Structure of Annexes - overview

Annexes—Overview

A. Case studies

B. Methodology

C. Additional details on results

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A.1 Multiple-Use Services by Design
A.2 Domestic+
A.3 Irrigation+

A.1 Key Findings: Multiple Use Services by Design Case Studies

Nepal, Zimbabwe, India

1) Multiple uses support multiple livelihoods and impact on multiple poverty manifestations
All case studies demonstrate the combined domestic and productive uses of multiple use services. There is definite evidence that multiple use services result in improved health, food security, diversified household livelihoods and improved household incomes

2) Benefits multiply when multiple use approaches are complemented with improved technology, market knowledge and asset-redistribution
Water is a key, but not the only poverty driver. A number of other variables need to be in place for optimal realization of benefits from improved water supplies

3) High reliability and increased scheme sustainability are demonstrated
Multiple Use Schemes demonstrate a combination of service level criteria - improved quality and quantities of water, assured reliability and improved access. In reverse, these 'service level' issues are met by improved technologies, and collectively, impact positively on user ownership and maintenance.

4) Improved equity and empowerment are achieved only through targeting
As with Domestic- and Irrigation-Plus studies, benefits accrue to the poorest through prioritized provision of drinking water access for all households, targeting of women, lower income areas and disadvantaged groups, targeted subsidies, etc.

A.1 Multiple Use Services By Design: The Smallholder Irrigation Market Initiative, Nepal

CONTEXT

The Smallholder Irrigation Market Initiative project has developed 64 multiple-use schemes to supply water for both domestic and productive purposes. A total of 14 Districts and 74 Village Development Committees have at least one multiple use scheme covering 1,603 households and 9,330 beneficiaries (WI, 2007).

Population (64 MUS schemes in Nepal)	1,603 households, 9,330 beneficiaries
Average household size	5

SYSTEM TYPE

Intermediate Multiple Use Services: 3000L gravity fed tank collects spring water for prioritized domestic needs, which is then gravity fed to communal taps throughout the villages. Overflow from this tank goes into a 10,000L tank which is used for irrigation, and is fed through off-takes to the homestead plots. 78% households use drip and/or sprinkler technology, which was promoted by the project.

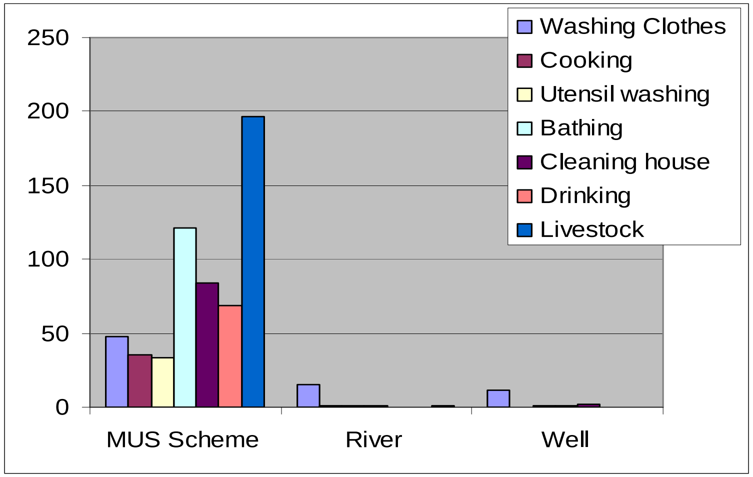
Key Findings

1. **Benefits of formal multiple use services***:* Formal allocations for domestic and productive water use. Reduced labor and time in fetching water for domestic and productive uses; improved health, diversified household livelihoods and income, and social cohesion and mobilization
2. **Equity in incremental benefits achieved through conscious targeting***:* Benefits achieved through: prioritizing drinking water access for all households, the targeting of women, lower income areas and disadvantaged groups, and capacity building
3. **Technical and market support multiply benefits***:* Assured water complemented by improved technology improves irrigation efficiency by ~300%; improved market information and credit facilities result in rise in household incomes by ~$216/household (2007) compared to base-line surveys in 2003-04.

Service Levels in Nepal

	Intermediate Multiple Use *MUS by design*
Access	Average distance to water for irrigation: 64m (range: 5-137m) Average time to water for domestic use: 4 minutes (range: 2-11 minutes)
Reliability	Over all months: 49% of respondents felt supplies were adequate 29% felt supplies were just right 22% felt supplies were scarce In Summer: 60% felt supplies were scarce
Quality	88% of users felt supplies under MUS were 'safe' for drinking and domestic use
Quantity	45 lpcd for domestic uses: 87% of households report increased water availability for cooking and drinking. Similar high satisfaction levels for water for domestic hygiene uses. 600L/day per household for productive uses: 89% of households report increased water availability for livestock

Domestic water use (L) and reliance on MUS increases



Summary Benefits and Impacts of Intermediate Multiple Use Services

	Benefits	Limitations
Income and Service Costs	• Cropping intensity in plots is more than 300%, a 100% increase compared to rain-fed crops • Income gains determined by several externalities and vary by village and household; 80% households report improved incomes - a 100-200m^2 garden generates an average net annual income of US$163/household • Income gains increase incrementally over the years, as do farmer capabilities – and cover all costs, including all software costs (project staff costs too!) • Average annual income repays the initial costs of the scheme and micro-irrigation investments in year 1: average weighted income of project participants was US$1,393/household as compared to the $216/household baseline (2003-04) •80% of produce is sold	**Incremental Costs:** *Drip system:* US$20/household *Average cash cost:* US$76/household *Average non-cash cost:* US$4/household **But** • Upfront capital costs are significant despite variation on the cost of materials, use of old materials and number of households served • Users contributed 50% of total project costs through labor and material. • Income and high valued crop sale increases are large because prior to scheme, very few farmers practiced irrigation and most agricultural production was staple crops for home consumption.

Number of households producing vegetables and income: before and after multiple-use services

Activity	Baseline, at start of Multiple Use Scheme	After Multiple Use Scheme
Percentage of household income from vegetable production	10-20%	50-70%
Total average household income	$215/yr	$1390/yr

*High value crops are grown, with technical support from scheme; local demand for vegetables is high, especially in the monsoon, when rain hinders transportation from outside; 91% farmers walk and sell to local market traders, probable transportation and sale of vegetables elsewhere by local traders.

Summary Benefits and Impacts of Intermediate Multiple Use Services

	Benefits	Limitations
Health	• 2kg/day of vegetables consumed per MUS household as compared to 0.3kg/day/household before scheme • 22 min/day in time savings used to do more farming, weaving and resting at home	**But** • 16% of households saw an increase in mosquito breeding and water borne disease from waste water logging
Livelihoods	• Water availability for livestock increased • Scheme enables reliable use of labor and time, impacts on reducing out-migration • Livelihood diversification: 43% women use time saved in production activities; drudgery from hauling water for domestic and productive uses, is significantly reduced	**But** • Production of millet and maize has been entirely replaced by more lucrative high value vegetable production
Social	• Farmers mobilized to observe market trends, and more inclined toward group approaches in which women are involved in decision making •'Equity' in domestic water for all; productive water access for small and large land-holders • Pro-poor intervention: vegetable cultivation generates employment for landless households **• 76% of user households report more girls going to school**	**But** • Scheme criteria (including village access to land, water source and markets) could be biased against locationally and socio-economically backward areas • While women outnumber men in MUS management groups and shoulder more management responsibilities, they make fewer decisions than men, and have less access to cash

Chuya Aryal, a mother of 4 lives in an extended family of 12 members. She used time saved in fetching water for domestic use to grow vegetables. The US$88 she earns per season (3 seasons/year) goes to her husband or her father-in-law. "Sometimes they consult me to spend the money…"

Sources: Pant et. al., 2005; Internal Documents: Khara Kola Case Study, 2007a, Senapuk Case Study, 2007c, The Nepal Experience, 2007d, Lessons and Conclusions Drawn from the IDE/Winrock Experience in Nepal, 2007b

CONTEXT

This case focuses on seven garden schemes that were part of a pilot project to examine new approaches to improving water and food insecurity in dry land areas

Population	Improved domestic and productive water for 545 member-households Domestic water offered to 911 non-member households

SYSTEM TYPE

Basic Multiple Use: Collector wells: radial and lateral drilling up to 30m ensure year-round water supply; water used for domestic and a range of productive uses, but primarily for half-hectare community vegetable garden schemes that are managed by the community.

