

Executive Summary

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While there is growing interest in multiple-use services, a key knowledge gap has been lack of information on the costs and benefits of multiple-use services in comparison to single-use services. Some studies and anecdotal evidences have suggested the net financial benefits of multiple-use approaches are greater than single-use approaches.

To test this hypothesis, the study made the following calculations for new domestic and domestic+ services and for upgrading existing services to domestic+ and irrigation+

- The potential income generated from the most commonly observed productive activities—home gardens, livestock and small-scale enterprises—supported at each service level.
- The costs by service level for new domestic+ services and for upgrading existing domestic and irrigation services, including hardware, software and annual recurrent costs.
- Repayment periods for hardware and software based on average annual financial benefits less annual recurrent costs.
- Cost-benefit ratios with sensitivity analysis to evaluate how variations in net income might influence the results.

Key Findings

- **Multiple-use services cost more than single-use services but generate greater income and poverty impacts** (see section 4 for more details on poverty impacts).
- **For domestic+, the intermediate multiple-use service level optimizes benefits** (including poverty impacts) relative to costs for new services and most upgrades.
- **For irrigation+, upgrading from the basic irrigation to the basic multiple-use service level optimizes financial benefits relative to costs**, but upgrading to the intermediate multiple-use service level optimizes poverty impacts, including substantial health benefits in areas without domestic water services (see section 4).
- **Income generated by multiple-use services can enable repayment of initial and ongoing costs for some service levels and technology options**, making multiple-use services more likely to be sustained.
 - Incremental income benefits are sufficient to cover the costs of new piped domestic+ multiple-use services at the intermediate multiple-use service level. Repayment periods for systems at this level of service are between 6-36 months under typical microfinance conditions.
 - Upgrading existing domestic and irrigation services to the basic and intermediate multiple-use service levels can result in sufficient income to repay full investment costs and recurrent annual costs within 3-30 months.
 - Appropriate finance models, including possible subsidies for poorest households, will be required to ensure affordability and equitable access to services.

Key findings

- **Once basic domestic needs are met (approximately 20 lpcd), each additional lpcd of water generates approximately \$.5-\$1/year of income.** Based on this analysis, improving water service levels from 20 to 100 lpcd has the potential to generate \$40-\$80 per capita per year. For a family of five this translates to an additional \$200-\$400 in income per year.
- Several factors cause variations in income benefits:
 - Differences in the asset base of households (different plot sizes, livestock types and numbers, and opportunities for small-scale enterprises) and extent of home consumption.*
 - Differences in the nature and intensity of production (access to inputs, technologies, know-how, credit) and climatic factors.
 - Market prices and access, and financial, technical and managerial support.

*For example, lower income estimates for home gardens assume small plots, seasonal production, traditional garden (low intensity production) with nearly all produce consumed.

2.2.1 Domestic+: Income Benefits by Service Level

Per capita annual income benefits by service level for domestic+ are:

Highest level multiple uses: \$71/capita
 Intermediate level multiple uses: \$61/capita
 Basic level multiple uses: \$25/capita¹

Finding: The largest incremental gains in income are achieved at the intermediate service level.

Average incremental income benefit: \$10

Average incremental income benefit: \$36

Average incremental income benefit: \$25

Highest level MUS

| | Home gardens | Livestock | Small-scale enterprises | Total |
|---------|--------------|-----------|-------------------------|---------|
| Average | \$64 | \$87 | \$19 | \$71 |
| Range | \$4-50 | \$36-138 | \$4-35 | \$4-138 |

Intermediate level MUS

| | Home gardens | Livestock | Small-scale enterprises | Total |
|---------|--------------|-----------|-------------------------|---------|
| Average | \$23 | \$67 | \$17 | \$61 |
| Range | \$2-43 | \$14-120 | \$4-30 | \$2-120 |

Basic level MUS

| | Home gardens | Livestock | Small-scale enterprises | Total |
|---------|--------------|-----------|-------------------------|--------|
| Average | 11 | 27 | 17 | 25 |
| Range | \$1-22 | \$4-50 | \$4-30 | \$1-50 |

Basic Domestic

No Service

Although basic domestic services generate a range of non-financial economic benefits related especially to health and time savings, any income generated is through unplanned and often illegal activities, making sustainability uncertain.

Key findings

- For new services, the intermediate multiple-use service level optimizes income benefits (and poverty impacts) relative to costs. Income benefits are sufficient to cover the costs of new piped domestic+ multiple-use services with repayment periods of 6-36 months.
- For upgrades to existing services, the intermediate multiple-use service level optimizes income benefits relative to costs for piped systems and hand-dug household wells. For these two technologies, repayment periods for incremental upgrades range from 7-25 months, depending on the extent of the service upgrade and technology. For boreholes with hand pumps, the basic multiple-use service level optimizes income benefits with repayment periods averaging 12 months.

Factors influencing the cost and ease of moving up the water service ladder

- **Population density and economies of scale of water supply:** The higher the population density, the smaller the per capita incremental costs of moving to a higher level of service.
- **Water availability:** Shallow groundwater sources cost less to develop; sources that are less distant are less costly to develop for networked systems.
- **Technology:** Technology choice is an important determinant of costs for both new services and incremental upgrades. For example, the initial costs of gravity-fed piped systems are significantly less than those for deep boreholes. For upgrades, the incremental costs are determined by existing technology and upgrade options.
- **Institutional readiness and implementation capacity:** As institutional readiness and implementation capacity increase, incremental costs (initial and recurrent) decrease.

