LUMS | Centre for Chinese Legal Studies

The Critical Junction between CPEC, Agriculture and Climate Change

By Ammar Junaid Asghar, Amna Mahnoor Cheema, Muhammad Ibrahim Hameed, Syed Qasim Abbas, & Uswah Fatima[1]

(June, 2021)

Introduction

The China Pakistan Economic Corridor (CPEC) has shown great potential in boosting Pakistan's economy, especially by increasing export opportunities in the Pak-China agricultural trade. It is likely that under Chinese technological assistance and experience Pakistan is, and will be further able to add value to agricultural commodities, thus ensuring greater benefit for its economy. Infrastructure projects will help increase connectivity in remote regions, and facilitate the upgradation of practical rural infrastructure necessary for agricultural mechanization. Collectively, it will ensure the development and remediation of medium and low yielding land, as well as the construction of water-saving modern agricultural zones, to maximize resource efficiency.

Although CPEC brings along many benefits for the agriculture industry, its environmental sustainability has been a significant concern, especially in light of Pakistan's recent efforts to protect the environment. Other than the impact of CPEC on climate and agriculture, what further increases the concern for CPEC's environmental sustainability are its negative externalities like social inequity. In this sense, if environmental sustainability is overlooked while evaluating a mega project such as CPEC, it will have significant long-term impacts not only on the agricultural land, but also on the communities that inhabit it.

This paper attempts to evaluate CPEC's environmental sustainability. Where on the one hand, it recognizes CPEC's potential to cause significant environmental damage through mechanization and construction of large dams, on the other it argues that Pak-China cooperation would yield positive impacts on sustainability. It argues for Chinese assistance in training local farmers about sustainable agricultural practices and ensuring more ground-based local water sources in areas most susceptible to droughts as measures to a more environmentally friendly future. Chinese agricultural sustainability model complemented by Chinese investment can enable the PTI's government to fulfil its promise of protecting the environment. The paper also gives policy recommendations that can help mitigate CPEC's sustainability threat. Conclusively, a sustainable CPEC means ease in complementing global climate change protocols, which may open new horizons of opportunities for the country's agriculture.

[1] The authors were working as interns at the Centre for Chinese Legal Studies at the time of this publication.

Literature Review

According to Edward B. Barbier, a green economy equates to the promise of "improved human well-being and social equity while reducing environmental risks and ecological sacrifices". His paper explores the consequences of an emergence of the green economy in North America and concludes that a green economy promotes and catalyzes a new wave of industrial innovation, employment, research and development. All of these benefits hinge on the policy choice taken by the policy makers in the coming years to cater to the issue of effective and complementary public policies (Barbier). Green technology, which includes irrigation, research, improved varieties and fertilizers have associated positively with the agricultural output. Hussain and Hanjra have established and explored the positive impact of irrigation, a green technology, on growth of high veiled crops, generation of higher income and employment, reduction of the incidence and severity of poverty and many other positive consequences (Hussain and Hanjra).

Baksh and Kamran discuss the need for Punjab, Pakistan to adapt to climate change, especially in the rain-fed farming system. They have discussed the problems faced by the farmers who are highly exposed to the adverse effects of climate change due to complete 'reliance on frequency intensity, and timings of the rainfall'. This study investigated the different adaptational strategies of farmers in the rural setting of the less developed areas and examined the role of socio economics characteristics of these farmers on adaptation to the climate change. The results highlighted that education, farming experience, family size and tractor ownership are significantly related with the adaptation to climate change. This paper concludes that policy makers should first evaluate the potential difference in private benefits and public benefits from private adaptation to climate change in relation to human capital, family assets, and farm machinery, before designing policy interventions for these climate adaptations (Bakhsh and Kamran).

Other than Punjab, Ullah has focused on land ownership and catastrophic management in agriculture from analysing the case of rugged areas in Khyber Pakhtunkhwa Province of Pakistan and has identified a number of threats in the agriculture sector from the growing instability in production levels arising due to adverse weather conditions. These climate risks and changes are beyond the control of farmers and hence more sustainable agricultural methods are required to caer to the ever-increasing risk of mismanagement of the existing agriculture system in Pakistan (Ullah et al.).