Key Findings

1. **Participatory multiple use promotes secure livelihoods, gender equity and scheme sustainability***:*
   - 77% of member households reported regular income from the scheme, financial benefits make up 27% of the average income of 50% households in the area
   - Improved water services complemented with established land tenure rights for member households ensures equity and empowerment
   - Small, reliable benefits from home gardens accrued primarily to women, women report: “If I give up my plot, I’d be giving up my future.”
   - User perception of ownership is extremely important to sustaining scheme and system: significant software investments in this project resulted in 80% members identifying themselves as decision-makers regarding water scheduling, maintenance requirements and member and non-member use of productive and domestic water
2. **Service reliability overcomes access limitations***:* In semi-arid Zimbabwe, boring sites are determined by water aquifers, hence services are at best communal and available between 500-1000m from houses. However, high reliability and quality overcomes access issues; people will travel longer if reliability is high
3. **Subsidies required if capital costs for service is high**: High capital costs of US$11,600 limit provision of higher service levels in low-income settlements unless supported through project subsidies.

Service Levels in Masvingo Province

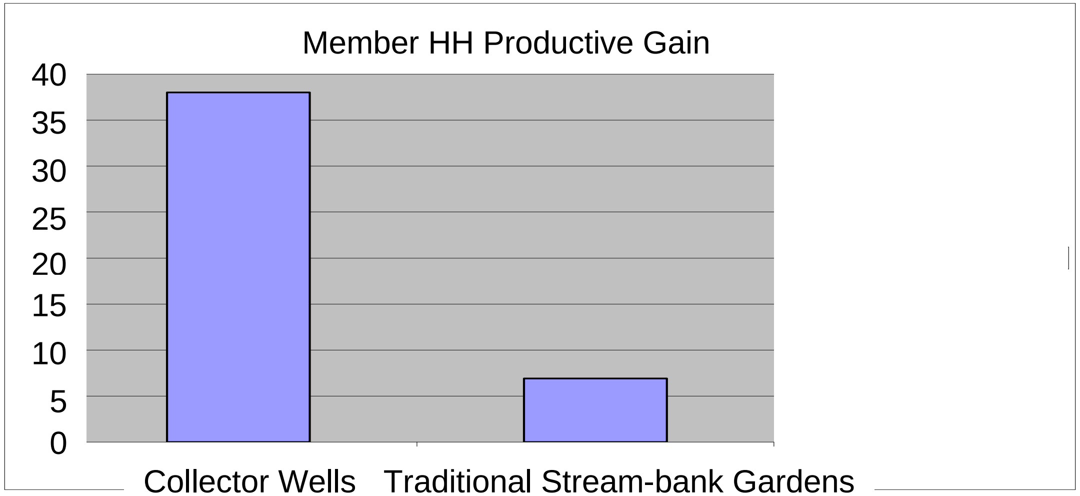
	Basic MUS *Communal wells with hand pumps*
Access	Water aquifer variability requires boring at specific sites: on average access to collector wells is between 500-1000m from the household
Reliability	HIGH: across seasons Other commonly available sources (boreholes): have frequent break downs and fluctuations in water availability
Quality	Improved: depth of wells ensures higher quality water than other surface water sources
Quantity	2 hand pumps on a collector well provide 10-40m^3/day year round

Reliability, quantity and quality outweigh problems of access; users will walk farther for productive use water if reliability is high.

Summary of Benefits and Impacts of Basic Multiple Use

	Benefits	Limitations
Income and Service Costs	• Annual average gross income per member households: US$45.15/household equal to 27% of the average income of 50% households in the area • 77% of member households reported regular income from the scheme	**Incremental Costs:** • *High Capital Costs:* collector well and fencing: USD$11,600 due to need for specialized drilling material and local capacity building • *Start-up Costs for communal gardens:* • Land preparation costs, inputs, etc total US$4-44/household • *Recurring costs:* reported as negligible due to high technical quality of system

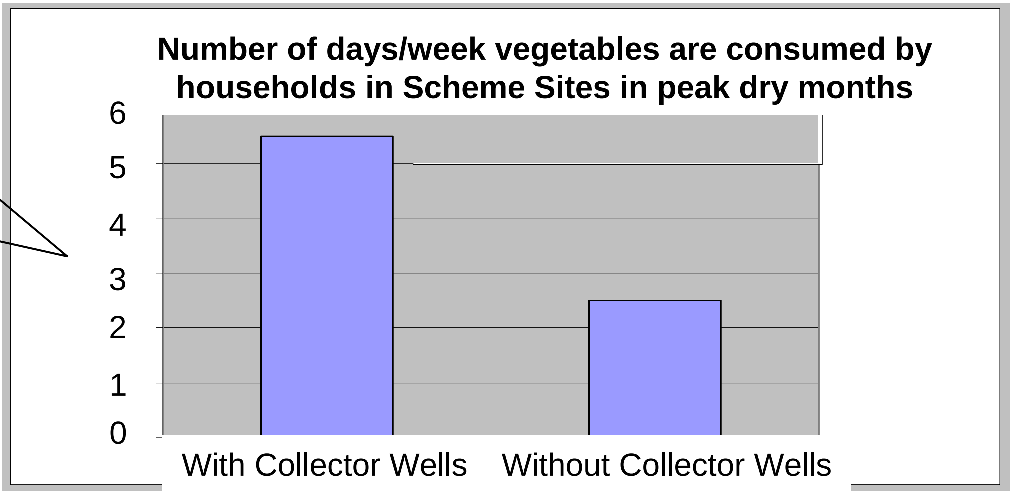
Comparative gains US$ per season



Summary of Benefits and Impacts of Basic Multiple Use

	Benefits
Health	• Safe, reliable water supply for domestic use – service extended also to non-member households • Year round vegetable consumption assured for member-households, sale to non-member households impacts positively on local nutrition
Livelihoods	• Steady, reliable income has helped revive by 53%, a traditional, membership-based revolving fund (Kukandirana) • Fund use expanded from meeting basic needs (education, household expenses) to directly promoting livelihood and income diversification initiatives like tree-growing, pottery, knitting, clothes sales
Social	• 49% of the member households were the ‘poorest’ in the community, many including the landless • Investments in social mobilization and user capacity building add to total investment costs, but have wide ranging long term benefits • For water initiatives to impact the poorest – emphasis on rights and access to land and other resources is essential, as is the focus on equity – targeting the poorest • Evident health and economic benefits to non-member households

Increased vegetable consumption



Sources: Waughray and Lovell, 1998

A.1 Multiple Use Services By Design: Bikita Province, Zimbabwe

Basic MUS:
communal garden wells with pumps

CONTEXT

This case describes the Productive Water Point (PWP) pilot project – a domestic+ by design to promote home gardens and diversify livelihoods. The province receives between 400mm and 700mm of rainfall annually.