2.2.3 Domestic+: Per Capita Costs and Income Benefits of New Multiple-Use Services

The intermediate service level is the most promising option for NEW domestic+ services.

Incremental income benefits are most likely to cover capital investment and annual recurrent costs at the intermediate multiple-use service level. Average repayment periods range from 6-30 months. A particularly promising option is low-cost gravity-fed spring systems.

Appropriate finance models, including possible subsidies for poorest households, will be required to ensure affordability and equitable access to services.

Units: US\$/per capita

Capital investment = Average hardware and software costs in year 1

Recurrent costs = Average annual costs for operation and maintenance, source protection, and capital maintenance fund

Income = Average annual income due to incremental upgrade to higher service level

| Highest level MUS | | | |
|-----------------------------------------|-----|--|--|
| Piped scheme, individual HH connections | | | |
| Capital investment | 140 | | |
| Recurrent cost/yr | 50 | | |
| Annual income | 71 | | |

| Intermediate level MUS | | |
|------------------------|-----------------------------------|------------------------------------------|
| | Piped scheme, frequent standpipes | Piped spring systems close to households |
| Capital investment | 105 | 19 |
| Recurrent cost/yr | 19 | 10 |
| Annual income | 61 | 61 |

| Basic MUS | | |
|--------------------|-------------------------------|-----------------------------------------|
| | Piped scheme, some standpipes | Borehole w/ hand pump & communal add-on |
| Capital investment | 98 | 116 |
| Recurrent cost/yr | 18 | 17 |
| Annual income | 25 | 25 |

| Basic Domestic | | | |
|--------------------|-------------------------------------|-----------------------|--------------------------------------------|
| | Community shallow well w/ hand pump | Borehole w/ hand pump | Piped scheme w/ few & dispersed standpipes |
| Capital investment | 63 | 91 | 70 |
| Recurrent cost/yr | 9 | 13 | 13 |
| Annual income | 0 | 0 | 0 |

| No Service | | | |
|--------------------|---|--|--|
| Capital investment | 0 | | |
| Recurrent cost/yr | 0 | | |
| Annual income | 0 | | |

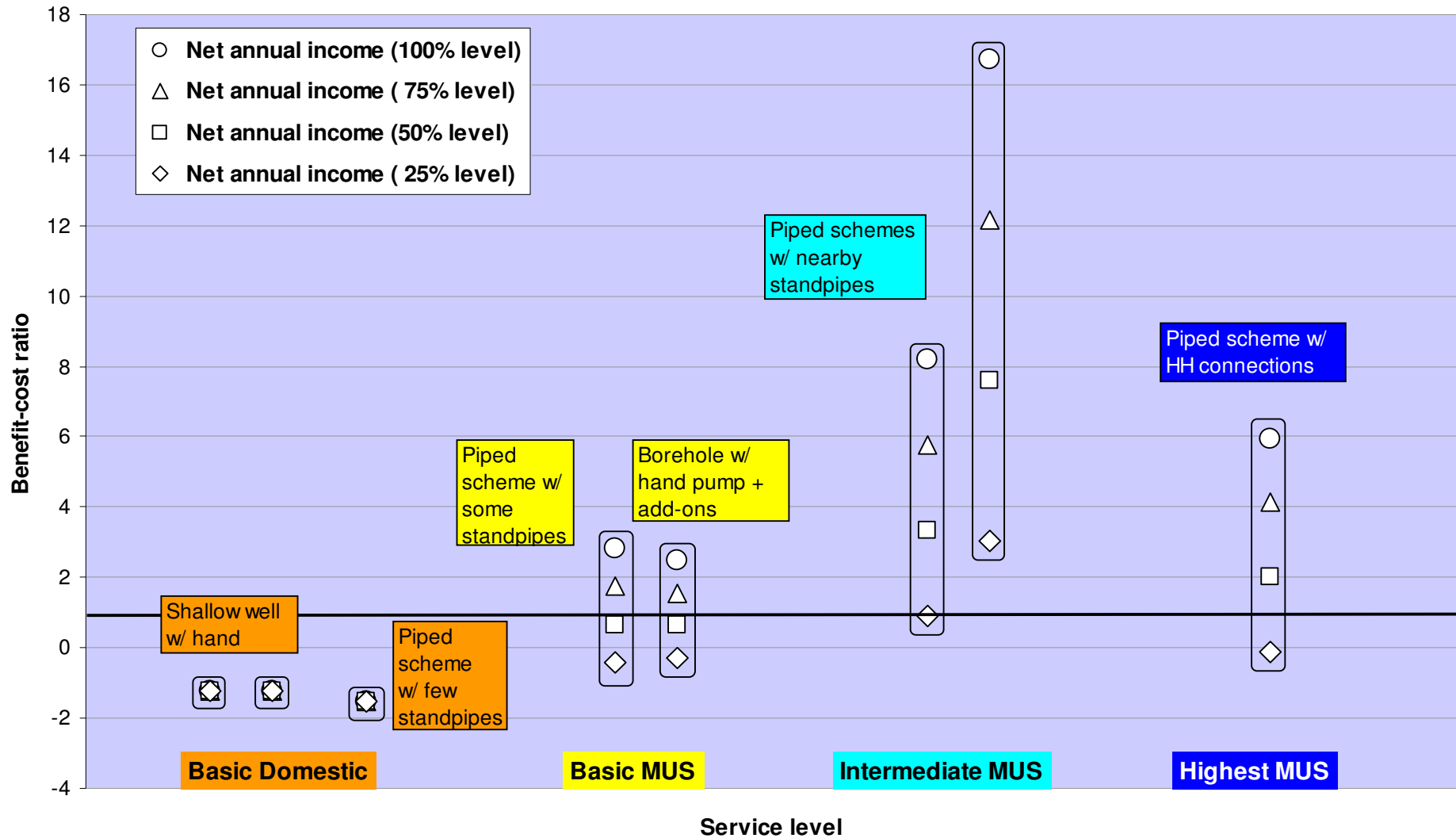
To evaluate how variations in net returns might influence the results, the research team conducted benefit-cost analyses under four net income scenarios:

