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논 문

# Extended Benefit-Cost Analysis of Irrigation and Drainage Project

# 관개배수사업의 확장편익비용분석

Lim, Jae Hwan*, Koo, Seung mo*
임 재 환, 구 승 모

## 요 약

농업부문이 사회에 제공하는 다양한 긍정적 외부효과가 인정됨에 따라, 대부분의 농업생산기반시설은 국부를 증진시키는 사회간접자본으로 인식되고 있다. 과거에는 수리시설을 비롯한 기반시설이 단지 생산성 향상을 위한 사회적 투자로 간주되었으며 따라서 사업에 대한 경제성 분석 또한 직접적인 경제적 효과에 대한 편익비용분석에 국한되었다. 그러나 최근에는 농업 및 생산기반시설이 제공하는 비시장적 가치가 점차 인정됨에 따라 그러한 가치 또한 경제성분석에 포함될 수 있다. 이 연구에서는 최근 수년간 조성된 한국의 관개배수사업과 관련된 수리시설의 관행적 경제성 분석결과를 요약 및 정리하였으며, 충남 해창지구를 사례지역으로 하여 농업생산기반시설의 다양한 비시장적 가치를 포함시키는 확장편익비용분석을 시도하였다. 그 결과 관행적인 경제적 수익률보다 사업의 사회적 수익률이 증가함으로서써 사업의 지속적 추진을 정당화할 수 있는 수량적 지표로 활용될 수 있음이 입증되었다.

## I. Introduction

Most parts of agricultural infrastructures are being considered to be Social Overhead Capitals (SOC's) in recent years. When considering wide ranges of agricultural benefits to the society, the extent of the projects could be effective to every member of society. Main purpose of investments on SOC's are to improve public welfare by using public or government funds. For Korean agricultural sector, not many years have passed to recognize the fact that the investments on agricultural infrastructures may improve national welfare as well as the farmers' income in relevant regions of the projects.

In the past, government's investments on agricultural infrastructures such as reservoirs for agricultural use were considered to be only supporting farmers' income based on the primary agricultural policy issues

* College of Agriculture, Chungnam National University

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protecting agricultural sector. For example, economic performance of the projects were only measured through the improved productivity or cost reduction.

However, recent policy interests have extended this primary policy issues to the public benefits of the society as a whole, from the relevant projects. This fact could be indirectly found from many recent researches regarding public benefits from agricultural sector in terms of environmental benefits, food security, etc. Recent activities made by Non-Government Organizations (NGO's) also imply that some of the agricultural products should not be traded in international markets due to the distinct contributions to their own country, such as environmental benefits and food security. They argue that one country should not import certain food products even though their domestic price is much higher than that in the international market, because domestic production process itself provides food as well as public benefits.

These trends imply that agricultural sector of a country may possess additional value to the society which cannot be simply captured by "prices" in usual markets. These reasons justify that investments on agricultural infrastructures should not be excluded from general SOCs' projects of a nation, improving public welfare. In the past, especially 1960's and 1970's in Korea, agricultural infrastructure projects have received relatively good priorities among many government projects. These priorities necessarily should have given to agricultural sector to provide enough food products to other industrial sectors at cheaper price, to maintain cheaper wages for economic development.

Even without this policy purpose or technological progress, agricultural productivity has kept increasing as more public funds were invested to construct agricultural infrastructures, primarily due to scarcity of water resource in the past. These apparent effects from the project have been enough justification for expanding the investments in the past. However, agricultural productivity has almost reached relatively high levels in recent years and society is demanding more simultaneous and various benefits from the projects.

The main purposes of this paper are; 1) to evaluate economic performance of irrigation/drainage projects, and 2) to relate public benefits (non market values) to irrigation/drainage projects. The next section introduces traditional procedures of economic analysis to evaluate economic performance of irrigation and drainage projects. Survey statistics will be presented summarizing the recent economic performance of irrigation and drainage improvement projects in Korea. The third section refers public or nonmarket benefits of domestic agricultural production, and, will discuss how these benefits relate to evaluate socio-economic performance of irrigation/drainage projects.