Population	200,000 (province); 33 PWPs serve 5,000 people
Study Area	10,000 km^2 (province); ~15 ha of gardens

SYSTEM TYPE

Basic Multiple Use: Communal garden wells (boreholes) fitted with bush pumps

Key Findings

1. **High demand and social acceptance of multiple use scheme**: 49%-68% of all households in the village applied for membership to the scheme in an area of extreme poverty, and non-cash contribution 'only' demand of the scheme; new members paid US$1.66-2 to compensate labor inputs of original members
2. **Appropriate upgrades in technology ensure high reliability**: Bush pumps last 14 years without any maintenance – year round water for domestic and productive needs
3. **Integrated services multiply benefits***:* Access to markets crucial to improving financial gains from home garden cultivation
4. **Participatory and Income-generating multiple use scheme promotes equity and system sustainability***:*
   - Assured returns (financial and non-financial) results in motivation and interest to maintain scheme members invested returns to improve productivity
   - Targeting of poorest households; formal allocation of equal sized plots to all members, sharing of start-up costs across households – multiplier effects on social cohesion

"My plots in the garden are growing all that myself, my husband and my three grandchildren are eating. What we grow in the garden is keeping us alive."
-Selina, 70 year old grandmother, taking care of grandchildren in an HIV-AIDS affected household

Summary of Benefits and Impacts of Basic Multiple Use

	Benefits	Limitations
Income	• On average, member households make US$5 per month from sale of home garden produce • Sale, and income from produce determined by proximity to markets and need for cash among members	**Incremental Costs** • *Capital Costs:* Total costs for scheme - pump and well, capacity building, garden allocations and fencing not mentioned in case study; members paid the *equivalent of* US$1.5-2 /household through labor contributions • *O&M:* small amounts contributed by garden members for minor repairs, high pump reliability

Garden membership and value of production: Bikita

Garden	# of members	Annual value of production per member (US$)
Nzwisiso	12	52
Mapetere	18	112
Mujiche	53	19

Summary of Benefits and Impacts of Basic Multiple Use

	Benefits
Health	• Improved food security: monthly income from garden produce buys a 50 kg bag of subsidized maize meal, which provides 83% of the cereal ration for a family of 5 for a month • Improved nutrition through consumption of vegetable produce
Livelihoods	• Possibility to improve livelihood security for an additional 12% of the rural population in Bikita, with existing infrastructure which can be upgraded to productive water points
Social	• Complementing water service upgrades with land allocations. This pro-poor intervention impacted most landless households, including many female-headed households • A coping strategy for households affected by drought, economic and health crises, particularly for HIV/AIDS affected households • Communal management of productive water points and gardens improved group cohesion. For example, assured returns resulted in pooling of money to purchase seeds for garden members, fund raising for spare parts for pumps

Sources: Matthew, 2003

A.2 Summary Findings: Domestic+ Case Studies South Africa, India, Mauritania, Nicaragua, Vietnam

1) Reliable, Assured Productive Returns Improve System Sustainability

- Improved consumption and nutrition, and livelihood diversification from higher level services, regardless of local ecology and economy
- In domestic+ services, productive activities are given priority (India) and system add-ons are valued and maintained because of their productive value (Nicaragua)
- If domestic+ services meet productive needs, there is increased willingness and ability to pay for services

2) Health Impacts maximized at Highest Level Services

- Improved domestic hygiene best achieved when water is available at home. If water has to be carried home, there is only a modest increase in amount used for domestic hygiene (South Africa)

3) Targeted Subsidies impact Water-Poverty and Inequity

- Unless subsidized, access to improved 'multiple-use' services is determined by household well-being
- Improved, higher-level and incremental benefits achieved through conscious targeting of women and poorer households
- Need for self-investments (including capital costs and connection fees, start-up costs for productive activities) for higher service levels restricts the ability of poor households to upgrade and may exclude them from the full range of possible benefits (Mauritania, South Africa)

4) Case Specific Findings

Uses, benefits, negative impacts and enabling factors are determined by climatic, economic, cultural and institutional contexts. Multiple use services meet multiple service needs: improve quality and reliability in Vietnam; improve quantity, reliability and access in Mauritania, improve access, quantity and reliability in South Africa, improve quantity, access and reliability in India, improve quantity, quality, access and reliability in Nicaragua. The impacts are multi-dimensional – improved food security and nutrition in South Africa, reduced health-risks in Vietnam and India, reduced vulnerability and opportunities for off-farm income in land-scarce Vietnam; and assured income returns from available assets in India and Nicaragua.

Summary Benefits and Impacts of Intermediate Multiple Use Services

	Benefits	Limitations
Income benefits and Service Costs	• Household asset base and well-being often determine access to, and range and scale of benefits from improved water supplies • An increase in gross annual incomes by an average of US$180/household with higher levels of water service • Amongst water-dependent activities, rate of return per unit of water is highest for small scale enterprises	**But** • 'Need and demand' restrict highly productive water-dependent enterprises (ice-making and saloons) • Intermediate multiple use services have significantly higher capital costs (see table below), restricting access among poorest households if payments for improved services are demanded upfront • Opportunity costs of not having improved water services outweigh investment costs for improved service: water from vendors costs on average between US$0.019 and US$0.05 per 25L

Rates of return per liter water for productive activities

Activity	Rate of Return (US$/liter water)
Small-scale enterprises	0.60
Livestock rearing	0.03
Home gardens	0.16

Costs of basic domestic verse Intermediate multiple uses

Incremental Costs		US$/household
Connection Costs	Communal hand pump	5.88
	Communal piped stand post	38.10
Capital Costs	Communal hand pump	23.80
	Communal piped stand post	371.40
Monthly O&M	Communal Hand pump	0.38
	Communal piped stand post	1.33

Summary Benefits and Impacts of Intermediate Multiple Use

	Benefits	Limitations
Health	• Home gardens result in sustained consumption and improved nutrition from fruits, mangos, bananas, tomatoes, cabbage, lettuce and pepper • Significant component of the stable cash income from home garden sale is used to buy cereal/grain food	**But** • There is little difference in quantities of water used for basic domestic needs between households, increased water use at home is achieved when water no longer needs to be carried from source to home • 'Re'contamination of water from improved sources possible during household storage
Livelihoods	• Regardless of market access, a diverse range of livelihood activities provide sustained non-financial benefits: more than 35% Intermediate multiple-use households productively use water • Livelihoods are diversified: households are less dependent on insecure livelihoods such as rain-fed agriculture • Poor productivity cultivation is transformed into sustained income-generating activities; financial returns are small, but steady and there is improved livelihood security	**But** • High productivity livelihoods like small scale enterprises are often restricted by demand • Labor intensive activities, like home gardening and sometimes livestock rearing, are often not possible for the elderly, critically sick and disabled
Social Benefits	• Private 'yard' connections and reliable, adequate water supply reduce communal water conflicts • If access to improved sources is enabled, poorer households, many woman-headed, gain proportionally more from productive water activities	

Sources: Perez de Mendiguren Castresana, 2003; Perez de Mendiguren and Mbalane, 2001; Soussan et al., 2002

A.2 Domestic Plus: Gujarat, India

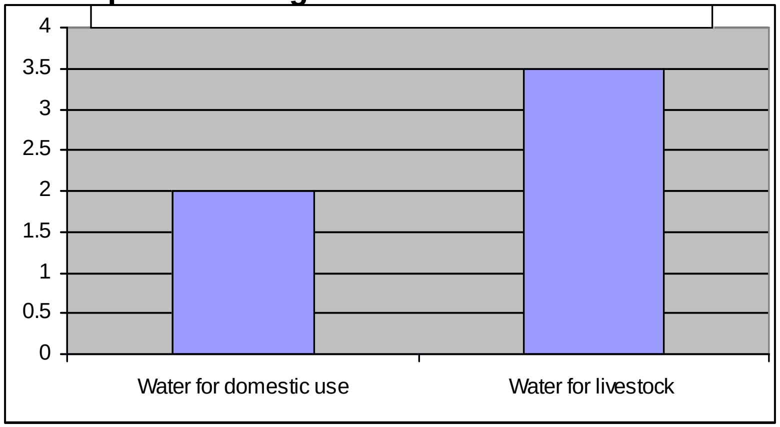
No Service to Basic MUS: tanker → communal standpipes

Summary Benefits and Impacts of Basic Multiple Use

	Benefits	Limitations
Health	• The money earned from the sale of milk products is used to pay for children's and women's medical fees, among other household expenses – substantial benefits for the poorest households	**But** • Livestock rearing demands women's time and labor significantly and this is not accounted for in the estimation of benefits and costs
Livelihoods	• Improved water supplies saves women's time in fetching water for domestic and livestock use; enabling poorest women adequate time for livestock rearing activities • Higher quantities of water, improve milk productivity, improve food and income security for the poorest households	
Social	• Income from livestock is managed by women, increasing their intra-household bargaining power • Village dairy cooperatives raise the socio-economic status of women	

In no-source villages, women spend 2 hours per day fetching water for domestic use and 3.5 for livestock.