- Conservative: 25% of estimated net income potential achieved
- Moderately conservative: 50% of estimated net income potential achieved (base case)
- Moderately optimistic: 75% of net income potential achieved
- Optimistic: 100% of income potential achieved

Key Findings

- At the **intermediate** multiple-use service level, the benefit-cost ratios exceed 1 for all income scenarios, indicating that potential investments in multiple-use water services at the intermediate service level are likely to be financially viable even when income returns are modest.
- The **highest** multiple-use service level offers a relatively attractive investment opportunity. Achieving impact at scale, however, could be challenging given the relatively high costs of household connections and competing demands for water services for those currently without services.
- The **basic** multiple-use service level is a viable investment option under two scenarios:
 - Capital investment costs are subsidized. Under this scenario, the income generated should be sufficient to cover recurrent annual costs, including capital maintenance funds for infrastructure replacement at the end of its useful life.
 - Users achieve higher income levels. This is an optimistic, risky assumption.

Baseline used
for analysis is
50% level



2.2.6 Summary of Domestic+: Financial Analysis for New Domestic+ Services

Investments in new domestic+ multiple-use services should focus on the intermediate multiple-use service level, where incremental benefits are sufficient to cover full investment and annual recurrent costs within 3 years and achieve significant poverty impacts. A particularly promising option is low-cost piped, gravity-fed spring systems.

Incremental costs and benefits, repayment periods and benefit-cost ratios of new domestic+ services

| Water services systems | Technology | Capital investment costs (hardware plus software) | Annual income net of recurrent costs | Repayment period (months) | Benefit-cost ratio (10% discount rate) |
|-----------------------------------------------|------------------------------------------------------------------------|------------------------------------------------------|--------------------------------------|---------------------------|-------------------------------------------|
| Level 1: Basic domestic | Range | \$63-\$91 | (\$9-\$13) | | (negative) |
| | Piped systems, dispersed standpipes | \$70 | (\$12) | | |
| | Shallow wells w/ hand pumps | \$63 | (\$9) | | |
| | Boreholes w/ hand pumps | \$91 | (\$13) | | |
| Level 2: Basic multiple uses | Range | \$98-\$116 | \$8-\$9 | 147-155 | .66-69 |
| | Piped systems, some standpipes | \$98 | \$8 | 147 | .69 |
| | Boreholes w/ hand pumps & in situ add-ons | \$116 | \$9 | 155 | .66 |
| Level 3: Intermediate multiple use | Range | \$56-\$105 | \$42-\$51 | 13-30 | 3.4-7.8 |
| | Piped systems, frequent standpipes | \$105 | \$42 | 30 | 3.4 |
| | Piped gravity-fed spring systems | \$56 | \$51 | 13 | 7.8 |
| | Hand-dug household wells: protecting & adding improved lifting devices | \$102 | \$47 | 24 | 3.4 |
| Level 4: Highest multiple uses | Piped schemes, household connections | \$140 | \$21 | 80 | 1.28 |

2.2.7 Domestic+: Per Capita Benefits & Costs of Upgrading Existing Systems to Multiple-Use Systems

The best option is upgrading from the basic domestic to intermediate multiple-use service level. Repayment periods range from 20-24 months.

| Highest level MUS | |
|--------------------|----------------------|
| | Piped system upgrade |
| Capital investment | 56 |
| Recurrent cost/yr | 10 |
| Annual income | 10 |

| Intermediate level MUS | |
|------------------------|----------------------|
| | Piped system upgrade |
| Capital investment | 84 |
| Annual recurrent | 15 |
| Annual income | 62 |

| Intermediate level MUS | |
|------------------------|----------------------|
| | Piped system upgrade |
| Capital investment | 56 |
| Recurrent cost/yr | 10 |
| Annual income | 36 |

| Basic MUS | |
|--------------------|----------------------|
| | Piped system upgrade |
| Capital investment | 56 |
| Recurrent cost/yr | 10 |
| Annual income | 25 |

| Basic Domestic | |
|--------------------|----------------------|
| | Piped system upgrade |
| Capital investment | 70 |
| Recurrent cost/yr | 13 |
| Annual income | 0 |

No Service

Costs and benefits are for stepwise incremental upgrades from one service level to the next, except for upgrades from basic domestic directly to intermediate multiple use level.

Going from basic domestic to intermediate multiple use

Units: US\$/per capita

Capital investment = Average hardware and software costs in year 1

Recurrent costs = Average annual costs for operation and maintenance, source protection, and capital maintenance fund

Income = Average annual income due to incremental upgrade to higher service level

2.2.8 Domestic+: Per capita Benefits and Costs of Upgrading Boreholes with Hand Pumps

The best option is upgrading basic domestic services to basic multiple-use services by adding communal infrastructure to support livestock and communal gardens. The repayment period averages 12-14 months.