## Ⅱ. Economic Analysis for Irrigation and Drainage Projects

The traditional methods evaluating economic

feasibility of the public projects are benefit-cost ratio analysis (B/C ratio) and internal rate of return (IRR). B/C ratio analysis implies that any project can be judged to be feasible when the ratio between the present value of total benefit and cost is greater than 1. This definition is equivalent in that the project is to be judged to be economically feasible when the present value of total benefits exceeds the present value of total costs. Internal rate of return project is the discounting rate which makes the B/C ratio to be 1. Therefore, any project is judged to be economically feasible when the calculated IRR exceeds the current social discounting rate. The surveyed statistics shown in table 1 and 2 contain the above primary economic standards measuring economic performance of each project. 3 districts of irrigation and 26 districts of drainage improvement were selected in this survey. The survey period is between 1995 and 1999.

B/C ratios shown in table 1 are less than 1, which are not feasible in terms of comparing benefit and cost. However, the ratios have been calculated using 10 percent of discounting rate which is fairly high for the present time. Because SOC's opportunity cost of capital should reflect social preference of time, it may be varied such as market interest rate. It is general for the social discounting rate, which can be interpreted as SOC's opportunity cost of capital, to be selected to be lower than the private market interest rate.

10 percent of discounting rate has been changed to 8 percent for the present time in Korea. Therefore the B/C results in the table should be re-evaluated using 8 percent of discounting rate to reflect the current social preference of time and capital. Otherwise it may underestimate the effectiveness of the projects when using 10 percent of discounting rate. It is also expected that the B/C ratios would be increased when applying 8 percent of discounting rate.

Even without the re-evaluation by B/C using 8 percent of discounting rate, the calculated IRR's in the tables provide decision information for the project. According

〈Table 1〉 Primary economic feasibility of the recent irrigation projects(1995~1999)

| District | Location | | | Area (ha) | | Costs (1,000 won) | | Economic Feasibility | |
|---|---|---|---|---|---|---|---|---|---|
| | Do | Gun | Eup/ Myun | Total developed area | Agricultural land | Total cost | Cost per ha | IRR | B/C (i=10)* |
| Goma | Chung-nam | Seo-cheon | Hwayang | 224.7 | 202.9 | 6,258,535 | 27,853 | 7.2 | 0.72 |
| Eoeun | Cheon-buk | Gunsan | Okgu | 357.3 | 331.6 | 9,545,372 | 26,715 | 9.0 | 0.90 |
| Okbong | Cheon-buk | Gunsan | Okseo | 353.4 | 323.3 | 9,620,378 | 27,222 | 8.6 | 0.86 |

* 10% discounting rate is applied

〈Table 2〉 Primary economic feasibility of the recent drainage improvement projects (1995-1999)