Time spent fetching water for domestic and livestock use



Source: Upadhyay, 2004

A.2 Domestic Plus: Thidé, Mauritania

***Basic MUS to Intermediate MUS**: few standpipes & cement wells → frequent yard taps*

CONTEXT

This study focuses on one village in southern Mauritania that lies in a semi-arid zone, receiving 400-600mm of rain per year

Population	~1800 people
Study Area	~ 2 km^2
Average household size	13

SYSTEM TYPES

Basic Multiple Use: Piped water supply system provides basic multiple use households (15%) with public standpipes and additional communal unprotected cement wells

Intermediate Multiple Use: Piped water supply system provides intermediate multiple use households (85%) with a private yard tap plus additional communal wells

Key Findings

1. **Intermediate multiple use services assure financial and non-financial returns to poor households from water-dependent primary livelihoods***:* 82% of intermediate multiple use households report income from sale of livestock produce; evidence of comparatively more livestock, improved diverse diet, higher social standing for intermediate multiple use households vis-à-vis basic multiple use households as a result of an improved livestock rearing practice
2. **Water service levels, productivity and poverty – a mutually reinforcing link**: 25% of the basic multiple use households' (poorest in the area) use income from water-dependent activities to pay for (lower level) water services, but are unable to afford higher level services (intermediate multiple use) and incur high opportunity costs of seasonal scarcity*;* higher level services would have improved incomes and assured supply throughout the year
3. **Costs, rather than need, determine water service level***:* Households with diverse and reliable income sources can pay for higher level services - 46% of intermediate multiple use households use 'steady' remittances to pay for water; on the other hand, 'unaffordability' was the 'only' constraint to upgrading services, as cited by households with lower level services; increase in water prices by 26% reduced demand and use by 28%

Service Levels in Thidé

	Basic Multiple Use *Standpipes & cement wells*	**Intermediate Multiple Use** *Frequent yard taps*
Access	<200m on average, to a public standpipe ~86 min/day to collect water for domestic needs, livestock and trees	<10m from yard tap to house ~71 min/day to collect water for livestock, trees and domestic needs
Reliability	HIGH: piped system has not broken down in 10 years, same reliability for public and private services	HIGH: piped system has not broken down in 10 years, same reliability for public and private services
Quality	Improved: public standpipes Unimproved: unprotected cement wells	Improved
Quantity	104L per day for livestock in the dry season[1]	246L per day for livestock in the dry season

Standpipes are well distributed throughout the village. Intermediate multiple use households take about as much time in collecting water because they keep more livestock

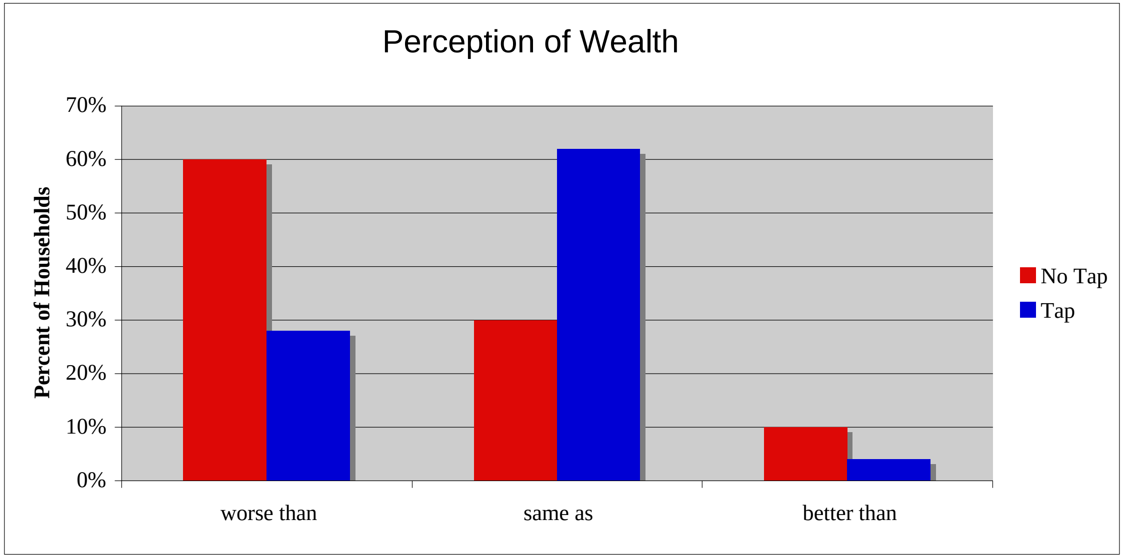
No statistical difference in the prevalence of diarrhea between households at different service levels

With increased quantity, households increase numbers of livestock kept. This impacts on food consumption, nutrition, income and social standing and capital

[1] Livestock include poultry, horses, sheep, goats, cows and donkeys

Summary Benefits and Impacts of Intermediate Multiple Use

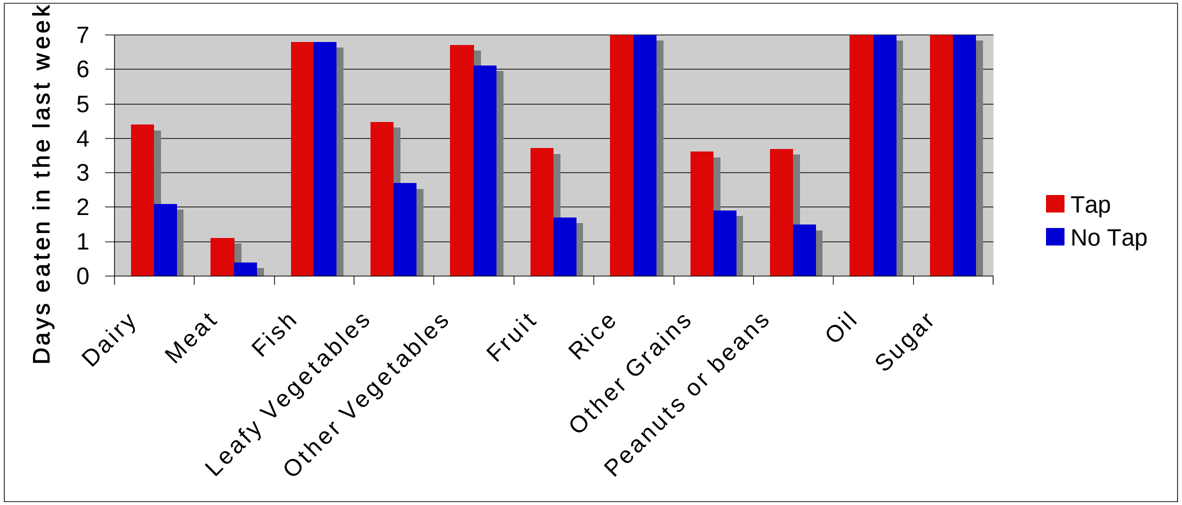
	Benefits	Limitations
Income and Service Costs	• 82% of intermediate multiple use households report income from sale of livestock produce • 25% of basic multiple use households (compared to 6% intermediate multiple use households) rely on water-based activities to pay for water services	**Incremental Costs:** • *Connection Costs:* US$95/yard tap (includes materials, labor and connection fees) for intermediate multiple use compared to no costs for basic multiple use • *Average Monthly Water Bill:* US$4.50/ intermediate multiple use household **But** • Intermediate multiple use households pay an additional US$339/household per dry season (150 days) for water and fodder costs • Lower level services are an indicator of poverty when service levels are determined (only) by ability to pay: 60% of households without a private tap see themselves as 'worse off' than the average household (see graph below)