The positive association between infrastructure and agricultural output has been established by many studies across the world. The development of irrigation infrastructure has been proven to bring groundbreaking changes in agricultural development. Dhawan has discussed the effect of irrigation on the stability of agricultural production and the factors that influence inequality of income gains from irrigation between small and large farms (Dhawan). Datt and Ravallion have advocated a strong relationship between development of rural infrastructure and output growth. They combined data from 24 households and estimated a model of the joint determination of consumption-poverty measures, agricultural wages, and food prices.Their model discovered that states having better physical and human infrastructure resulted in higher rates of agricultural output growth as compared to the growth in states with poor infrastructure (Datt and Ravallion).

CPEC bringing Sustainability

a) Improved Water Systems

The agriculture industry of Pakistan employs 43% of the rural population hence effects of climate change are significantly harmful for the economy.Not only that, but the lack of water security may very well be a threat to the region's stability. CPEC has the potential to introduce water management plans and policies and impart knowledge related to this matter to ensure Pakistan's water security, thus making agriculture more viable in the face of climate change. However, it can be said that the CPEC plans are perhaps a tad shortsighted in that the plans neglect to take into account the effects of climate change on the regional water supply. For example, a number of coal powered energy plants are to be/have been constructed and put to use under CPEC and are likely to consume large amounts of water that Pakistan might not have access to in the future due to the effects of climate change (Waheed et al.). According to some experts, the impact on water consumption will be overall negative due to the CPEC investment as it will lead to large amounts of water being used for the construction of the infrastructure and the operation of power plants that require water (Baloch). Given that scarcity of water due to climate change will be a large problem, it could be said that not enough is being done under the CPEC projects to mitigate the effects of climate change, even though it would be in the CPEC's best interest to ensure water security. This fact has been recognized by the Chinese government in a Joint Cooperation Committee meeting, in which China agreed to transfer knowledge on matters related to water resources management, urban development, and climate change (Huang et al.). Phase 1 of ensuring a water supply distribution system and water treatment plant in Gwadar is near completion, indicating that the Chinese government has considered the matter, but this is not enough (Rana). The two desalination plants installed in Gawadar have not been functioning effectively due to the power requirements to keep them running, which is not to mention the fact that these projects only make mention of water for the general use of citizens, which, whilst necessary, does not alleviate concerns of a lack of water for irrigation ("Necessary Facilites of…"). According to experts, Pakistan is likely to experience irrigation water shortages due to climate change as a result of changes in river flows and erratic rainfall patterns which will severely affect drought ridden and arid/semi-arid areas. Crop water demand will also increase by approximately 10-30% due to higher rates of evapo-transpiration due to higher overall temperatures, and it is expected that Pakistan will experience heavy flooding within the next few decades due to melting glaciers, which holds serious implications for sustainable water resources as river flows will decrease once the glaciers have receded (Crellin). Furthermore, the efficiency of the irrigation system in Pakistan is abysmally low, with overall irrigation efficiency being approximately only 30%, and with poor irrigation practices and a lack of inputs being responsible for lower crop yields and low productivity of water (for wheat in Pakistan, this would be 0.5 kg/m^3, yet for California and India, it is 1.5 kg/m^3 and 1.0 kg/m^3 respectively) (Saif Ullah). The Indus Basin Irrigation System is quite outdated and inefficient due to its numerous problems (such as water loss through unlined canals, waterlogging, salinization etcetera). New storage and irrigation schemes are needed to increase the productivity and sustainability of agriculture in the region. Much of the water infrastructure is in decay and due to a lack of maintenance, the canals are 30% less efficient than designed, whilst the government only designates a maximum of 10% of the funds required for the maintenance and repair of said infrastructure (Qureshi). All of this, however, simply means that there is a large potential for

improvement under CPEC, under which both nations could cooperate to ensure that Pakistan uses its water resources in the most productive, efficient methods possible.

