian rice farms requires a significant amount of water. Therefore, it is necessary to change the way food is produced to make it more environmentally friendly and sustainable. Climate-smart methods of production that use less water should therefore be prioritized. Increasing irrigation water demand and decreasing water supplies as a result of climate change necessitate technologies and practices that boost water productivity. Laser land leveling was first used in Pakistan in the 1980s. It has only been introduced by the International Rice Research Institute (IRRI) a novel water-saving approach.

References

[1] M. C. V Manlagn, "Journal of Asian Economics Cost efficiency , determinants , and risk preferences in banking : A case of stochastic frontier analysis in the Philippines," vol. 22, pp. 23–35, 2011, doi: 10.1016/j.asieco.2010.10.001.

[2] E. J. Malesky et al., "Journal of Southeast Asian Economies," vol. 33, no. 2, 2016.

[3] F. Authors, "The total factor productivity in China and India : new measures and approaches," 2012, doi: 10.1108/17561370910915339.

[4] D. J. Mayston, "Analysing the effectiveness of public service producers with endogenous resourcing," no. 1977, 2015, doi: 10.1007/s11123-014-0428-5.

[5] T. M. Zulqarnain Anwar, Zain Rafique1, Aamer Amin, "Impact Assessment of Organizational Stress in Agriculture Sector," Int. J. Agric. Sustain. Dev., vol. 3, no. 1, pp. 1–6, 2021.

[6] R. Developments and E. Measurement, "RECENT DEVELOPMENTS I N FRONTIER MODELLING AND EFFICIENCY MEASUREMENT," vol. 39, no. 3, 1995.

[7] A. Cullmann, Æ. C. Von Hirschhausen, A. Cullmann, and Á. C. Von Hirschhausen, "Efficiency analysis of East European electricity distribution in transition : legacy of the past ?," pp. 155–167, 2008, doi: 10.1007/s11123-007-0075-1.

[8] D. Molden, H. Murray-Rust, R. Sakthivadivel, and I. Makin, "A water-productivity framework for understanding and action.," Water Product. Agric. limits Oppor. Improv., no. August, pp. 1–18, 2009, doi: 10.1079/9780851996691.0001.

[9] W. Yang, Y. Shao, H. Qiao, and S. Wang, "An Empirical Analysis on Regional Technical Efficiency of Chinese Steel Sector Based on Network DEA Method," Procedia - Procedia Comput. Sci., vol. 31, no. Itqm, pp. 615–624, 2014, doi: 10.1016/j.procs.2014.05.308.

[10] P. Fu, Z. Zhan, and C. Wu, "Efficiency Analysis of Chinese Road Systems with DEA and Order Relation Analysis Method : Externality Concerned," Procedia - Soc. Behav. Sci., vol. 96, no. Cictp, pp. 1227–1238, 2013, doi: 10.1016/j.sbspro.2013.08.140.

[11] N. Jackson, M. Konar, and A. Y. Hoekstra, "The water footprint of food aid," Sustain., vol. 7, no. 6, pp. 6435–6456, 2015, doi: 10.3390/su7066435.

[12] T. M. Hamna Butt, Aamer Amin , Shahida Haji, "Family Farming Improves The Livelihood in Highlands of Pakistan," Int. J. Agric. Sustain. Dev., vol. 3, no. 1, pp. 24–30, 2021.

[13] Z. Svitalkova, "Comparison and evaluation of bank efficiency in selected countries in EU," Procedia Econ. Financ., vol. 12, no. March, pp. 644–653, 2014, doi: 10.1016/S2212-5671(14)00389-X.

[14] C. Detotto, M. Pulina, and J. Gabriel, "Assessing the productivity of the Italian hospitality sector : a post-WDEA pooled-truncated and spatial analysis," 2013, doi: 10.1007/s11123-013-0371-x.

[15] A. A. Saira Batool, "Drip Irrigation Toward Sustainable Future," Int. J. Agric. Sustain. Dev., vol. 3, no. 1, pp. 7–14, 2021.

[16] A. A. Junaid Sabir, Kashif Shafique , Jamal Hasan, "Activism of Child Labour in Agricutural Sector," Int. J. Agric. Sustain. Dev., vol. 3, no. 1, pp. 15–23, 2021.

[17] T. B. Sapkota, M. L. Jat, J. P. Aryal, R. K. Jat, and A. Khatri-Chhetri, "Climate change adaptation, greenhouse gas mitigation and economic profitability of conservation agriculture: Some examples from cereal systems of Indo-Gangetic Plains," J. Integr. Agric., vol. 14, no. 8, pp. 1524–1533, Aug. 2015, doi: 10.1016/S2095-3119(15)61093-0.

[18] CCAFS, "Big facts on climate change, agriculture and food security," Clim Change, Agric. Food Secur. (CCAFS)., 2013.

[19] R. Kumar and H. Raj Gautam, "Climate Change and its Impact on Agricultural Productivity in India," J. Climatol. Weather Forecast., vol. 2, no. 1, pp. 2–4, 2014, doi: 10.4172/2332-2594.1000109.

[20] V. Gitz, A. Meybeck, L. Lipper, C. Young, and S. Braatz, Climate change and food security: Risks and responses. 2016. doi: 10.1080/14767058.2017.1347921.

[21] S. H. Johnson, Z. S. Khan, and C. M. Husain, "The economics of precision land leveling: A case study from Pakistan," Agric. Water Manag., vol. 1, no. 4, pp. 319–331, Dec. 1977, doi: 10.1016/0378-3774(77)90023-3.

[22] F. H. K. and A. R. T. Sattar, A., "Impact of precision land leveling on water saving and drainage requirement," J. AMA, vol. 34, no. 39, p. 41, 2003.

[23] S. Hosseini, "The Perception of Farmers about Laser Land Levelling as an Appropriate Technology in Agricultural Sector of Iran," Annu. Res. Rev. Biol., vol. 4, no. 13, pp. 2207–2214, 2014, doi: 10.9734/arrb/2014/9688.

[24] R. A. K. and S. U. K. Khattak, J.K., K.E. Larsen, A. Rashid, "Effect of land leveling and irrigation on wheat yield," J. AMA, vol. 12, no. 11, p. 14, 1981.

[25] W. C. and A. C. E. Ali, A., "The improved water and land use management through precision land leveling," J. Water Manag., 1991.

[26] A. Nizami, M. Zulfiqar, J. Ali, N. Khan, and I. Sheikh, "Improving water productivity in rice-a response to climate change and water stress in Pakistan," Sarhad J. Agric., vol. 36, no. 2, pp. 383–388, 2020, doi: 10.17582/JOURNAL.SJA/2020/36.2.383.388.

[27] K. Hasan, A. H. M. Abdullah, D. Bhattacharjee, and S. I. Afrad, "Impact of Alternate Wetting and Drying Technique on Rice Production in the Drought Prone Areas of Bangladesh," Indian Res. J. Ext. Educ., vol. 16, no. 1, pp. 39–48, 2016, [Online]. Available: https://www.researchgate.net/publication/317046550

[28] R. M. Rejesus, F. G. Palis, D. G. P. Rodriguez, R. M. Lampayan, and B. A. M. Bouman, "Impact of the alternate wetting and drying (AWD) water-saving irrigation technique: Evidence from rice producers in the Philippines," Food Policy, vol. 36, no. 2, pp. 280–288, Apr. 2011, doi: 10.1016/J.FOODPOL.2010.11.026.