Summary Benefits and Impacts of Intermediate Multiple Use

	Benefits	Limitations
Health	• 40% of intermediate multiple use households have a diverse diet (eat more than three different foods each week) compared to 0% basic multiple use households	**But** • Tension is created between neighbors with different service levels. Local custom requires that neighbors share water, but this is a cost burden on intermediate multiple use households
Livelihoods	• On average, intermediate multiple use households keep a larger number of animals (1.5 more cows, 3 more sheep or goats, 4 more poultry)	
Social	• Cultural and religious customs of giving away animals and animal products to neighbors and family are upheld – gains social standing and privileges for intermediate multiple use households	

Greater dietary diversity of intermediate multiple use households

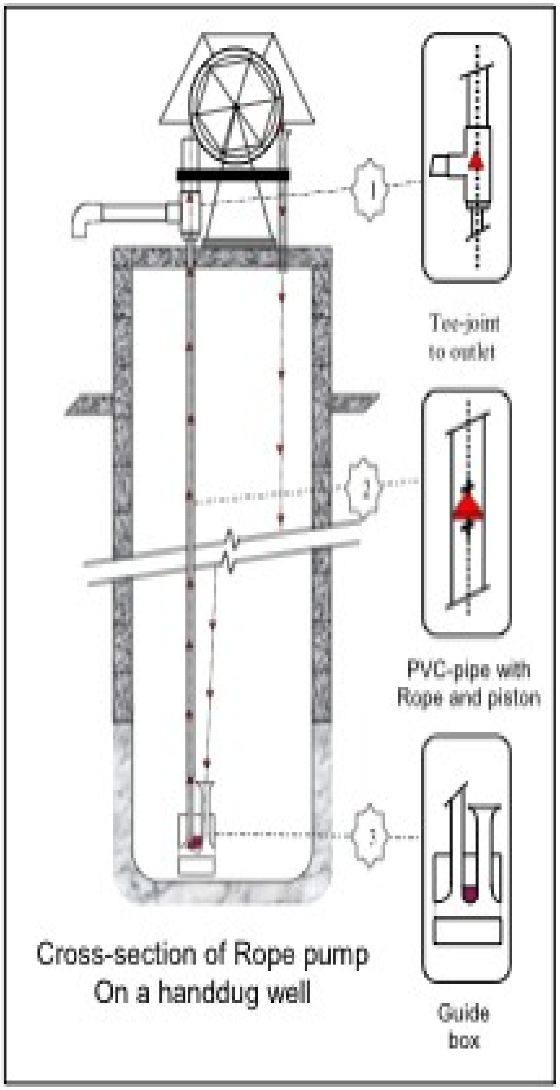


Source: Bingham, 2007

CONTEXT

This study reviewed the impact of rope pumps, developed in Nicaragua, since 1990 and widely operational. Benefits and Impacts from the pump are drawn from a survey of 1,469 farms of which half had rope pumps.

Population	5,000,000
Study Area	121,000 km^2



Cross-section of Rope pump On a handdug well

SYSTEM TYPES

No Service: surface water sources, unimproved shallow wells
Intermediate Multiple Use: rope pumps added to borehole wells (represents 23% of the total rural water supply)

Key Findings

1. **Domestic and productive needs met better from higher level services**: Assured, good quality water, improved access, low maintenance costs and year round availability from this simple technical upgrade
2. **Service Promotion and Reliability**: The popularity of rope pumps can be attributed to active promotion of the technology by the private sector, low maintenance and high reliance
3. **Multiple-use approaches can be implemented at scale**: Rope pumps provide multiple use services for over 20% of rural Nicaragua

Service Levels in Nicaragua

	Basic Multiple Use	Intermediate Multiple Use
Quality	**Unimproved:** water sources open, unprotected, used by humans and animals, often contaminated	**Improved:** Ground water made available with rope pump add-ons, water meets WHO quality standards (<3 coliform/100ml)
Quantity	Unlimited surface and shallow ground water sources (rivers, streams, ponds, dams, hand dug wells, etc)	Sufficient to meet domestic and productive needs

Improved water quality from rope pump sources because of source protection (deep well, rope to extract water)

The highly efficient pumping capacity of the rope pump makes it possible for both children and adults to lift large quantities of water quickly: at a depth of 40m an adult can pump 10L of water/minute and a child 4.8L/minute

Summary Benefits and Impacts of Intermediate Multiple Use

	Benefits	Limitations
Income and Service Costs	• With the rope pump, average incomes increase by US$225/household/year on[1], representing 50% of the total income of lower income groups and contributing US$4.5 million to Nicaragua's annual rural income, roughly 0.5% of Nicaragua's GDP • Income is from year round cultivation of home gardens and livestock rearing (poultry, pigs, fruit trees and irrigated vegetables)	**Incremental Costs:** • *Capital Costs:* US$50-100/pump • *Maintenance Cost*: ranges U$0-5/household/year, but can reach US$10/household/year for an intensively used community pump

Annual farm income according to property size and with or without a well: Municipality of La Paz Centro and Nagarote				
Farm Size (Ha)	**# of Farms**	**No Well (US$)**	**Well (US$)**	**% difference**
<0.7	11	514	640	25
0.7-1.4	22	713	843	18
1.4-2.8	42	1059	2040	93
2.8-4.2	57	868	1366	57
4.2-7	65	1605	1762	10
7-14	117	1575	2389	52
14-21	63	1175	2530	115

[1] Study estimate indicate that a family of 6 would need to make $425/capita a year to meet all basic needs

Summary Benefits and Impacts of Intermediate Multiple Use

	Benefits
Health	• Food security and nutritional supplement from reliable water-dependent livelihoods is highest for the smallest category of farms (<0.70 ha) with the lowest incomes (US$514/household) • Rope pump delivered water that meets WHO quality standards (<3 Coliform/100ml)
Social	• Income from home gardens, as well as household food security, demonstrate positive gender outcomes

Source: Alberts and van der Zee, 2003

CONTEXT

This study looked at the impact of piped water supplies on household based water-dependent livelihoods in an area of extreme land poverty (260 people/km2)

Population	7 villages, roughly 1000 households in each village

SYSTEM TYPES

No Service (3 villages): Rainwater catchment tanks, unimproved wells, surface water
Intermediate Multiple Use (4 villages): Piped water, improved wells with hand pumps or electric pumps, taps in yard, and communal taps

Key Findings

1. **Intermediate multiple use services provide reliable livelihood alternatives***:* households diversify to productive off-farm livelihood activities, especially in lean agricultural periods; amongst water-dependent livelihoods, micro-enterprises provide the highest value per unit of water used
2. **Piped water supplies help mitigate local ground and surface water scarcity and contamination***:* Improved services address seasonal scarcity and poor quality water
3. **Intermediate multiple use services can help pay off capital investments, but will likely exclude the poorest if subsidies are not provided upfront**: Households without piped connections pay up to 15 times more than those with improved services for purchasing water (especially for drinking and domestic use) from private vendors; however, majority of the population cannot meet capital costs for service upgrades without a subsidy.