Highest level MUS

| | |
|--------------------|---------------------------------------------------------------------|
| | Increasing pumping, storage capacity and piped distribution network |
| Capital investment | 67 |
| Annual recurrent | 10 |
| Annual income | 10 |

Intermediate level MUS

| | |
|--------------------|-----------------------------------------|
| | Network: Adding pump, storage and pipes |
| Capital investment | 67 |
| Annual recurrent | 10 |
| Annual income | 36 |

Basic MUS

| | |
|--------------------|-------------------------------------------------------------|
| | Communal add-ons (livestock, bathing and community gardens) |
| Capital investment | 25 |
| Annual recurrent | 4 |
| Annual income | 25 |

Basic Domestic

| | |
|--------------------|-------------------------|
| | Borehole with hand pump |
| Capital investment | 91 |
| Annual recurrent | 13 |
| Annual income | 0 |

No Service

Costs and benefits are for stepwise incremental upgrades from one service level to the next

Units: US\$/per capita
 Capital investment = Average hardware and software costs in year 1
 Recurrent costs = Average annual costs for operation and maintenance, source protection and capital maintenance fund
 Income = Average annual income due to incremental upgrade to higher service level

The best option is upgrading from the basic domestic service level to the intermediate multiple-use level by installing improved lifting devices for protected wells. Repayment periods range from 6-12 months. To achieve health benefits as part of the upgrade, however, well protection/lining is essential. For households without protected wells, well lining coupled with improved lifting devices is a promising upgrade; repayment periods average 24 months.

Intermediate level MUS

| | Lining/protecting and improved lifting |
|--------------------|----------------------------------------|
| Capital investment | \$102 |
| Annual recurrent | \$15 |
| Annual income | \$61 |

Going from “no service” to intermediate multiple use service level though well protection and by improved lifting devices

Going from basic domestic to intermediate multiple use by adding improved lifting devices to protected wells

Intermediate level MUS

| | Treadle pump | Rope pump |
|--------------------|--------------|-----------|
| Capital investment | \$32 | \$56 |
| Annual recurrent | \$5 | \$8 |
| Annual income | \$61 | \$61 |

Basic MUS

Basic Domestic

| | Lining/protecting |
|--------------------|-------------------|
| Capital investment | \$63 |
| Annual recurrent | \$9 |
| Annual income | \$0 |

No Service

Unprotected hand-dug wells; unimproved source

Units: US\$/per capita

Capital investment = Average hardware and software costs in year 1

Recurrent costs = Average annual costs for operation and maintenance, source protection, and capital maintenance fund

Income = Average annual income due to incremental upgrade to higher service level

Key Findings

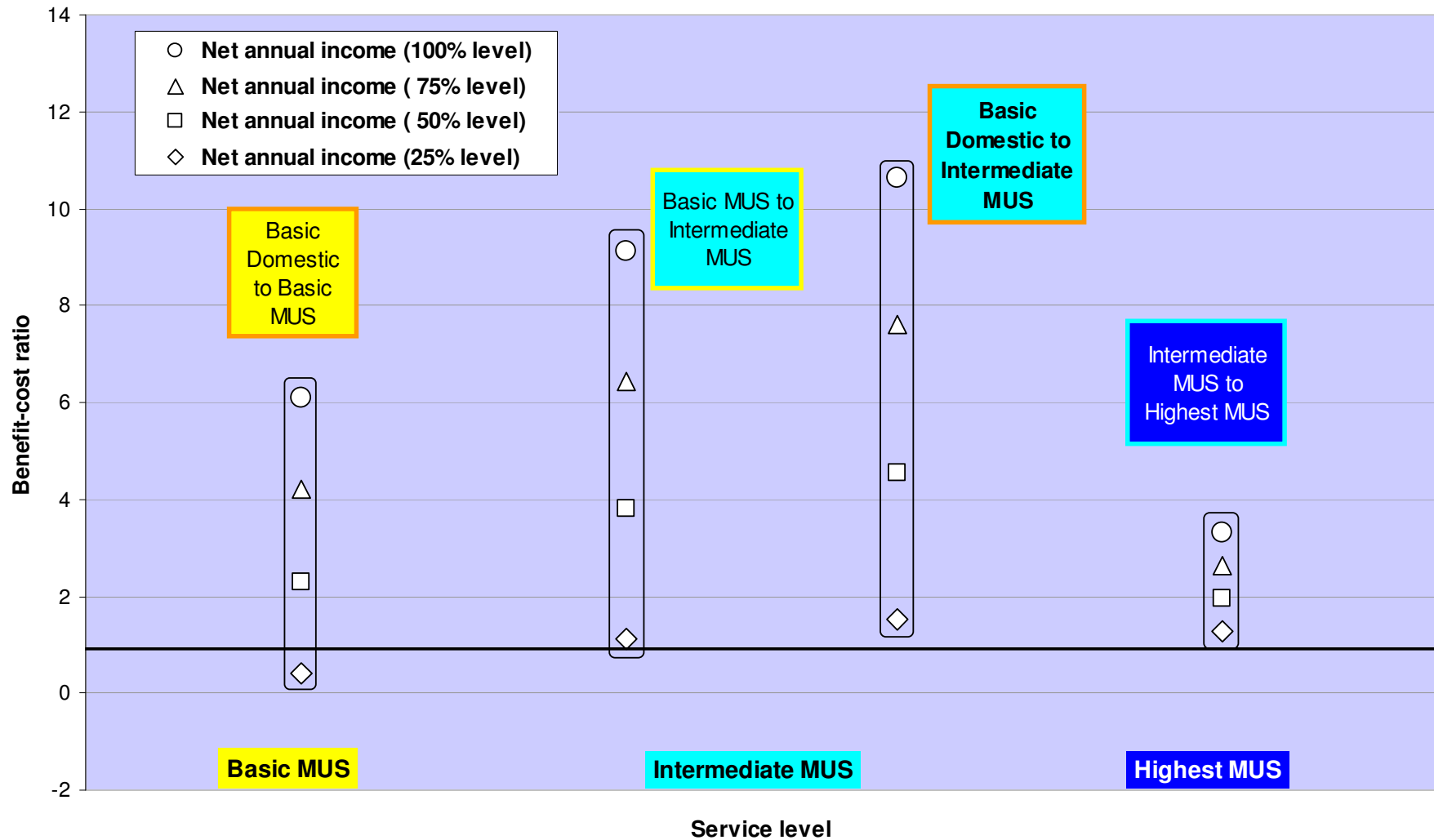
- **For piped systems**, the benefit-cost ratios exceed 1 at all income levels for upgrades that result in water service levels at the intermediate multiple-use level and higher. The highest benefit-cost ratios are achieved when upgrading from the basic domestic to intermediate multiple-use service level.
- **For communal boreholes with hand pumps**, the benefit-cost ratios for all upgrades exceeded 1 for all income scenarios. The highest benefit-cost ratio under all scenarios resulted from upgrading from the basic domestic to basic multiple-use service levels.
- **For household hand-dug wells**, the benefit-cost ratios exceeded 1 for all options evaluated. The largest benefit cost ratios resulted from improved lifting devices for protected wells that increased service levels from basic domestic to intermediate multiple-use level.