| District | Location | | | Area (ha) | | Costs (1,000 won) | | Economic feasibility | |
|---|---|---|---|---|---|---|---|---|---|
| | Do | Gun | Eup/ Myun | Total Developed Area | Agricultural Land | Total cost | Cost per ha | IRR | B/C (i=10)* |
| Sudeok | Jeonbuk | Namwon | Daesan | 60.1 | 56.3 | 1,899,456 | 31,631 | 11.2 | 1.12 |
| Maryang | Jeonnam | Gangjin | Maryang | 77.8 | 68.4 | 3,512,667 | 45,150 | 8.2 | 0.84 |
| Yangwang | Jeonnam | Gurye | Gurye | 99.0 | 78.0 | 2,963,295 | 29,932 | 11.2 | 1.13 |
| Sonrim | Jeonnam | Goheung | Daeseo | 184.0 | 156.0 | 6,421,535 | 34,900 | 11.7 | 1.18 |
| Godal | Jeonnam | Gokseong | Gokseong | 156.7 | 141.1 | 6,691,574 | 42,703 | 10.5 | 1.05 |
| Jangyang | Jeonnam | Boseong | Beolgyo | 127.1 | 105.5 | 2,963,590 | 23,317 | 13.3 | 1.34 |
| Habin | Daegu | Dalseong | Habin | 255.0 | 243.4 | 12,641,837 | 49,576 | 10.2 | 1.02 |
| Dongam | Kyungbuk | Seongju | Seonnam | 51.0 | 51.0 | 2,288,401 | 44,871 | 11.3 | 1.87 |
| Wanjeon | Kyungbuk | Youngcheon | Sinpyoung | 47.0 | 47.0 | 1,469,000 | 31,255 | 14.1 | 1.41 |
| Angyo | Kyungbuk | Andong | Pungsan | 101.3 | 89.9 | 3,691,000 | 36,436 | 12.9 | 1.31 |
| Sanjeon | Kyungnam | Sacheon | Seopo | 84.0 | 69.0 | 3,735,648 | 44,472 | 9.6 | 0.96 |
| Naegu | Kyungnam | Sacheon | Seopo | 80.4 | 58.9 | 3,805,814 | 47,336 | 10.1 | 1.01 |
| Banpo | Kyungnam | Changnyoung | Namji | 126.0 | 103.8 | 6,180,999 | 49,056 | 11.0 | 1.11 |
| Wondang | Kyungnam | Jinju | Sugok | 54.6 | 50.8 | 2,302,429 | 42,169 | 10.2 | 1.02 |
| Gwanpyoung | Kyungnam | Hapcheon | Chogye | 63.0 | 63.0 | 3,141,343 | 49,871 | 9.4 | 0.94 |
| Daesan | Kyungnam | Haman | Daesan | 308.6 | 308.6 | 12,824,383 | 41,557 | 12.6 | 1.30 |
| Daesin | Kyungggi | Yeoju | Daesin | 167.5 | 167.5 | 3,024,013 | 18,054 | 10.1 | 1.01 |
| Geumhwa | Jeonnam | Goheung | Daeseo | 140.6 | 126.3 | 2,807,000 | 19,966 | 12.7 | 1.26 |
| Bukgo | Chungnam | Buyeo | Jangam | 52.0 | 42.0 | 2,560,220 | 49,235 | 9.0 | 0.90 |
| Yongjeong | Jeonbuk | Gochang | Sangha | 135.0 | 115.0 | 3,273,683 | 24,250 | 13.9 | 1.37 |
| Dalji | Kyungbuk | Mungyoung | Youngsun | 86.0 | 62.0 | 4,017,713 | 46,718 | 11.8 | 1.17 |
| Hwanggye | Kyungbuk | Gimcheon | Gaeryoung | 153.6 | 140.1 | 6,729,984 | 43,815 | 10.3 | 1.03 |
| Jingyo | Kyungnam | Hadong | Jingyo | 91.2 | 68.3 | 2,077,603 | 22,781 | 11.5 | 1.14 |
| Daejeo | Pusan | Gangseo | Daejeo | 475.0 | 457.4 | 17,999,000 | 37,893 | 6.5 | 0.69 |
| Youngnam | Kyungnam | Changnyoung | Youngsan | 341.1 | 294.5 | 13,012,815 | 38,150 | 7.3 | 0.75 |
| Geumhwa | Jeonbuk | Gunsan | Seosu | 324.0 | 294.0 | 4,224,000 | 13,037 | 11.1 | 1.12 |

*10% discounting rate is applied

to the decision criteria of IRR, the project is economically feasible if social discounting rate is less than the calculated IRR. In <Table 1>, IRR's for the 2 districts (Eoeun and Okbong) exceed 8 percent, which is known to be the current discounting rate. The above interpretation regarding B/C ratio and IRR is applied to drainage improvement projects in the same way. As shown in <Table 2>, it can be judged that the drainage

projects in many districts are economically feasible by looking at the calculated IRR's exceeding 8 percent.

## Ⅲ. Extended Benefit-Cost Analysis for Irrigation and Drainage Projects (A Case Study for Haechang district)

The approach used in the previous section only considers direct benefits and costs of the recent projects proceeded in Korea. However, as referred in the introduction section, more precise analysis could be performed by including indirect or non-market benefits and costs, when social welfare is emphasized rather than focusing on site-based economic analysis. In this chapter, a certain site, at which the farmland consolidation project is completed together with drainage improvement project, is analyzed using the "extended benefit-cost analysis". In extended B/C analysis, possible benefits and costs from both market and non-market aspects are included into B/C ratio and IRR framework.

The following analysis is a part of the research performed in "A Study on the Performance of Agricultural Infrastructure Projects and the Measures of Efficient Rural Development." by Korea Agricultural & Rural Infrastructure Corporation (2000). More specific descriptions regarding the study area and data source can be found in the reference.

### 1. Study Area

The study area is Haechang district, which is located in Dangjin-gun, Chungnam-do. The area includes upperstream dike of Daehoe reclaimed site. Poor drainage condition is especially severe when Daehoe dike malfunctions by floods in rainy season. The district covers 560 hectares total, which is composed of 69 percent (388 hectares) for paddy, and 31 percent for forest and others. The average annual flooded area is recorded at 61.7 hectares. Farmland consolidation project were carried with drainage project between November 1991 and May 1993.