b) Organic and Sustainable Farming

In the face of climate change, it seems that agriculture must switch to more sustainable methods that ensure eco-friendly practices. Here, CPEC can contribute to a switch towards a more sustainable agricultural model in Pakistan, as sustainable practices are becoming increasingly popular in China. These practices include intercropping, using manure, compost, and other natural fertilizers, crop rotations, cover crops etcetera that contribute towards healthier soils (Qureshi). Governmental policies in China that support organic farming include a system of organic certification, the cost of which is covered by the government, funding of on-farm infrastructure and provision of organic fertilizers as well as training and marketing ("CPEC New Ray…"). Not only is sustainable agriculture better for the environment (and in turn, better for the farmers), it can also be combined with advancements in agricultural technology (such as the use of dispersal drones) to vastly reduce the amount of resources required to grow the same crops, with the requirements for pesticides and water dropping drastically once more efficient methods of dispersal are used (Chen). But whilst China seems to be on a path of developing its sustainable agricultural model, the same cannot be said for Pakistan. It is interesting to note that in Pakistan whilst the consumption of fertilizer per hectare is substantially higher than the world average (133kg/hectare versus approximately 94.1kg/hectare), the yield is significantly lower (for example, 2.5 tons of cotton per hectare, as compare to China's 4.8 tons) (Scott and Si). Furthermore, the rate at which agricultural products are wasted in Pakistan goes against the grain of any sustainable model of agriculture, as the agricultural supply chain is not well organized in Pakistan due to inefficiencies in processing, storage facilities, and logistics (Jiayi and Gkritsi). An agricultural system that emphasizes an overuse of fertilizers and repeatedly growing cash crops instead of practicing crop rotation can and often does lead to numerous problems in the soil such as salinity, nutrient depletion, and waterlogging, all of which can render cultivable land useless (Khaskheli).

Challenges to Sustainability

Although CPEC provides the region with political, structural and economic stability and growth which would ultimately seep into the agricultural industry, critics of the Project have contested this wider claim. These critiques of CPEC's agricultural promise are two tiered: firstly, they contend that increased mechanization, whilst displacing smaller farmers, would also inevitably lead to overexploitation of natural resources pertaining to land. Secondly, the question is raised whether mass projects under CPEC threaten national water supply, and in the long-term, further limit the land possible for cultivation.

Natural resources, which are used as part of both the primary and secondary industry, usually as raw material, are finite, and unless sustained through yearly cycles, can spell massive food and industry shortages, the ramifications for which are of course, felt across the region owing to the global nature of the economy. The first threat that is almost perennial, is that of deforestation. Mechanization of agriculture covering wider areas has often led to mass logging, in which trees are cut down to ensure more land for cultivation, as was the case in Jair Bolsonaro's regime in Brazil.

As CPEC introduces widespread livestock farming, it poses the risk of using the already minimal forest area of Pakistan for the purpose of cattle grazing and crop cultivation. The harm posed to the climate is hence, more pronounced, as trees and forest areas help alleviate harsher temperatures during the summers, protect the soil from erosion, and steadies the soil so as to prevent crop damage by flash floods during the monsoon. Without the additional forest coverage, the soil is left bare, and the risk of flash floods and changing climate patterns threatens the very stakeholders that were meant to benefit from the deforestation: agriculturalists (Hanif). Furthermore, overexploitation of land for cultivation is also a likely correlative consequence of CPEC's agenda of increased productivity and efficiency through mechanized technology like threshers and harvesters (Ahmad et al.). This is the caveat with every industrialization venture since the Industrial Revolution, more sophisticated technology carries the quintessential risk of overexploitation of land. This can manifest in many ways; ranging from an increased livestock production to facilitate the dairy industry for export and hence overgrazing and the additional CO2 release or simply the usage of technology to cultivate the soil past the point of soil exhaustion. The larger argument remains the same: CPEC threatens the already volatile land resources beyond a point of return. Whilst these claims may have anecdotal merit, a closer analysis reveals both the potential and the capacity of CPEC to mitigate these threats to ensure a more sustainable agricultural outlook for Pakistan. The concern of deforestation has been raised with industrial developments and building projects as well as agriculture. China, as part of its agenda for Pakistan's fledgling technological agriculture, includes reforestation at the forefront. One estimate suggests a million trees in Gwadar alone, by 2025 ("Climate Change Can…"). Similar planning exists for the wider belt of agriculture across Punjab and Sindh, and work is already being done. This, coupled with the government's 'Billion Tree Tsunami' promises not just a mitigation of deforestation concerns, but also promotes building new plantations, including region-wise appropriate trees. For example, Gwadar's forestation program includes the planting of 'mangrove' trees, which are highly suited for the salty coastal area, and can survive in those conditions (Naveed et al.). The second concern of overexploitation is similarly mitigated by a number of cross-developmental practices. In addition to the sustainable agricultural model of the Chinese government that includes sustainable techniques, specific examples can be gauged to assure the upholding of land in line with global conventions of agricultural output. In Ethiopia, for example, with the help of the Chinese government, sustainable technologies and practices like crop-rotation and designated, fenced land for grazing have been used, partially developed out of the Chinese aid for Ethiopia and its agriculture (Hampf et al.). With this, and multiple other precedents, agricultural technology is likely to overlap with a careful consideration of sustainability to benefit output in the long-term rather than the need for immediate, and ultimately exploitative use of technology to gain better output.