2.2.11 Domestic+: Sensitivity Analysis of Benefit-Cost Ratios for Upgrades to Existing Piped Services

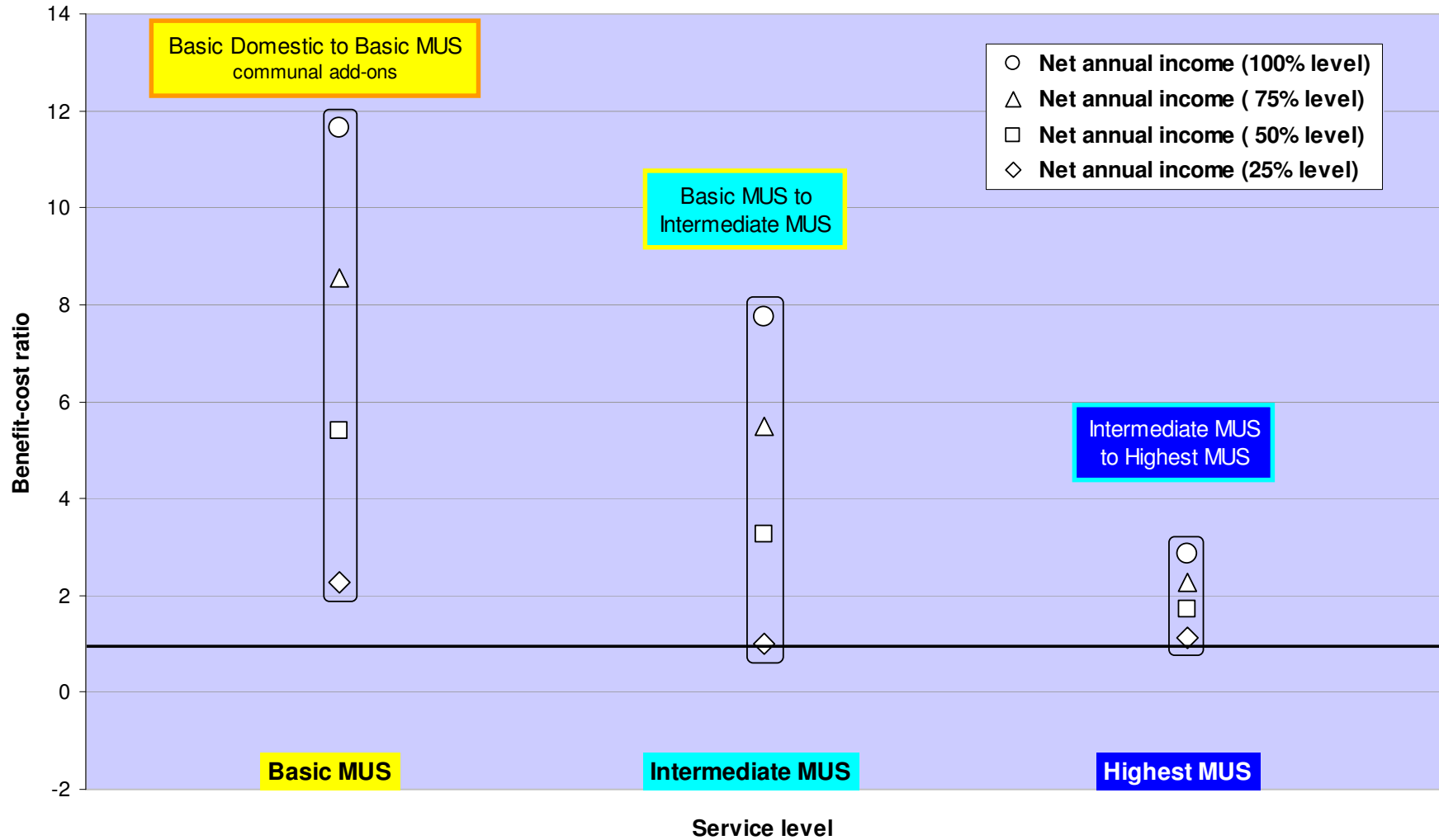
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Wi

