Irrigation Investment and Crop Diversification: A System-Level Analysis

Ricardo A. Guino and Leonardo A. Gonzales [1]

Abstract

The economics of irrigation investment of four national irrigation systems (NIS) were analyzed under rice-mungbean, rice-peanut, rice-corn, rice-garlic and rice-onion cropping patterns. The four **NIS** were: Laoag-Vintar (LVRIS), Bonga Pump No. 2, Tarlac-San Miguel-O'Donnel (TASMORIS), and Upper Talavera River Irrigation System (UTRIS).

Results from the benefit-cost analyses indicate low levels of benefits and rate of return across cropping patterns for **all** irrigation systems. This low rate of return **as** reflected by the low BCRs could be attributed to high capital investment cost and high operation and maintenance cost.

Sensitivity analysis was applied to evaluate whether additional investment for rehabilitation designed for crop diversification can he offset by the benefits from irrigating non-rice crops. Results showed that low IRRs and BCRs cannot justify investment in rehabilitation.

Introduction

The Philippine government, through the National Irrigation Administration **(NIA),** has pursued extensive construction of new irrigation systems and intensive development of existing systems through the rehabilitation and upgrading of infrastructure and improvement of systems management.

The importance of irrigation as a mechanism for the country's agricultural growth and development is widely accepted. Not only does it harness the potential of high yielding rice varieties, it **also** facilitates the diffusion and adoption of several recommended practices and complementary inputs. There is a need to produce more rice to meet increasing demand due to population pressure but crop diversification offers more food sources and opportunities **for** the country to save foreign exchange (Gonzales, 1984).

Investments in irrigation in the country were mainly designed for rice. It was hypothesized that due to the increasing costs in developing new irrigation system, there will be shifts in the use of irrigation water for non-rice crops. However, there are still unresolved issues regarding the economics of irrigating non-rice crops. One issue **is** whether irrigation investment is financially and economically viable if diverted to non-rice crops. This paper analyzes the financial and economic viabilities of irrigation investment using the benefit-cost approach to determine whether capital investment on irrigation can give higher return on investment among irrigating non-rice crops.

Review of irrigation investment **From** 1965 to 1982, annual growth rate in irrigation investment averaged 43% hut remained almost constant from 1983 to 1987. This trend was partly attributed to the shift in government investment priorities and partly because of budget constraints (Table I). As a consequence, irrigation development accounted fur 47% of the 3.1 million hectares potential irrigable area. While these irrigation systems were designed to irrigate rice, they **also** accommodate to a minor extent, non-rice crop. In 1985, there were about 20,450 hectares planted to irrigated non-rice crops (Table 2). However, NIA estimated that there were about 209,777 hectares of potential diversified cropland under irrigation.

[1]Senior Research Assistant, The International Rice Research Institute (IRRI) and Liaison Scientist for Asia, *International Food Policy* Research Institute (IFPRI) and Agricultural Economist, IRRI, respectively.

Table 1. Investments in irrigation in the Philippines, 1965-87.

Year	Total Investment (000,000₱)	
	At current price	At constant 1987 prices
1965	5.60	8.69
1966	20.12	280.28
1967	19.58	262.44
1968	23.60	297.17
1969	43.99	535.18
1970	114.80	1202.11
1971	137.92	1303.60
1972	240.04	21 12.98
1973	390.11	2906.93
1974	744.10	3459.32
1975	922.18	4263.43
1976	760.55	3257.17
1977	1160.46	4608.66
1978	1627.15	5934.17
1979	2038.89	6212.34
1980	2107.70	5522.88
1981	2248.01	5182.14
1982	2366.89	5075.89
1983	1741.76	3395.25
1984	1570.80	2052.26
1985	1700.00	1874.10
1986	1729.80	1816.25
1987	1745.90	1745.90

Since 1983, government expenditures on irrigation drastically decreased due largely to the country's financial problems. **NIA** has to set back its irrigation investment plan of 1983. Moreover, the economic costs of constructing new irrigation systems has significantly increased, thereby making it more appropriate to diversify the use of irrigation water for other crops. As an alternative strategy, rehabilitation of old irrigation system is necessary to facilitate the production of non-rice crops during the dry season.