Policy Recommendations

The CPEC has been taking some measures to include irrigation water provision plans, such as the Chashma Right Bank Canal project in Khyber-Pakhtunkhwa designed to make 300,000 acres of fertile land cultivable (Kouser et al.). However, this project is merely in its planning stages, and more must be done to ensure water (and thus, food) security in face of Pakistan's impending ecological and water crisis. Both countries need to form collaborative research centers that focus on enhancing the agricultural productivity of Pakistan via research and development of crops that demand less water. This could be done via collaborative efforts to introduce drip irrigation and

other more effective irrigation systems in Pakistan, given that (for example) China has managed to innovate and produce systems that lower the water cost of cotton crops by 25% and increase yield by 20% (Yadav et al.). Agricultural productivity in Pakistan is quite low, so critical investment is needed with regards to the development of new and improved seeds and farming techniques and technology. Furthermore, small scale, poorer farmers are not able to access the required machinery, technology, inputs, and productive seeds due to a lack of support from the government and due to the lack of infrastructure (improperly built roads, poor electricity and transport services, a lack of storage facilities etcetera). The CPEC has great potential to improve upon the infrastructure of such regions that fall within the vicinity of the CPEC route, with the introduction of water saving irrigation technologies and strengthened agricultural inputs enabling higher land productivity. A successful example of such a (non-CPEC) undertaking would be the "Livelihood Restoration, Protection and Sustainable Empowerment of Vulnerable Peasant Communities in Sindh Province" program of the Food and Agriculture organization of the United Nations. This introduced in Sindh a "System of Rice Intensification" that enabled farmers to combat water shortages by applying a variety of technologies as well as water efficient agricultural practices. Farmers must also be encouraged and given incentives to use other water efficient methods of irrigation, such as sprinklers and drip irrigation. The government should, with the aid of Chinese experts, look into rainwater harvesting technologies and structure to supplement irrigation.

Furthermore, policies should be made to replace high water demand and high value crops such as sugar cane with low water demand, high value crops such as sunflowers. It is essential that farmers be educated via awareness programs and demonstrations so that water mismanagement issues are not perpetuated in times when water is scarce. For this, investment in institutions capable of carrying out these tasks will be necessary, and thus cooperation between Chinese and Pakistani research and awareness institutes could be beneficial.

This could perhaps be corrected with the more electricity in the nation's power grid that is bound to be introduced with the construction of the CPEC power plants, alongside improved plant design and a more effective desalination system.

Furthermore, similar to how desalination plants in the UAE often employ the use of solar energy, perhaps the same could be used for desalination plants in Gwadar as the solar energy potential of the region might lower the operating costs of the power plants. Adding to this, knowledge could be exchanged so that farmers can be educated with regards to conservative but effective water usage, so that the effects of climate change are not felt as drastically.

