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SUMMARY OF DOCTORAL THESIS

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Title: A Comparative Study of Improved and Traditional Irrigation System in the Gilgit District of Northern Areas of Pakistan: From the Farm Management Perspectives

パキスタン北部ギルギット地域における改良型/伝統型灌漑システムの比較研究
―農業経営学の視点から―

Pakistan is one of the world's most arid countries, with an annual average rainfall of under 240mm. In the northern parts of the country, Himalaya, Karakorum and Hindukush together make the largest mountain chain on the earth. The Northern Areas (NAs) of Pakistan recently known as (Gilgit-Baltistan) bordering with China, Afghanistan and India. As a result of the regions' politically sensitive location, the area has been accorded special territorial status and is administered directly by the Federal Government of Pakistan. It is a known fact that most people of the region are poor and depends on agriculture, growing traditional crops and water is supplied through irrigation channels. However, after completion of Karakorum Highway in 1986s, isolation came to the end with rapid social and ecological transformation, i.e. potato and vegetables turned into cash crops because of easy access to the market while on the other hand, demand for water increased due to growing population and cropping pattern.

NAs are considered as water stressed region in the country. It is mainly due to low rainfall (annually 150mm to 240mm) and river flows used for irrigation are derived from glacial snowmelt. Vast amounts of water are lost due to deteriorating watercourses, uneven fields and poorly designed irrigation channels in the region. Therefore, farmers in the region are facing severe water scarcity for agricultural activities. To overcome these problems, National Program for Improvement of the Watercourses (NPIW) was setup in Gilgit-Baltistan during 2003/2004 with the aim of improving irrigation infrastructure by converting irrigation system from traditional to lined/improved (channels made by cement concrete and stone). A total of 600 watercourses were constructed in 2009/2010 and lining of around 1,200 are underway. Given these developments in the irrigation sector, the broad objective of this study is to determine the benefits of the improved irrigation system to the farmers' economy. This is achieved by comparing an improved irrigation system (IIS) with a traditional irrigation system (TIS) in terms of overall management of irrigation system, land use, productivity, profitability and technical efficiency of crop production.

The study is based on primary data collected from two villages (Sultanabad and Parri) in Gilgit District of NAs Pakistan by using a comprehensive questionnaire. The secondary data was obtained from the local, national and international sources. Using multiple regressions a comparative economic analysis encompassing land use, productivity, cost of production and profitability were examined. To test empirically the perception, satisfaction and participation in irrigation management Yeh's Index of Satisfaction (YIS) was used. Moreover, stochastic frontier production function was employed to ascertain the impact of irrigation on crop production. Technical inefficiency model was estimated to determine the level of technical efficiency and its determinants.

The content in the chapter five examines the benefits of IIS in terms of land use, crop productivity and

profitability. The result shows that the land utilization by IIS farmers is significantly higher than TIS farmers in the dry season due to availability of irrigation water. All the crops cultivated by IIS farmers in dry season produce higher yields. However, in wet season except maize other crops productivity is not significantly different. The higher productivity in maize crop in IIS can be attributed to the use of higher amount of inputs. The higher productivity of IIS farmers in dry season is due to both availability of water and high input usage. The cost of production and profitability analysis shows that the farmers in IIS had obtained higher gross production and net profit in all crops. This is mainly due to the higher input usage and availability of water as the input use is statistically significant between the two groups. This study also shows that farmers are willing to invest more on agricultural inputs if continuous water availability is assured.

The results presented in chapter six are based on estimation of technical efficiency of selected crops and its determinants. The production elasticity estimates indicated that fertilizer, agrochemicals, purchased seeds, irrigation and labor used to perform various farming activities significantly contributed to wheat, vegetable and potato productivity. The results further indicate that increasing the farm size has a positive effect upon the technical efficiency of potato production. However, it might not be true to correlate the farm holding with inefficiency, especially in the case of potato where farmers have large farm holdings, but the area allocated to potato cultivation is only a part of total cultivated land.

Considering determinants of technical efficiency it was found that with an increase in age of the vegetable and potato growers level of technical efficiency declined except in wheat production where it was positively related to respondents' age. Education was positively related to technical efficiency except wheat crop implying that the highly educated vegetable and potato growers were using available resources more efficiently. Family size was not related with technical efficiency in cultivation of all crops. One of the important findings of the study was the statistical significance of the IIS dummy in the technical inefficiency model implying that the IIS farmers are technically more efficient than those farmers in TIS. It shows that there is a positive relationship and significant differences between IIS and TIS. This could be attributed to substantial saving of water losses by IIS in study area. The coefficient of location (head & tail) of water channels is also significant indicating that the farmers located at the head are more efficient. The distance from village to city is significant in potato crop but not for wheat and vegetables. Mean level of technical efficiency was 77% for wheat, 85% for vegetable, and 81% for potato implying that potential to increase crop production by using existing resources more efficiently.

The chapter seven examines IIS and TIS to understand how the level of satisfaction with irrigation system influences the level of participation. This study identified a statistically significant difference between the two systems in terms of farmers' satisfaction, participation and agricultural income. The higher farm income, developing physical infrastructure, family size and efficient distribution of water enhances farmers' participation as well their level of satisfaction. Furthermore, it was found that per acre cost of improving traditional channels are not considerably high. The total operations and maintenance (O&M) cost of irrigation is 0.19% of gross agriculture income of farm households per year, and thus makes it more affordable for farmers to pay the annual O&M costs.

The overall results of this study confirm the importance of IIS in terms of its beneficial effects such as enhancing farmers' participation in overall irrigation management, better land utilization and improved productivity leading to higher farm income. In the long run, increase in per unit production can be achieved by improving technical efficiency. Most issues related to water scarcity can be solved by investing in irrigation infrastructures. Moreover, to face new challenges and transfer the latest technology to the farmers' effective education programs through farmers training should be provided. The government should allocate more funds to improve irrigation infrastructure and farmers' education in NAs of Pakistan as a whole and in particular, in the study area.