In a study, Rosegrant, et al., (1987) disclosed that the **NIA** investment plan was inadequate to provide for the necessary productivity increases to meet growth in domestic demand for rice. Such inadequacy was due to planned levels of irrigation investments which were not based on long-term food production requirements but as a result of the government's financial crisis. Based on the **NIA** investment plan, rehabilitation constituted only 30% of the total planned investment while the rest was allocated for the construction of new irrigation systems. Although these planned rehabilitation schemes were intended to irrigate rice, policy decisions should be weighed to consider rehabilitating irrigation systems for crop diversification. This is very crucial in the light of the foreign exchange constraint being faced by the Philippines

Table 2. Crop diversified irrigated area (ha) by region, Philippines, 1985.

	Potential Irrigated Area	NIA Irrigated	Estimated Diversified Cropland	Actual Irrigated Diversified Crop Area
1	309,810	179,887	12,299	15,140
2	539,710	249,404	36,538	20
3	482,220	284,490	33,852	40
4	263,590	139,032	30,735	60
5	239,650	149,110		0
6	197,250	106,002	13,137	0
7	50,740	19,771		0
8	84,380	67,880		**0**
9	76,500	34,461		**0**
10	230,150	62,592	3,015	0
11	290,250	89,890	33,118	790
12	362,080	98,134	18,140	4,400
TOTAL	3,126,330	1,480,653	209,777	20,450

Source: **NIA**

today. If this rehabilitation plans for crop diversification becomes economically feasible, then millions offoreign exchangecan be saved (Gonzales, 1984).

Methodology

Benefit-cost analysis was applied to assess the financial and economic viabilities of irrigation investments at the system-level. System-level analysis describes the performance of each irrigation system in terms of economic viability. to determine whether benefits derived from irrigating non-rice crops can offset investment cost. Using two basic criteria: benefit-cost ratio (BCR) and internal rate of return (IRR), the system's viability with respect to rice-non-rice cropping patterns under irrigated conditions was estimated.

Sensitivity analysis was applied to each system to determine whether incremental costs of rehabilitation can still hc offset by the benefits obtained from non-rice crops during the dry season.

Irrigating non-rice crops is a relatively new concern in the Philippines. There are no existing irrigation systems designed to irrigate non-rice crops. In the absence of a detailed cost estimates for rehabilitation, the 1986 **NIA** draft plan of rehabilitation cost was applied (Table **3).** The rehabilitation cost/ha was ₱10,816 at 1987 prices. This rehabilitation cost per hectare was applied to the service area of each of the four irrigation systems (Table 4) in order to derive the total rehabilitation cost for the wholesystem. Thecomputed IRRs and BCRs were used as indicators whether the incremental benefits derived after rehabilitation were enough to cover the incremental costs incurred. Data obtained for the analysis were capital investment costs. operation and maintenance costs, and computed values **of** net benefit.

For the irrigation component, real values of capital investment and operation and maintenance wcrc adjusted to 1987 prices. Since the IFPRI-**ADB** nationwide irrigation survey (Phase I) was unable to gather disaggregated investment costs for each individual irrigation system, a generalized inventory of construction items was developcd. The generalized inventory was used to facilitate the computation of each system's economic cost components for construction materials. Construction costs were classified according to tradeable and non-tradeable components. Tradeable construction items were cement. reinforcing steel bars, nails and wires, fuel and oil, spare parts and heavy equip-

Table 3. Planned investment costs for construction and rehabilitation, **1986** NIA draft investment plan, **1987-1996** (at **1987** prices).

	Planned Investment Costs		Cost/ha of Service Area (₱/ha)
	Amount ('000,000₱)	Percent	
New Area	*13,909*	70	
National reservoir	**5,404**	**39**	
National diversion	**6,535**	**47**	**48,048**
Communal	**1,970**	**14**	**25,272**
Rehabilitation	*5.805*	*30*	**10,816**
National reservoir			
National diversion	**4,461**	*11*	
Communal	**1,345**	**23**	
Total	*19,714*	*100*	
National reservoir	**5,404**	**27**	
National diversion	**10,996**	**56**	
Communal	**3,315**	**17**	

"Rehabilitation cost includes new area cost. Disaggregation not available.