〈Table 3〉 Project summary for Haechang district

| | |
|---|---|
| Location : Sambong and Tongjeong, Dangjin, Chungnam | |
| Area : Total area : 174.76ha | |
| Project area : 151.42ha | |
| Total project cost | : 4,292,000 thousand won |
| Project period | : November 1991~May 1993 |

### 2. Project Benefit Estimation

1) Direct Benefits

(1) Increase in Rice Productivity : Increase in rice productivity without project can be measured by comparing the past record of the study area with the record of the other area(Jigok district) without project. For Haechang district, rate of increase were estimated at 1.48% per year. This estimate can be interpreted as the rate of increase by other factors without irrigation and drainage project, such as technological progress or machinery uses. To estimate the increase in productivity, the survey records from the fringe area(Gobuk district) with the project

were used. The productivity after the year of 2000 is assumed to be recent five-year average. The differences in productivity between with-and without-project is interpreted to be the net increase by irrigation and drainage project. The survey showed that there have been 100 to 200 M/T of net increases per year, by the project, in Haechang district.

(2) Labor Cost Saving : Cost saving from labor reduction was estimated by comparing labor hours per 10a of Haechang district with the ones of comparison district (Jigok). On-farm survey was conducted to estimate net difference of labor hours between the two districts. When combining with the total area of the district and average rural wage, it was found that there exist 1.3 hundred million wons for the district (22 days of labor reduction per ha per year). When using shadow wages of rural labor(economic wage), 1.1 hundred million won has been being saved every year.

(3) Material Input Cost Saving : Material input cost saving was also estimated by comparing the districts between with and without project. Significant difference in consignment fee and area was found between the two districts, primarily due to the decrease in the area consigned as the project completed. This result implies that cost efficiency of machinery use has increased as the land were consolidated. The input items considered in the survey include seed, fertilizer, other chemicals, heat, consignment, and machinery costs. The total input cost saved with the project were calculated to be 0.5 million won per year (3,352 won/ha/year).

(4) Machinery Repair Cost Saving : Cost saving from reduction in machinery repair directly comes from farmland consolidation project. Annual saving was estimated at 19,154 thousand won, by comparing the two districts, Harchang and Jigok. Economic benefit of 18,790 thousand won is calculated using general conversion factor. Agricultural machinery considered in this study includes combine, tractor, planting machine, and cultivator.

(5) Medical Cost Saving (Health Improvement Effect) : Labor hours reduced after the project's completion are related to the farmers' medical costs. Medical cost saving can be estimated by using the reduced number of days going hospital after the completion of project, and, shadow wage/medical cost. On-farm interview data of sample population were used to calculate economic benefits from medical cost saving. For Haechang district, annual saving was estimated to be 4,241 thousand won per year.

(6) Income Effect in Agricultural Off-Season : Construction for drainage improvement is usually made in agricultural off-season, such as farmland consolidation project. Construction costs not only include labor cost, but also provide another income source for regional people. When the opportunity cost of rural labor in off-season is assumed to be 30 percent of the usual laborer, the rest of 70 percent increases GNP at the same time. Based on this

assumption, off-farm income annual effect for Haechang district was estimated at 0.5 million won in 1991, 37.1 million won in 1992, and 28.6 million won in 1993.

(7) Income Effects from Other Crops (except for rice) : Improvement in drainage makes possible to grow various crops. For the study district, garlic, pepper, and strawberry were newly planted on 5.97 hectares. Income created from these crops were estimated to be 18,848 thousand won in present year(2000) value.

2) Indirect Benefits

(1) Public Benefits from Rice Paddy : Indirect benefits from farmland consolidation and drainage projects can be estimated by measuring improved environmental function of rice paddy such as water/air purification, flood control, water resource fostering, and soil loss prevention. For instance, function of water fostering by rice paddy can be improved by increasing the height of paddy levee. Water fostering function can be estimated by replacing dam construction cost. Function of air purification by rice could also be improved by increased productivity and area to be planted. Soil loss could be reduced in well-consolidated area. Existing literature containing the values of these public benefits was used with physical survey data of the district, to estimate the net public benefit generated in Haechang district. Table 4 summarizes to sum of the values of various public benefits, which could be classified by area and productivity. Annual values between 2000 and 2053 were assumed to be constant at 603 million won.