Through CPEC, knowledge related to the sustainable agricultural model could be exchanged and farmers could be educated and given training to ensure that the needs of the populace are met in a sustainable manner. This would also help mitigate the effects of climate change and allow farmers to adapt, as manufacturing pesticides and fertilizers consumes a significant amount of energy; Organic farming also makes the soil more resilient against droughts, floods, and land degradation, all of which are effects of climate change ("Clean & Green…"). Thus, information sharing initiatives under CPEC could lead to Chinese experts sharing knowledge related to organic farming and enable Pakistan to venture into the organic foods landscape, thereby contributing positively towards more climate change resistant agriculture.

There are perhaps some financial gains to be made as well if sustainable agriculture is developed in Pakistan. A study estimated that even a 10% switch towards biofertilizers (fertilizers made from organic, biological material, often material that would have gone to waste) could save the government a hefty 10 billion Rupees, as Pakistan imports and manufactures more than 100 billion Rupees worth of fertilizer each year ("Clean & Green…"). Whilst there are limitations, many of them can be overcome with training, sufficient exchange of knowledge, cultivar specific biofertilizer development, marketing and awareness campaigns, as well as governmental support. This is not to say that all or even the majority of inorganic fertilizer can be replaced with biofertilizer, but even a partial switch to the sustainable alternative would be good for the economy as well as the arable land. At present, much of the agricultural waste in Pakistan is often burned, and there is potential for training the local, rural farmers in mulching to reduce reliance on inorganic fertilizers. The government could subsidize and provide loans for production units of biofertilizer at local levels, legislation should be made with regards to the regulation of biofertilizer, and Pakistan and China could collaborate to exchange relevant knowledge via institutions or committees and research centers set up as part of CPEC to ensure a sustainable agricultural future.

Through CPEC, China could invest in the provision of certain seed varieties or cultivars that could provide more yield whilst using less resources. Setting up a nationwide logistics network that includes storage, distribution, transport, and warehousing as China plans to do from Islamabad to Gwadar as part of CPEC could prove massively beneficial in making the agricultural supply chain more efficient and reducing waste, thus making the system more sustainable. Providing technical expertise and carrying out demonstrations, whilst educating farmers about sustainable, balanced use of resources would also aid in increasing efficiency and output. This could be done by carrying out surveys of agricultural areas to gauge what type of agricultural input is most effective in each region, then offering technical expertise at the local and grassroots level accordingly, all whilst carrying out long term and short term experiments in agricultural universities and laboratories around the country to apply any knowledge exchanged via CPEC to testing before approving it for practical use.

Reforestation on a larger scale, with special focus on ensuring environmentally and territorially appropriate plantations. Pakistan's own tree planting drives have often introduced water-quenching species like the Eucalyptus species, further lowering ground water levels, and requiring more irrigation. Water-friendly species should be planted as part of the reforestation agenda, which is likely to sustain groundwater levels for a longer amount of time. Similarly, reforestation must be a proportionate project, especially reforesting areas of South Punjab and Balochistan which have been neglected due to provincial politics and lack of provincial/federal funding.

Sustainable water management is of the utmost importance for the agriculturalists residing in Pakistan. Although groundwater levels have been decreasing exponentially as part of the larger effect of climate change, water mismanagement and theft remains a perennial threat. Mismanagement includes bribes at both the tehsil and the provincial level, as well as installation of water supply pipelines that are inadequate, archaic and prone to theft. CPEC needs to ensure that the water for irrigation, which acts as the heart line for agricultural and economic activity is protected and miscellaneous water losses are minimized. This requires further legislation, as the 2006 amendment to the Canal and Drainage Act of 1873, promulgates only a 5,000 RS fine on

serial and non-serial water thieves. Larger fines and more importantly, stricter law enforcement is required to introduce a deterrent (Muhammad). Furthermore, water mafias have been increasingly powerful in urban centers, and this requires a special dedicated database for serial offenders, so as to smoothen the magisterial process and ensure swift and ready justice for both the environment and for the various stakeholders that suffer as the result of water shortage and mismanagement.