Source: Rosegrant, et al., **1987.**

Table 4. Basic information of the four national irrigation systems.

System	Service Area (ha)	Benefited Area		Location/ Region
		Wet (ha)	Dry (ha)	
Laoag Vinrar River Irrigation System (LVRIS)	2,311	**2,204**	**1,423**	Laoag, Ilocos Norte/Ilocos
Bonga Pump (BP#2)	614	**450**	**275**	Laoag, Ilocos Norte/Ilocos
Tarlac-San Miguel-O'Donnel River Irrigation System(TASMORIS)	17,075	9,159	3,156	Tarlac/ Central Luron
Upper Talavera River Irrigation System (UTRIS)	*3,629*	3,598	921	San **Jose,** Nueva Ecija/ Central Luzon

ment. Economic prices (i.e., themarket price which is net of subsidies and taxes) of tradable items were estimated based on **CIF** prices, **if** they were imported, and on FOB prices, if exported. Oh the other hand, non-tradeable items or domestic components included sand, gravel, labor and management. **All** costs (i.e. real values of capital investment and operation and maintenance cost) were adjusted to **1987** prices.

Computed net benefits for rice-non-rice cropping pattern were derived from the basic farm budgets using different production technologies. Given the different cropping patterns, the comparative performance of each system was also assessed. Using two indicators, net financial profit (NFP) and net economic profit (NEP), financial and economic profitabilities were derived for each non-rice crop. Five irrigated non-rice crops were evaluated: corn, mungbean, peanut, garlic and onion. Financial analysis of non-rice crop was based on market prices at wholesale while economic analysis was based on the economic prices for inputs and border price or world market price for outputs. In general, the methods and assumptions of this study were patterned after the procedure of Gonzales **(1984)** study on crop diversification.

Benefits and Rates of Return from Crop Diversification

Results generally indicate low benefits and returns to irrigation investment. Sensitivity analysis on the additional investment for rehabilitation designed to irrigate non-rice crops showed low IRRs and BCRs.

Laoag- Vintar River Irrigation System (LVRIS). **LVRIS** was built in **1930.** Its designed service area was **2,377** hectares. Because of siltation resulting in reduced canal capacities and inefficient water distribution, the system was rehabilitated in **1977.** Rehabilitation was funded by the World Bank under the National Irrigation System Improvement Project (NISIP). The rehahilitation involved improvement **of** the existing facilities. **An** additional 149 hectares was added to its service area. However. duc to wear and tear, the current benefited area is only **2,204** hectares with a cropping intensity equal to 1.64. The benefited area includes 586 hectares planted to non-rice crop duringthe dry season. Non-ricecrops traditionally planted by llocano farmers were garlic, peanut, onions. mungbean, tomato, watermelon and corn.

Irrigation fee for non-rice crops is **60%** of the equivalent fee for rice. Irrigation fee for rice is 100 kg of paddy/ha during the wet season and 150 kg of paddy/ha during the dry season. Financial cost of irrigating rice is 100 kg multiplied by the prevailing market farm gate price. The economic cost of irrigation is computed by valuing the irrigation service fee at the economic price of rice and adjusting lor the irrigation subsidy.

Results show that LVRIS was financially viable for rice-peanut cropping pattern with 15.56% FIRR. However, the system was not Economically feasible for rice-mungbean and rice-peanut cropping patterns because of negative FIRR (Table **5).**

Table 5. Internal rate of return (IRR) and benefit-cost-ratio (BCR) for rice-non-rice cropping pattern by system, Luzon, **1987.**

System / Cropping Pattern	Financial		Economic	
	IRR(%)	BCR*	IRR(%)	BCR*
LVRIS				
Rice-Mungbean	**8.75**	**0.56**	Negative	
Rice-Peanut	**15.56**	**1.05**	Negative	
BP # 2				
Rice-Garlic	**8.38**	0.63	**3.73**	**0.47**
TASMORIS				
Rice-Corn	Negative		Negative	
UTRIS				
Rice-Corn	**14.62**	**0.97**	**3.46**	**0.39**

* at **15%** discount rate

Rice-mungbean cropping pattern gave lower rate of returns on investment, with an IRR of *8.75%* and a BCR of 0.56 at 15% discount rate. On the other hand, rice-peanut cropping pattern showed a marginal rate of return with BCR of 1.05.