(2) Value of Food Security : The value of food security was estimated by using Contingent Valuation Method. This method is a survey technique asking respondents about willingness to pay for non-market goods. Assuming food security is a non-tradable public good having the characteristics of non-exclusiveness and nonrivaly in a society, CVM could be one of the appropriate methodologies estimating its value. Detailed description regarding structure of questionaries and statistical results are found in KARICO (2000). According to the study,

**〈Table 4〉 Annual public benefits improved in Haechang district** (unit : million won)

| Year | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000-2053 |
|---|---|---|---|---|---|---|---|---|
| public benefit by area | 374.5 | 374.5 | 374.5 | 374.5 | 374.5 | 374.5 | 374.5 | 374.5 |
| public benefit by productivity | 220.8 | 212.0 | 172.6 | 280.1 | 386.7 | 211.5 | 247.8 | 241.0 |
| Total value of public benefit | 595.3 | 586.5 | 547.1 | 654.6 | 761.2 | 586.0 | 622.3 | 615.5 |
| adjusted value of public benefit* | 583.9 | 575.3 | 536.6 | 642.1 | 746.6 | 574.8 | 610.4 | 603.7 |

*adjusted value of public benefit = Total value of public benefit x general conversion factor (0.981)

〈Table 5〉 Annual food security value from Haechang district

| | unit | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | --2053 |
|---|---|---|---|---|---|---|---|---|---|---|
| rice productivity with project | ton | 666.0 | 669.7 | 657.7 | 721.3 | 784.6 | 703.4 | 730.7 | 727.3 | 727.3 |
| rice productivity without project | " | 552.7 | 560.9 | 569.1 | 577.6 | 586.2 | 594.9 | 603.6 | 603.7 | 603.7 |
| productivity difference | " | 113.3 | 108.8 | 88.6 | 143.7 | 198.4 | 108.5 | 127.1 | 123.6 | 123.6 |
| food security value per ton | thousand won | 3,921 | 3,921 | 3,921 | 3,921 | 3,921 | 3,921 | 3,921 | 3,921 | 3,921 |
| net food security value per ton | " | 1,927 | 1,927 | 1,927 | 1,927 | 1,927 | 1,927 | 1,927 | 1,927 | 1,927 |
| security value of the district | million won | 218.3 | 209.7 | 170.7 | 276.9 | 382.3 | 209.1 | 244.9 | 238.2 | 238.2 |
| adjusted value of food security | " | 214.2 | 206.0 | 167.5 | 271.6 | 375.0 | 205.1 | 240.2 | 233.7 | 233.7 |

it was found that there is 1.7 to 3.8 hundred million won of food security value per year, in Haechang district. Table 5 summarizes net annual values of food security improved by increased rice productivity, based on the value per ton. Security value of the district was obtained by multiplying net food security value per ton and net increase in rice productivity (in tons) of the district.

### 3. Cash Flow Table and Project Efficiency Analysis(B/C Ratio, IRR, NPV)

When the values of public benefits and food security are considered in extended benefit-cost analysis, these values are the items included into cash inflow in cash flow table. As shown in Table 6, there are 10-16 million hundred won of cash inflow peryear, except for the investment cost in the first two years. Investment costs were adjusted considering the income losses from the lost farmland for newly built facilities and roads. As a results, social rate of return (SRR) came out to be 27.10 percent according to the cash flow table (Table 7). The economic rate of return (ERR) calculated in project plan was 10.50 percent. Difference between the two values is, of course, primarily from the inclusion of the values of public benefits and food security.

## Ⅳ. Summary and Conclusion

Most parts of agricultural infrastructures are being considered to be Social Overhead Capitals (SOC's) in recent years. When considering wide ranges of agricultural benefits to the society, the extent of the projects could be effective to every member of society. Main purpose of investments on