Conclusion

While threats to climate change due to the increased mechanization of agriculture do exist, they can be mitigated if CPEC commits to green technology. The theoretical framework of this paper places multiple stakeholders, especially agricultural producers and consumers at the center of its concern. By identifying Chinese policies that have previously been enacted in other developing nations, as well as those which are directed to impact Pakistan's agricultural sector, the paper evaluates the extent of environmental sustainability in such projects. While discrepancies do exist, a renewed commitment to environmental protection can go a long way in shaping the corridor's success in creating an eco-friendly agricultural sector. This paper posits that reforestation and water management efforts can contribute towards achieving greater environmental sustainability through CPEC. Hence, policymakers must be cognizant of these aspects while taking into account the environmental risks of the CPEC projects.

References

Jiayi, Shi, and Eliza Gkritsi. "How Tech Is Changing Agriculture in China · TechNode." *TechNode*, 17 Mar. 2020, technode.com/2020/01/03/video-how-tech-is-changing-agriculture-in-china/.

Ahmad, Bashir, et al. "Restoration of Soil Health for Achieving Sustainable Growth in Agriculture." *The Pakistan Development Review*, vol. 37, no. 4, ser. 2, 1998, pp. 997–1015. *2*, doi:10.30541/v37i4iipp.997-1015.

Bakhsh, Khuda, and M. Asif Kamran. "Adaptation to Climate Change in Rain-Fed Farming System in Punjab, Pakistan." *International Journal of the Commons*, vol. 13, no. 2, 2019, pp. 833–847.

Baloch, Shah Meer. "CPEC's Environmental Toll." *The Diplomat*, The Diplomat, 7 Apr. 2020, thediplomat.com/2018/04/cpecs-environmental-toll/.

Barbier, Edward B. "Building the Green Economy." *Canadian Public Policy / Analyse De Politiques*, vol. 42, no. S1, Nov. 2016, pp. S1–S9., www.jstor.org/stable/canapublpolianal.42.s1.s1.

Chen, Stephen. "Chinese Scientists Recognised for Water-Saving Irrigation Technology." *South China Morning Post*, 21 Sept. 2019, www.scmp.com/news/china/science/article/3027909/chinese-scientists-recognised-water-saving-irrigation-technology.

"Clean & Green Gwadar, COPHC Will Plant One Million Trees." *China Pakistan Economic Corridor*, 5 Sept. 2019, cpecinfo.com/clean-green-gwadar-cophc-will-plant-one-million-trees/.

"Climate Change Can Be Mitigated with the Help of Organic Agriculture, as Well as Help Farmers to Adapt to Changing Climate Conditions!" *Organic Without Boundaries*, 1 July 2019, www.organicwithoutboundaries.bio/2018/09/12/climate-change-mitigation/.

"CPEC New Ray of Hope for Irrigation Project." *The Express Tribune*, The Express Tribune, 23 Nov. 2020, tribune.com.pk/story/2273312/cpec-new-ray-of-hope-for-irrigation-project.

Crellin, Christopher. "Pakistan: Confronting Gwadar's Water Crisis." *Future Directions International*, Future Directions International Pty Ltd, 11 July 2018, www.futuredirections.org.au/publication/pakistan-confronting-gwadars-water-crisis/.

Datt, Gaurav, and Martin Ravallion "Farm Productivity and Rural Poverty in India." *International Food Policy Research Institute* , www.ifpri.org/publication/farm-productivity-and-rural-poverty-india.

Dhawan, B. D. "Indian Irrigation: An Assessment." *Economic and Political Weekly*, vol. 23, no. 19, 7 May 1988, pp. 965–971.

Hampf, Anna C., et al. "Future Yields of Double-Cropping Systems in the Southern Amazon, Brazil, under Climate Change and Technological Development." *Agricultural Systems*, vol. 177, Nov. 2019, doi:10.1016/j.agsy.2019.102707.

Hanif , Usman. "Pakistan's Agriculture Productivity among the Lowest in the World." *The Express Tribune*, 23 Jan. 2018, tribune.com.pk/story/1616347/2-pakistans-agriculture-productivity-among-lowest-world.