Bonga Pump No. 2 Irrigation System (BP # 2). BP#2 is one of the three Bonga pumps being operated by NIA. It is a surface-type irrigation system with a service area of 674 hectares. BP#2 serves the towns of Laoag and San Nicolas in Ilocos Norte. BP#2 was built in 1959 simultaneously with two other Bonga pumps. The pumps are electrically powered. In 1979, BP#2 was rehabilitated due to engine breakdown.

The total benefited area was 725 hectares - 450 hectares planted to rice during the wet season, and 275 hectares during the dry season. Of the area planted during the dry season, 125 hectares were planted to non-rice crops, mostly garlic. Unlike other systems, BP#2 charges 300 kg/ha paddy equivalent for non-rice crops.

Farm budgets indicate that garlic production system was both financially and economically profitable in BP#2. Garlic was the most popular and widely planted non-rice crop in Ilocos Norte.

In spite of the low wholesale price for garlic (P17.97/kg), the crop was still highly profitable because of its high yield (2.5 t/ha). However, rice-garlic cropping pattern exhibited low FIRR (8.38%). This low rate of return was attributed to high operation and maintenance cost (Table 6).

Table **6.** Capital investment of four national irrigation systems, Luzon, at 1987 prices.

Svstem	Benefited Area		Capital Investment (₱/ benefited area)		Operation and Maintenance Cost (₱/ benefited area)
	Wet (ha)	Dry (ha)	Financial	Economic	
LVRIS	**2,204**	**1,423**	**28,259**	**24,863**	**360**
BP#2	**450**	**275**	**29,591**	**26,203**	**2,252**
TASMORIS	**9,159**	**3,156**	**10,984**	**9,664**	**295**
UTRIS	3,598	**927**	**31,752**	27,936	**1,441**

Tarlac-SonMiguel-O'Donnel River ***Zrrigation System*** (TASMORIS) TASMORIS serves the towns of Gerona, Pura, Victoria, La Paz, Capas and Concepcion, in the province of Tarlac. The designed service area is 17,075 hectares with a very low cropping intensity. Benefited area was **9,159** hectares or **53%** of the service area during the wet season and only **3,156** hectares or **18%** of the service area during the dry season.

TASMORIS is composed of three independent irrigation systems which were built separately but was merged into one for operation and maintenance. The three systems are the Tarlac River Irrigation System (RIS) which was built in **1959;** the San Miguel RIS, built in **1913** and O'Donnel RIS, constructed in **1927.**

In TASMORIS, where irrigated white open pollinated corn was widely planted, analysis showed that the irrigated rice-corn pattern could not justify the financial and economic viabilities of the system. The negative FIRR and EIRR under the rice-corn pattern in TASMORIS attest to this (Table 5).

Upper Talavera River Irrigation System (UTRIS). UTRIS is located upstream of the Talavera River serving the city of San Jose, Nueva Ecija. UTRIS is composed of the Talavera RIS constructed in **1923** and San Agustin Extension built in **1956** with a combined designed service area of **3,629** hectares. With the construction of Pantabangan dam also known as the Upper Pampanga River Project (UPRP) in **1975,** UTRIS was integrated with the Upper Pampanga River Integrated Irrigation System (UPRIIS) but without generating additional service area.

UTRIS has a benefited area of **3,598** hectares during the wet season and **927** hectares during the dry season; **465** hectares of the benefited area is planted to non-rice crops. UTRIS was designed to irrigate rice during both wet and dry seasons. However, most farmers shifted to non-rice crops during the dry season. The most popular and profitable crop in Central Luzon is onion. Similar with other irrigation systems, the irrigation fee for non-rice crops is **60%** of the equivalent irrigation fee for rice.

Onion was the most profitable non-rice crop, financially and economically. Onion production systems ranked high in Central Luzon. However, at the current level of the system's performance, economic and financial benefits from rice-onion cropping pattern showed that UTRIS cannot sustain the cropping pattern's financial and economic viabilities (Table 5).