Baseline used for analysis is 50% level



Baseline used for analysis is 50% level

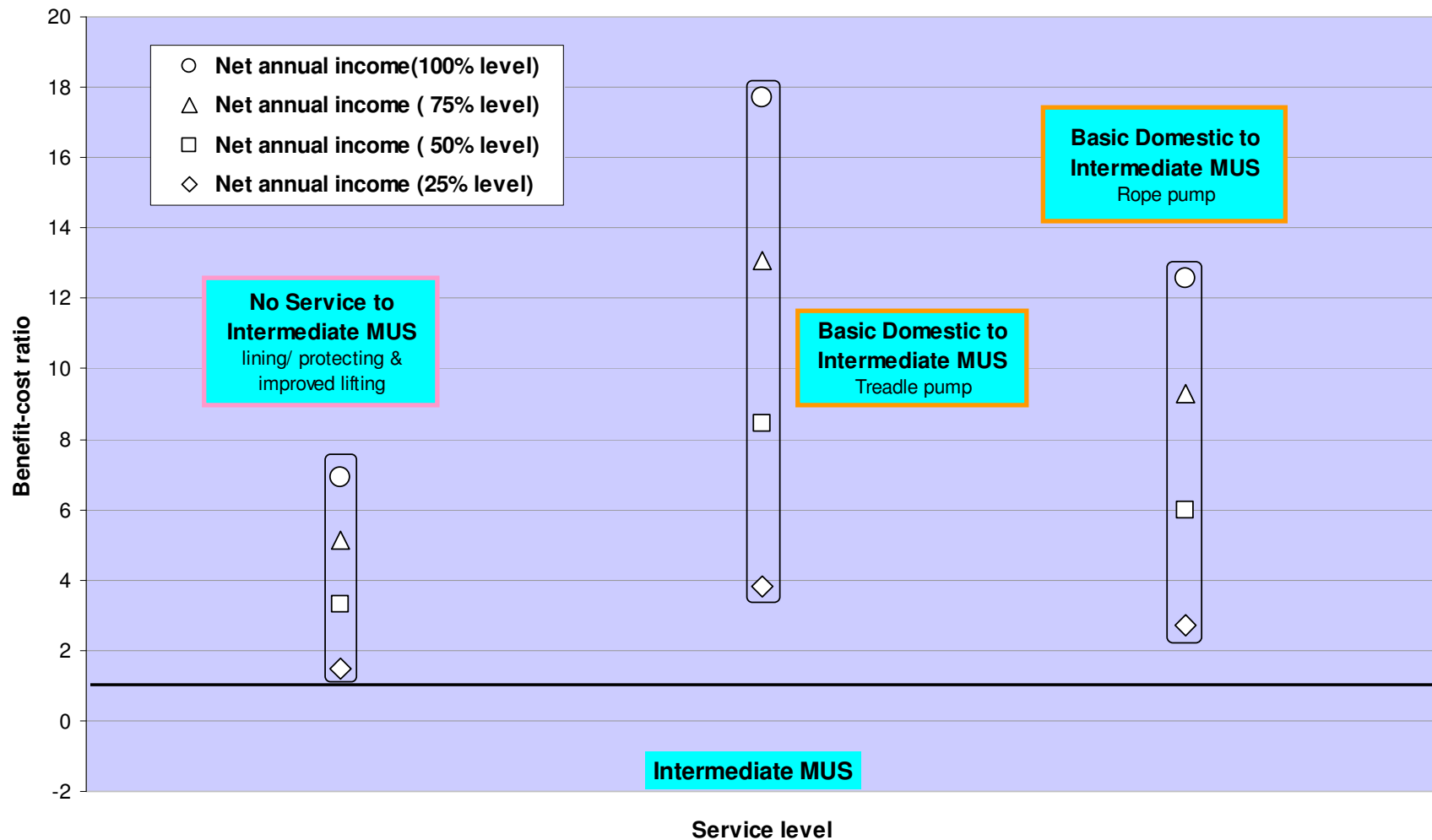


2.2.13 Domestic+: Sensitivity Analysis of Benefit-Cost Ratios for Upgrades to Existing Household Hand-Dug Wells

17

Wi

Baseline used
for analysis is
50% level





Investments in upgrading domestic multiple-use services should focus on the intermediate multiple-use service level for piped systems and hand-dug wells, where incremental benefits are sufficient to cover capital investment and annual recurrent cost within 7-22 months. An attractive option for boreholes fitted with hand pumps is upgrading to the basic multiple-use service level through in situ add-ons for domestic and productive activities, with repayment period of 1 year.