Huang, Yanying, et al. "The Stakeholder Analysis for SEA of Chinese Foreign Direct Investment: the Case of 'One Belt, One Road' Initiative in Pakistan." *Impact Assessment and Project Appraisal*, vol. 35, no. 2, 2016, pp. 158–171., doi:10.1080/14615517.2016.1251698.

Hussain, Intizar, and Munir A. Hanjra. "Does Irrigation Water Matter for Rural Poverty Alleviation? Evidence from South and South-East Asia." *Water Policy*, vol. 5, no. 5-6, 2003, pp. 429–442., doi:10.2166/wp.2003.0027.

Khaskheli, Mohammad Ali. "Sustainable Agriculture and Fertilizer Practices in Pakistan -:- Pakissan.com." *Pakissan*, 12 July 2021, www.pakissan.com/english/allabout/farminputs/fertilizers/sustainable.agriculture.and.fertilizer.shtml.

Kouser, Shahzad, et al. "Uncovering Pakistan's Environmental Risks and Remedies under the China-Pakistan Economic Corridor." *Environmental Science and Pollution Research*, vol. 27, no. 5, 26 Dec. 2019, pp. 4661–4663., doi:10.1007/s11356-019-07428-5.

Muhammad, Riaz. "Pakistan Agriculture & China Pakistan Economic Corridor (CPEC) – An Opportunity for Chinese Companies to Invest in Pakistan Agriculture Sector-35斗." *Vcearth*, 12 Mar. 2021, vcearth.com/p/M2U0MGVlNzBlMjI1N2EyMDY5NTFhMTA4NzAwNTljYTM=.

Naveed, Muhammad, et al. "Biofertilizers in Pakistan: Initiatives and Limitations." *International Journal of Agriculture and Biology*, vol. 17, no. 3, Oct. 2014, pp. 411–420., doi:10.17957/ijab/17.3.14.672.

"Necessary Facilities of Fresh Water Treatment, Water Supply and Distribution: China-Pakistan Economic Corridor (CPEC) Official Website." *CPEC*, CPEC, 2020, cpec.gov.pk/project-details/37.

Qureshi, Asad Sarwar. "Water Management in the Indus Basin in Pakistan: Challenges and Opportunities." *Mountain Research and Development*, vol. 31, no. 3, 2011, pp. 252–260., doi:10.1659/mrd-journal-d-11-00019.1.

Rana, Shahbaz. "Pakistan's Water Security Made Part of CPEC Framework." *The Express Tribune*, 29 Dec. 2016, tribune.com.pk/story/1279029/pakistans-water-security-made-part-cpec-framework.

Saif Ullah. "Climate Change Impact on Agriculture of Pakistan- A Leading Agent to Food Security." *International Journal of Environmental Sciences & Natural Resources*, vol. 6, no. 3, Nov. 2017, pp. 76–79., doi:10.19080/IJESNR.2017.06.555690.

Scott , Steffanie, and Zhenzhong Si . "Why China Is Emerging as a Leader in Sustainable and Organic Agriculture." *The Conversation*, The Conversation, 8 July 2021, theconversation.com/why-china-is-emerging-as-a-leader-in-sustainable-and-organic-agriculture-132407.

Ullah, Raza, et al. "Land Ownership and Catastrophic Risk Management in Agriculture: The Case of Khyber Pakhtunkhwa Province of Pakistan." *International Journal of the Commons*, vol. 13, no. 2, 2019, pp. 881–891.

Waheed, Abdul, et al. "Climate Change Policy Coherence across Policies, Plans, and Strategies in Pakistan—Implications for the China–Pakistan Economic Corridor Plan." *Environmental Management*, vol. 67, no. 5, 2021, pp. 793–810., doi:10.1007/s00267-021-01449-y.

Yadav, Shyam S., et al. "Climate Change, Agriculture and Food Security." *Food Security and Climate Change*, 21 Dec. 2018, pp. 1–24., doi:10.1002/9781119180661.ch1.