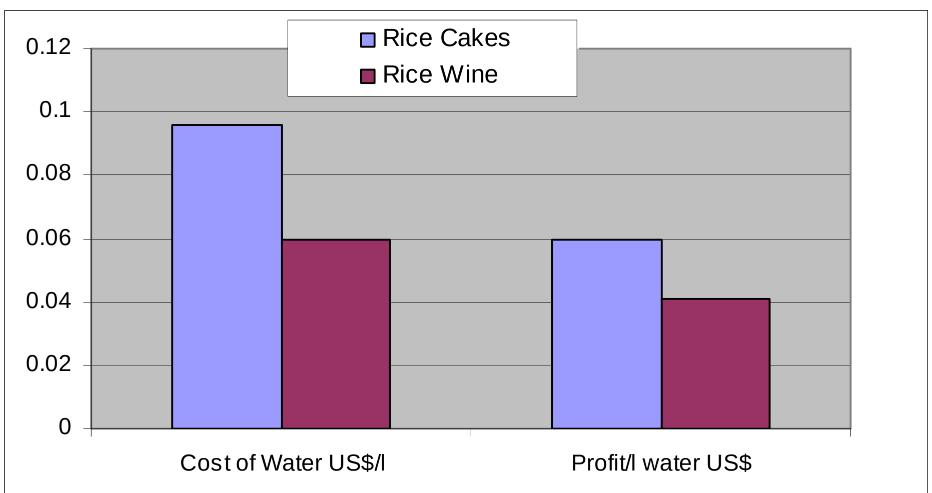
Service Levels in Vietnam

	No Service *Open wells & tanks*	**Intermediate Multiple Use** *Piped water & hand pumps*
Access	Shallow private wells in yards, but some 500m away (~20min round trip)	A mix of communal stand posts and private yard taps, in addition to private and communal wells
Reliability	MEDIUM: Seasonal droughts; rainwater catchment tanks improve supply in rainy season; Unimproved wells reliable for ~10 months/year	HIGH: Unlimited supply – year round
Quality	Unimproved: Poor quality water from open sources - wells, catchment tanks	Improved: water from piped system; but water is still boiled before use
Quantity	Seasonal shortages due to shallow wells and lack of rains. Rainfall high, but seasonal, resulting in a long 'lean' period of 9 months/year	Piped water provided for most of the day; wells provide unlimited quantities

Piped water significantly improves quality and therefore impacts on health in a situation where some wells are of such poor quality that available water could not even be used for cultivation

Summary Benefits and Impacts of Intermediate Multiple Use Services

	Benefits	Limitations
Income and Service Costs	• Water-dependent small scale enterprises earn vital cash income, especially in lean agricultural periods • On average most households undertake a water-dependent activity (griddle cakes or rice wine) 4-5 times a week during the lean (9 months/year) period • Income from rice noodle production increased by 110% and by 250% in pork production • Income crucial and uses labour that would otherwise be idle in lean periods	**Incremental Costs:** • *Capital Costs:* US$30 (hand pumps, cost for piped water not available) **But** • Water dependent activities are unlikely in areas where water is scarce or less reliable • All small scale enterprises have various start-up costs, such as equipment, training and labor, which can exclude the poorest households from these income benefits



Profits for two common small-scale enterprise products that rely on the same inputs (rice, water, and firewood)		
	Griddle Cakes	**Rice Wine**
Profits (US$/ day)	**4.83-11.17**	**3.50-6.52**
Average Water Use (liter/day/household)	**113**	**130**

Summary Benefits and Impacts of Intermediate Multiple Use

	Benefits	**Limitations**
Health	• Year round cultivation of vegetables, fruit trees and livestock rearing contribute to balanced nutrition • Minimum quantities of food available even in pre-harvest "hungry" seasons or when field crops fail • People perceive that improved water quality from piped system lowers eye infections and occurrence of kidney stones	**But** • Health and livelihood benefits are determined by household asset base such as space for home gardening and ability to invest in and undertake different livelihoods, livestock rearing, micro-enterprises etc.
Livelihoods	• Practice of water-dependent small scale enterprises quadruple (4.6% as compared to 1.2%) • 48% households have home gardens compared to only 11% • 56% households have livestock compared to 22%	

Source: Noel et al., 2007 (forthcoming).

1) Surface Irrigation Water Vital for Domestic Needs especially where Ground Water Quality and Quantity is a Problem
All case studies show that irrigation water critically meets drinking and domestic needs, especially when ground water quality is poor (saline, fluoride contamination) or inadequate

2) Institutional Readiness
Formalizing irrigation+ requires significant cooperation and coordination between irrigation agencies, formal and informal domestic service providers, and users. In the current institutional set-up, irrigation+ happens only when irrigation agencies see the value of non-irrigation allocations. Irrigation and domestic water use patterns are not synchronized, signaling need for formalization of allocations for non-irrigation uses if services are to be reliable and sustained. Significant uncertainty on who funds infrastructure add-ons.

3) Quantity, Quality and Health
Definite health benefits from increased use of water for domestic hygiene, but
In the absence of formal water treatment there is the risk of contaminated water consumption from open, irrigation sources and the risks are highest for poorest households unable to invest in self-invested improvements. Long term impacts of ground water contamination from bio-accumulation of irrigation products and by-products not considered by irrigation agencies and users

4) Necessary for Self-Investment for add-ons Excludes the Poorest
When multiple uses are not formalized, access, availability and reliability of irrigation water for non-irrigation uses is determined by households' ability to self-invest in add-ons (such as for storage) that often exclude the poorest

CONTEXT

This case study analyzes differential access to irrigation water for domestic use, and the impact on health from consumption of irrigation water along the Hakra-6R, the sixth largest distributory in Pakistan (45 km). The average rainfall is 160 mm per year.

Population	94 villages, 160,000 people
Average household size	7 people

SYSTEM TYPES for DIFFERENT HOUSEHOLDS

Basic Irrigation for poorer households, lacking ability to invest in add-ons: Direct and indirect water use from the Hakra-6/R irrigation canal for non-irrigation uses through: 1) Wells: recharged through unlined irrigation tank, and through irrigation, 2) Irrigation canals: lined, 30 cm wide and 30 cm deep – 45 km long, 3) Animal Pond: Water for livestock, collected in a pond, through irrigation recharge.

Basic Multiple Use for better-off households, with ability to invest in add-ons: In addition to above, add-ons to facilitate use of irrigation water for domestic use through: 1) Electric or hand pumps from '*diggis*' (irrigation pond located at center of the village for domestic use at the house): PVC pipes transport pumped water from '*diggis*', 2) *Wells with electric pumps***:** Seepage water pumped from wells at depths of 10-25 m, located in the proximity of canals and tanks; good quality and in most cases meets WHO standards for drinking water

Key Findings

1. **Surface irrigation vital for domestic use, when ground water quantity and quality is poor***:* 40 million people in Pakistan are dependent on surface irrigation water for domestic and non-irrigation productive uses, critical especially when ground water is inadequate and quality poor – in this case, saline and brackish
2. **Higher level services improves access and positively impacts on household health***:* Greater storage capacity in basic multiple use households increases amount of water available for domestic and personal hygiene, and reduces water collection time and labor
3. **Higher level services which demand self-investments exclude the poorest***:* When multiple uses are not formalized, access, availability and reliability of irrigation water for non-irrigation uses is determined by household ability to self-invest in add-ons. Less than 30% households have basic multiple use facilities.
4. **Quality concerns**: Health risks associated with using 'untreated' irrigation water for domestic needs from contaminated wells and unprotected home storage