〈Table 6〉 Cash flow table for Haechang district (unit : million won)

| | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | --- | 2053 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **A. Cash Inflow** | - | 1,247.1 | 1,155 | 1,037.2 | 1,357.6 | 1,675.6 | 1,153.1 | 1,231.3 | 1,241 | 1,241 | 1,241 |
| 1. Increased productivity | - | 227.8 | 218.7 | 178.1 | 288.9 | 399 | 218.2 | 225.7 | 248.6 | 248.6 | 248.6 |
| 2. Input cost saving | - | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| 3. Machinery repair saving | - | 18.8 | 18.8 | 18.8 | 18.8 | 18.8 | 18.8 | 18.8 | 18.8 | 18.8 | 18.8 |
| 4. Health improvement | - | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 |
| 5. Labor cost saving | - | 112.7 | 112.7 | 112.7 | 112.7 | 112.7 | 112.7 | 112.7 | 112.7 | 112.7 | 112.7 |
| 6. Off-season income | - | 66.2 | - | - | - | - | - | - | - | - | - |
| 7. Other crops | - | 18.8 | 18.8 | 18.8 | 18.8 | 18.8 | 18.8 | 18.8 | 18.8 | 18.8 | 18.8 |
| 8. Value of public benefit | - | 583.9 | 575.3 | 536.6 | 642.1 | 746.6 | 574.8 | 610.4 | 603.7 | 603.7 | 603.7 |
| 9. Value of food security | - | 214.2 | 206 | 167.5 | 271.6 | 375 | 205.1 | 240.2 | 233.7 | 233.7 | 233.7 |
| **B. Cash Outflow** | 2,503.0 | 2,553.2 | 25.2 | 25.2 | 25.2 | 25.2 | 25.2 | 25.2 | 25.2 | 25.2 | 25.2 |
| 1. Investment cost | 2,503.0 | 2,528 | - | - | - | - | - | - | - | - | - |
| 2. Management cost | - | 25.2 | 25.2 | 25.2 | 25.2 | 25.2 | 25.2 | 25.2 | 25.2 | 25.2 | 25.2 |
| **C. Net Cash Flow** | -2,503.0 | -1,306.1 | 1,129.8 | 1,012 | 1,332.4 | 1,650.4 | 1,127.9 | 1,206.1 | 1,215.8 | 1,215.8 | 1,215.8 |

SOC's are to improve public welfare by using public or government funds. For Korean agricultural sector, not many years have passed to recognize the fact that the investments on agricultural infrastructures may improve national welfare as well as the farmers' income in relevant regions of the projects.

Recent policy interests have extended this primary policy issues to the public benefits of the society as a whole, from the relevant projects. This fact could be indirectly found from many recent researches regarding public benefits from agricultural sector in terms of environmental benefits, food security, etc.

These trends imply that agricultural sector of a country may possess additional value to the society which cannot be simply captured by "prices" in markets. These reasons justifies that investments on agricultural

〈Table 7〉 Social rate of return for haechang district

| Discounting rate(%) | 4 | 8 | 12 | 16 | 20 | 24 | 28 |
|---|---|---|---|---|---|---|---|
| Discounted cost (million won) | 5,294.4 | 4,773.9 | 4,437.4 | 4,172.2 | 3,946.4 | 3,747.3 | 3,568.7 |
| Discounted benefit (million won) | 27,225.4 | 14,315.9 | 9,281.2 | 6,722.4 | 5,192.6 | 4,180.8 | 3,465.2 |
| **B/C Ratio** | 5.14 | 3.00 | 2.09 | 1.61 | 1.32 | 1.12 | 0.97 |
| **NPV** (million won) | 21,931.0 | 9,542.0 | 4,843.8 | 2,550.1 | 1,246.2 | 433.4 | -103.6 |

SRR : 27.10 %

infrastructures should not be excluded from general SOCs' projects of a nation, improving public welfare. In the past, especially 1960's and 1970's in Korea, agricultural infrastructure projects have received relatively good priorities among many government projects. These priorities necessarily should have given to agricultural sector to provide enough food products to other industrial sectors at cheaper price, to maintain cheaper wages for economic development.

This paper introduces economic measures explaining how irrigation and drainage projects contribute to increase rice productivity and farm income. It introduced traditional procedures of economic analysis to evaluate economic performance of irrigation and drainage projects. Survey statistics were presented summarizing the recent economic performance of irrigation and drainage improvement projects. The final section referred public or nonmarket benefits of domestic agricultural production, and, analyzed how these benefits are related to evaluate socio-economic performance of irrigation/drainage projects.

The extended benefit-cost analysis for a specific region analyzed in this study shows how public benefits could be applied quantitatively in terms of social rate of return (SRR). The results reflect and provide political justification as well as economic justification in propelling agricultural projects, with receiving higher policy priority than previous. There still exist other benefits measurable for each of agricultural infrastructure projects. However, there may exist negative welfare impact of the project such as environmental costs. These costs may also be considered for extended B/C analysis when the data and methodologies available.

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