Incremental costs and benefits, repayment periods and benefit-cost ratios of upgrading domestic services

| Water services systems | Technology | Capital investment costs (hardware plus software) | Annual income net of recurrent costs | Repayment period (months) | Benefit-cost ratio (10% discount rate) |
|----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|------------------------------------------------------|--------------------------------------|---------------------------|-------------------------------------------|
| Level 1 to Level 2: Basic Domestic to Basic Multiple Uses | Boreholes w/ hand pumps: in situ add-ons to support livestock, bathing and community gardens | \$25 | \$22 | 12 | 5.4 |
| Level 1 to Level 3: Basic Domestic to Intermediate Multiple Uses | Range | \$32-\$84 | \$46-\$58 | 7-25 | 4.7-8.6 |
| | Piped systems: increasing quantity and density of standpipes, adding some yard taps | \$84 | \$46 | 22 | 4.7 |
| | Hand-dug protected household wells: add improved lifting devices to increase quantity - treadle pump | \$32 | \$58 | 7 | 8.6 |
| | - rope pump | \$56 | \$54 | 13 | 6.1 |
| Level 2 to Level 3: Basic Multiple Uses to Intermediate Multiple Uses | Piped systems, increasing quantity and adding standpipes & yard taps to expand productive activities | \$56 | \$26 | 25 | 3.9 |

Key Findings

- **The income generated by irrigation+ multiple use services can enable repayment of initial and ongoing incremental costs for irrigation+ multiple-use service upgrades, particularly at the basic and intermediate multiple-use service levels.**
 - Upgrading services from the basic irrigation to **basic multiple-use service level is the most financially attractive** upgrade investment option, with an average repayment period of 3 months.
 - **Poverty impacts are maximized at the intermediate service level**, where water services near the homestead provide for drinking and domestic needs, as well as productive needs. This service level is also an attractive investment option, with income benefits sufficient to cover investment costs in 12-24 months.
- Cost-benefit ratios exceeded 1 for all sensitivity analysis scenarios, indicating that potential investments in irrigation+ multiple-use services are likely to be financially viable, even if income returns are modest, particularly at the basic multiple-use service level.

2.3.1 Irrigation+: Per Capita Annual Income Benefits by Service Level

Per capita annual income benefits by service level are:

Highest level multiple uses: \$71/capita
 Intermediate level multiple uses: \$61/capita
 Basic level multiple uses: \$52/capita

The greatest incremental income benefits are achieved at the basic multiple-use service level.

Average incremental income benefit: \$10

Average incremental income benefit: \$9

Average incremental income benefit: \$52

Highest level MUS

| | Home gardens | Livestock | Small-scale enterprises | Total |
|----------|--------------|-----------|-------------------------|---------|
| Midpoint | \$64 | \$87 | \$19 | \$71 |
| Range | \$4-124 | \$36-138 | \$4-35 | \$4-138 |

Intermediate level MUS

| | Home gardens | Livestock | Small-scale enterprises | Total |
|----------|--------------|-----------|-------------------------|---------|
| Midpoint | \$23 | \$67 | \$17 | \$61 |
| Range | \$2-43 | \$14-120 | \$4-30 | \$2-120 |

Basic MUS

| | Home gardens | Livestock | Small-scale enterprises | Total |
|----------|--------------|-----------|-------------------------|---------|
| Midpoint | - | \$52 | \$17 | \$52 |
| Range | - | \$4-100 | \$4-30 | \$4-100 |

Basic Irrigation

Basic irrigation services generate a range of income and poverty impacts, which are well documented. Given the focus on incremental benefits associated with multiple-use services, these benefits have not been estimated.

Two financially viable options:

- Upgrading from the basic irrigation service level to the basic multiple-use service level through communal add-ons to support livestock.¹ The average repayment period is 3 months.
- Upgrading from the basic irrigation level to the intermediate multiple-use service level by adding communal water storage, home water treatment, and in situ add-ons. The repayment periods average 12-24 months.

At the intermediate and highest multiple-use service levels, increasing domestic and some non-irrigation productive needs are met .

At the basic multiple-use service level, domestic needs are *not* addressed.

Basic Irrigation

| Highest level MUS | | |
|--------------------------|---------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| | Individual household water storage w/ taps | Multi-household water storage w/ taps |
| | In situ add-ons for livestock and domestic uses, plus household storage, hygiene education and home water treatment | |
| Capital investment | 98 | 165 |
| Recurrent cost/yr | 8 | 13 |
| Annual income | 71 | 71 |

| Intermediate level MUS | | |
|-------------------------------|---------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|
| | Community water storage w/ electric pump | Community water storage w/ electric pump & generator |
| | In situ add-ons for livestock and domestic uses, plus community water storage, hygiene education and home water treatment | |
| Capital investment | 56 | 110 |
| Recurrent cost/yr | 6 | 9 |
| Annual income | 61 | 61 |

| Basic MUS | |
|--------------------|-----------------------------------------------------------------------|
| | In situ add-ons for livestock (drinking troughs and cattle crossings) |
| Capital investment | 11 |
| Recurrent cost/yr | 1 |
| Annual income | 52 |