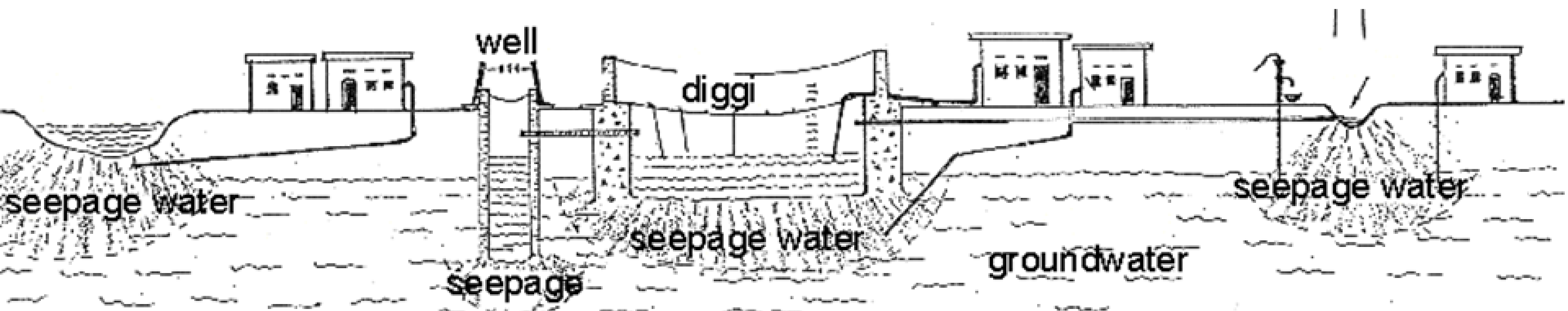
Service Levels in Pakistan

	Basic Irrigation *Direct and indirect communal use*	**Basic Multiple Use** *Add-ons for private, household services*
Access	Depends on distance from source to household, involves time and labor investments by women and children	Water available at home, and additional home storage enables high reliability
Quality	Unimproved: E.coli counts exceed WHO guidelines	Unimproved: from diggis Improved: Water from deep wells meets WHO drinking water quality standards
Quantity	Quantity varies by irrigation releases, for e.g. only 10 lpcd during canal closures: not enough for basic hygiene	More than 50 lpcd for domestic use, assured year round

Despite risks of water-borne diseases, storage tanks increase quantity of water used at home, which has been shown to statistically reduce incidences of diarrheal diseases, particularly of children under the age of 5 (van der Hoek et al 2001)

Summary Benefits and Impacts of Basic Multiple Uses

	Benefits	Limitations
Income and Service Costs	• No estimates available in the case study, but reports of irrigation water use for small scale enterprises	**But** • Costs for transportation and home storage
Health	• Storage tanks in households increase quantity of water used for domestic needs which have been shown to a decrease in diarrhea and stunting among children under 5 • Time and labor savings for water collectors (women and children)	**But** • High in-house contamination: 29.7/100 ml *E. coli* found in household storage pitchers, regardless of source or quantity of water used



Source: Boelee, 2007 (PowerPoint Presentations)

A.3 Irrigation Plus: Uda Walawe Irrigation Project, Sri Lanka

***Basic MUS:** irrigation scheme used for multiple purposes*

CONTEXT

The Uda Walawe Irrigation Project (UWIP) irrigates a large tract of land along the southern coast of Sri Lanka. Rainfall in the region varies from 1000-3000mm/year

Population	~9,900 legal settlers, 18,000 illegal encroachers
Project Area	3000 km^2

SYSTEM TYPE

Basic Multiple Use:

-Large scale irrigation development over period of 50 years with time and costs overruns; later phases of the project enabled irrigation+ uses

-Current planned and unplanned non-irrigation uses include - inland fisheries, home gardens, hydro-power, drinking water supply, wild-life tourism, flood control in downstream Hambantota district and water for small industries

Key Findings

1. **Economic value of non-irrigation uses is substantial:** Non-irrigation uses (home gardens, trees, fisheries, domestic use, power production) equal approximately 40% of the value of irrigated production.
2. **Surface irrigation water is vital for domestic use, especially when ground water quality is poor***:* High reliance on surface irrigation sources for domestic uses exists as a result of fluoride contamination in ground water and limited formal provision of domestic supplies.
3. **Irrigation can negatively impact ground water quality in the long term***:* Possible bio-accumulation of agricultural products and by-products impact ground water quality, which may impact health
4. **Institutional readiness essential for multiple use**: Complexity of regional plans impact local technological and social engineering planning, and can make the formalization of Irrigation+ difficult

Service Levels in Uda Walawe, Sri Lanka

	Basic Multiple Use *Irrigation scheme used for multiple purposes*
Access	Communities settled haphazardly in irrigation command: access varies for different households, but in all cases, there is reasonably close proximity to canals, tanks and reservoirs
Quality	Unimproved: possible bio-accumulation of agricultural wastes in ground water – impacts being assessed currently; no interventions to improve quality for domestic use but recharge from irrigation water from provides shallow ground water for domestic wells that is of higher quality than fluoride contaminated deep ground water
Quantity	Improved domestic supply due to irrigation recharge: homestead wells provide assured, year-round ~20 lpcd for domestic use and enable home garden cultivation

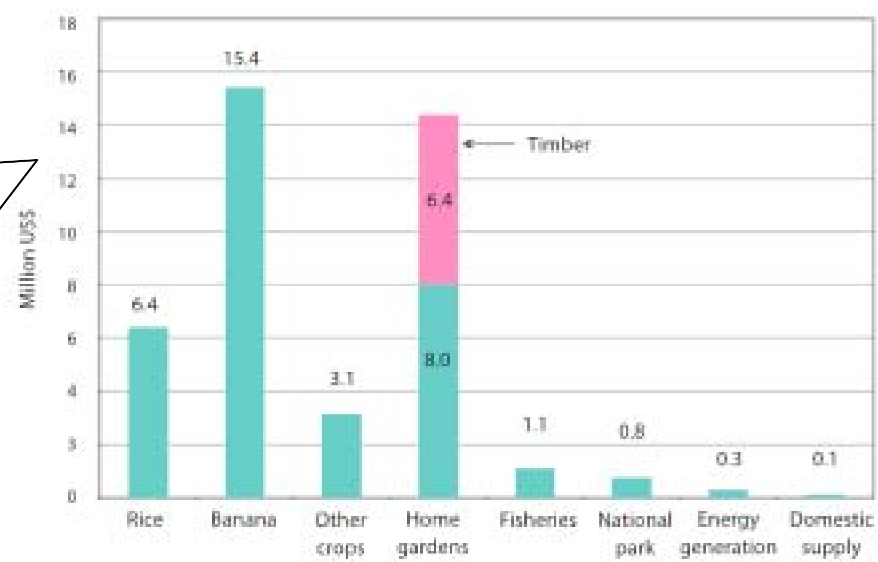
Recharge from unlined canals and rice fields can be as high as 74%, and improves supply and quality of water for domestic use from wells

Summary Benefits and Impacts of Basic Multiple Use

<table>
<tr><th></th><th>Benefits</th><th>Limitations</th></tr>
<tr><td>Income and Service Costs</td><td>• Steady cash incomes assured from sale of home garden produce, trees and fisheries contributes to returns generated from irrigated agriculture, boosting financial performance of the project and generating significant impacts to local economy

<table><tr><th>Activity</th><th>Annual Value ($US Millions)</th></tr><tr><td>Irrigated agriculture</td><td>25.1</td></tr><tr><td>Non-irrigation uses</td><td>16.7</td></tr></table></td><td>Incremental Costs:
Capital Costs: assumed at US$0.30/m³ including O&M costs
But
• Production returns from improved crops, fisheries and home gardens improve financial performance of the project</td></tr>
</table>

Economic value of non-irrigation uses is substantial and equals about 40% of total value of irrigation production



Summary Benefits and Impacts of Basic Multiple Use

	Benefits	Limitations
Health	• Fish, fruits and vegetables boost household nutrition and food security • Household wells, recharged by irrigation seepage provides water for domestic uses • Fluoride levels in deep groundwater 'diluted' through irrigation water recharge	**But** • Impact of bio-accumulation of agrochemical products and by-products in drinking water are not yet assessed, assessments are ongoing and results awaited
Livelihoods	• 28% of land use in irrigation command areas is in homestead gardens • Fruit trees, vegetables and bamboo groves provide greater livelihood opportunities and provide access to firewood and medicinal plants	
Social	• Provision of water for non-irrigation supports livelihoods of landless. • Reservoir fisheries, in particular, provide a 'safety net' for poorest	

Source: Molle and Renwick, 2005; Boelee, 2007 (PowerPoint Presentation)

A. Case studies

B. Methodology

C. Additional details on results

D. Bibliography

B.1 Benefits and Costs
B.2 Non-Financial Benefits and Poverty impacts
B.3 Market mapping
B.4 Selected data for analysis

Below is a more detailed description of the process the team used to analyze the costs, benefits and poverty impacts of multiple-use approaches compared to single-use approaches

Type and Extent of Uses Supported at Each Service Level

Identified common water use activities—home gardens, livestock, small-scale enterprises and domestic use of irrigation systems: To assess incremental benefits (both financial and non-financial), the research team identified the most common additional livelihood activities (home gardens, livestock, small-scale enterprises and domestic uses of irrigation systems). Identification of common livelihood activities was based on a review of the literature (see next slide for selected list of studies reviewed to identify uses and poverty impacts).