*Sensitivity **analysis of rates of return.*** Results in Table **7** show that the estimated IRRs and BCRs were very low to justify additional investment costs for rehabilitation across systems and cropping patterns.

Table 7. Sensitivity analysis of internal rate of return (IRR) and benefit-cost ratio (BCR) for rice -- non-rice cropping pattern, after adjustments in rehabilitation costs, four national irrigation systems, Luzon, **1987.**

System/Cropping Pattern	Financial		Economic	
	IRR(%)	BCR*	IRR(%)	BCR*
LVRIS				
Rice-Mungbean	**5.87**	**0.38**	Negative	
Rice-Peanut	**11.28**	0.72	Negative	
BP # 2				
Rice-Garlic	**6.19**	0.50	**2.17**	**0.27**
TASMORIS				
Rice-Corn	Negative		Negative	
UTRIS				
Rice-Corn	**11.57**	**0.54**	**2.01**	**0.30**

* at **15%** discount rate.

Summary and Conclusion

The economics of crop diversification and irrigation investment of four national irrigation systems were assessed. Cropping patterns evaluated were rice-mungbean, rice-peanut, rice-corn, rice-garlic and rice-onion. The four national systems analyzed were Laoag-Vintar (LVRIS), Bonga Pump No. 2, TASMORIS and UTRIS. The benefit cost ratio (BCR) and the internal rate of return (IRR) were used to determine the viability performance of each system. In the benefit-cost analysis, the financial and economic valuation was applied to assess the viability of irrigation investment at the system-level. In the financial analysis, the market prices actually encountered by farmers were used. On the other hand, in the economic analysis, border prices, i.e., the market price net of subsidies and taxes for inputs and border prices for outputs were used. The net financial profit (NFP) and net economic profit (NEP) of non-rice production systems were considered in evaluating the economic and financial viabilities of the four national irrigation systems.

Financial and economic analysis of the benefits and rates of return to irrigation investment on the four national irrigation systems with respect to rice-based crop diversification were very low. The low levels of benefits and rates of return across cropping patterns were attributed to high capital investment and high operation and maintenance costs. However, technical, agronomic, and institutional constraints must be taken into account before drawing generalizations on the desirability of irrigating non-rice crops (IIMI, 1986).

References

Bureau of Agricultural Statistics. 1987. Various reports.

Gonzales, L.A. 1984. "Philippine agricultural diversification: a regional economic comparative advantage analysis." Final report submitted to ADB as a sub-project component of the project Assessment of Food Demand/Supply Prospects and Related Strategies for Developing Member Countries of ADB.

Guino, R.A. and L.A. Gonzales. 1988. Irrigation investment under different rice-based cropping patterns in the Philippines. Paper presented at the 4th Meeting of the Federation of Crop Science Society of the Philippines (FCSSP), Davao City.

Guino, R.A. M.W. Rosegrant, L.A. Gonzales, and R.W. Herdt. 1984. "Configuration of irrigated areas in the Philippines". Final report submitted to the ADB as one of the sub-project components of the project Assessment of Food Demand and Supply Prospects and Related Strategies for Developing Member Countries of ADB, May 31, 1984.

International Irrigation Management Institute (IIMI). 1986. Study on Irrigation Management for Crop Diversification. December 1986.

National Irrigation Administration. Various reports.

Philippines Foreign Trade Statistics. 1987.

Rosegrant, M.W., L.A. Gonzales, H.E. Bouis, and J.F. Sison. 1987. Price and investment policies for food crop sector growth in the Philippines, IFPRI.

Sison, J.F. and R.A. Guino. 1984. "An assessment of cost and performance of various types of irrigation systems in the Philippines." Final report submitted to the ADB as one of the sub-project components of the project Assessment of Food Demand and Supply Prospects and Related Strategies for Developing Member Countries of ADB.

Sison, J.F. and R.A Guino. 1985. The impact of rehabilitation on system and farm level performance - a case of four national irrigation systems. PAEDA Annual Convention, DAP, Pasig, Metro Manila, June 1985.