Units: US\$/per capita

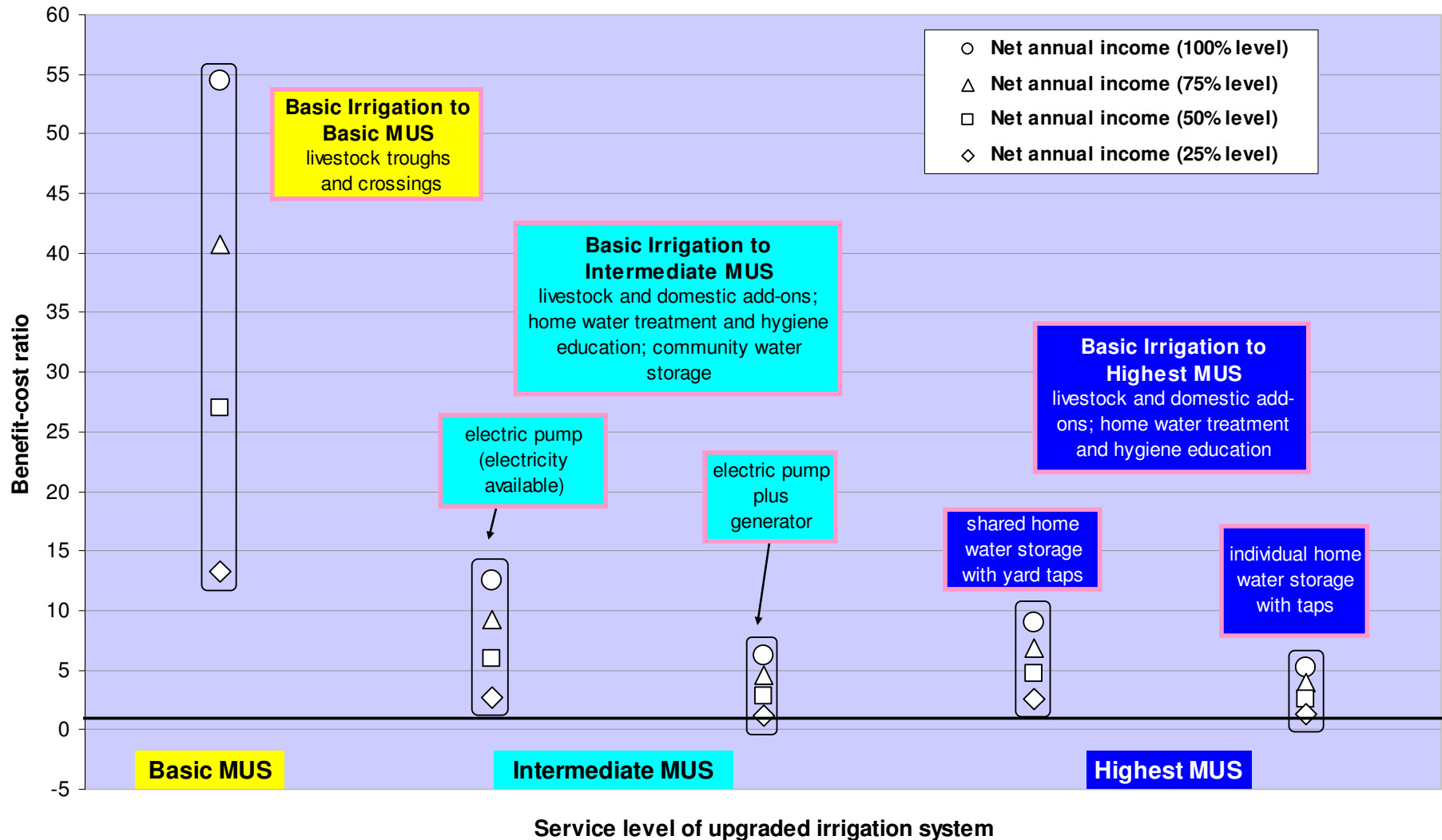
Capital investment = Average hardware and software costs in year 1

Recurrent costs = Average annual costs for operation and maintenance, source protection and capital maintenance fund

Income = Average annual income due to incremental upgrade to higher service level

2.3.3 Irrigation+: Sensitivity Analysis of Benefit-Cost Ratios for Upgrading Existing Irrigation Services

Baseline used for analysis is 50% level



2.3.5 Irrigation+: Summary of Costs and Benefits for **Upgrading** Existing Irrigation Services to Irrigation+

The results suggest there are significant investment opportunities for upgrading existing irrigation systems to support multiple-use services to improve productivity of sunk investments and enhance poverty impacts, including health benefits. Upgrading services from basic irrigation to basic multiple-use is the most financially attractive investment option, but higher levels of service are also financially viable and generate more significant poverty impacts (including health and social equity benefits).

Incremental costs and benefits, repayment periods and benefit-cost ratios of upgrading irrigation services

| Water services systems | Technology | Capital investment costs (hardware plus software) | Annual income net of recurrent costs | Repayment period (months) | Benefit-cost ratio (10% discount rate) |
|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|--------------------------------------|---------------------------|----------------------------------------|
| | | per capita | | | |
| Level 1 to Level 2: Basic Irrigation to Basic Multiple Uses | In situ add-ons* to support livestock (drinking troughs and livestock crossings) | \$10 | \$50 | 3 | 27 |
| Level 1 to Level 2: Basic Irrigation to Intermediate Multiple Uses | Community water storage (including home water treatment and hygiene education) and in situ add-ons for livestock and domestic uses (bathing and laundry)* | \$50-\$110 | \$51-\$57 | 12-24 | 2.9 - 6.8 |
| Level 1 to Level 3: Basic Irrigation to Highest Multiple Uses | Household water storage (including home water treatment and hygiene education) and in situ add-ons for livestock and domestic uses (bathing and laundry)* | \$98-\$165 | \$58-\$63 | 19-34 | 2.2 - 3.9 |

* In situ add-ons include infrastructure that is added at the source to support domestic and productive activities. The add-ons proposed at the basic multiple-use service level include livestock troughs near canals and livestock canals crossings. At the intermediate multiple-use services level, in situ add-ons include communal facilities near canals for bathing and laundry.