Assessed water requirements for each activity. Water service requirements to support each livelihood activity were estimated based on literature review and consultation with practitioners. For example, home gardens require 3-8 lpcd per m^2 and livestock drinking includes a wider range of water quantities (cattle 25 lpcd, goats and sheep 5 lpcd, chickens 0.3 lpcd). Other service level criteria, such as quality (required to support drinking and domestic uses), distance and reliability were assessed (see slide at the end of this section for analysis of distance, quantity of water hauled and time)

Estimated extent of activity that could be supported at each service level for domestic+ and irrigation+. For each service level, the potential extent of each livelihood activity was estimated. For example, number of cattle, square and meters of garden. Uses and water requirements were validated through consultations with experts in the field.

B.1 Benefits and Costs: Selected list articles reviewed to identify typical uses, costs, benefits and poverty impacts of multiple use approaches

	Geographical Area	Home Gardens	Livestock	Small Scale Enterprises
Domestic plus	**Sub-Saharan Africa**	**South Africa (9)** (Perez de Mendiguren, 2003; Hope, Dixon and von Malitz, 2003; McKenzie, 2003; Perez de Mendiguren and Mabelane, 2001; Soussan et al, 2002; Maluleke et al 2005; Maunder and Meaker, 2006; Gilimani, 2005; Averbeke and Khosa, 2007); **Zimbabwe (3)** (Proudfoot, 2003; Plan International; FAO, 2005); **Senegal (2)** (Brun et al, 1989; Marek et al 1990); **Cameroon** (Bradford et al, 2003); **Sudan** (Plan International); **Zambia** (Plan International); **Mauritania** (Bingham, 2007)	**South Africa (3)** (Perez de Mendiguren, 2003; Perez de Mendiguren and Mabelane, 2001; Gilimani, 2005); **Uganda** (Kabirizi, 2004); **Mauritania** (Bingham, 2007); **Sudan** (Plan International); **Zambia** (Plan International)	**South Africa (3)** (McKenzie, 2003; (Perez de Mendiguren and Mabelane, 2001; Perez de Mendiguren, 2003) **Malawi** (Mulwafu, 2003)
	South Asia	**Nepal (2)** (Pant, 2005; NEWAH, 2005) **India** (Bradford at al., 2003) **Bangladesh (2)** (Helen Keller Foundation, 2001; Marsh 1998)	**India (4)** (Bradford, et al 2003; Upadhyay, 2004; James, 2003; Verhagen, 2004); **Nepal** (NEWAH, 2005)	**India (3)** (James, 2003; Verhagen, 2004; James et al, 1992)
	Other	**Vietnam (2)** (SEI; URS, 2004)**; Nicaragua** (Alberts and van der Zee, 2003); **Global** (Nugent, 2000; IFRI, 2001); **Asia-Pacific** (Helen Keller International, 2001)	**Global** (Gura and LPP, 2003)	**Colombia** (Smits, et. al., 2003);
Irrigation plus	**Sub-Saharan Africa**	**Kenya** (Plan International);l **Sub-Saharan Africa** (Inocencio, 2002)	**Uganda (2)** (Dolan, 2002; van Hoeve and van Koppen, 2005); **Kenya** (Plan International); **Ethiopia (2)** (van Hoeve, 2004; van Hoeve & van Koppen, 2005);	
	South Asia	**Sri Lanka (2)** (Meinzen-Dick & Bakker, 2001; Molle and Renwick, 2005); **Bangladesh** (AVRDC, 2000)	**Sri Lanka (2)** (Meinzen-Dick and Bakker, 2001; Bakker and Matsuno, 2001) **Pakistan (4)** (Jehangir, Madasser, Ali, 2000; Ensink et al 2002; Jensen et al 2001; van der Hoek, 2002b); **Nepal** (Thomas-Slayter and Bhatt, 1994)	**Sri Lanka (2)** (Meinzen-Dick and Bakker, 2001; Bakker and Matsuno 2001)
	Other		**Morocco** (Boelee & Laamrani, 2003)	**Morocco** (Boelee and Laamrani, 2003)
MUS by design	**Sub-Saharan Africa**	**Zimbabwe (2)** (Waughray, et al, 1998; Matthew, 2003)		**Zimbabwe** (Matthew, 2003)
	South Asia		**India** (Palanisami and Meinzen-Dick, 2001); **Nepal** (Winrock 2007d)	**India** (Palanisami and Meinzen-Dick, 2001)

B.1

Benefits and Costs: Domestic plus--Relationship between distance, quantity and time hauling water

Quantity liters	# trips	Minutes to source round trip							
		0	5	10	15	20	30	60	90
		..... minutes							
10	1	0	5	10	15	20	30	60	90
20	1	0	5	10	15	20	30	60	90
40	2	0	10	20	30	40	60	120	180
60	3	0	15	30	45	60	90	180	270
80	4	0	20	40	60	80	120	240	
100	5	0	25	50	75	100	150		
150	7.5	0	38	75	113	150	225		
200	10	0	50	100	150	200			
250	12.5	0	63	125	188	250			
300	15	0	75	150	225				
400	20	0	100	200					
500	25	0	125	250					

Assumes 20 l/trip

The willingness of the poor to haul water for productive uses depends on a number of factors including physical capability, available labor, method of transport (e.g., wheelbarrow vs. bucket), income potential, and alternative sources of livelihoods.

Note: Some research suggests that men are willing to participate in hauling water and investing in water transportation and storage when productive activities are involved. Further research is needed to address this issue.

Financial Benefits

At each service level, the team calculated the potential income generated from home gardens, livestock, and small-scale enterprises using the following process:

Reviewed literature to identify estimated returns by activity area: Extensive review of literature for existing estimates of net returns for home, livestock and small-scale enterprises based those actually observed in the field supplemented by limited primary data collection (**see data and estimates below**).

Standardized estimates to allow comparison by:

Converting to common production units. All returns were converted into a standardized production unit, such as returns per head of livestock or square meter of garden.

Annualized. All returns were annualized where necessary.

Currency conversion to 2004 purchasing power parity international dollars (PPP $I). Because the data was collected from several countries over many different years, country specific GDP deflators were used to inflate/deflate to 2004 local currencies and then convert to US$ Purchasing Power Parity (PPP) (World Development Indicators, 1994-2006).

Estimating average returns per unit activity: For each of productive use, we conducted statistical analyses of standardized estimates to generate standard summary statistics such a mean, median and standard deviations (see summary statistics in annex C for each use).

Calculating potential income by service level: To estimate the potential income generated from livelihood activities at each service level, we multiplied the mean income generated by the extent of the activity supported at each service level. For example, based on the literature review, the average annualized return for home gardens was found to be $1.08/m^2. To reflect seasonality of home garden production and differences in intensity of production (some households produce year round, others only for one season), one-third of the average annualized return ($0.36/m^2) was used to derive an income range. Thus, the income potential from a 100m^2 home garden was estimated to be from $36-108/year (see estimates in Annex C below).

Calculating potential income by service level cont.

Validating estimates: Income estimates by activity and service level were cross-checked with available estimates from the literature, where possible, and were validated by experts in the field.

Converting household-level income estimates to per-capita estimates: For each service level, the range of annual household income estimates per activity were converted to per capita estimates, assuming an average household size of 5, to make comparable to cost data, which is expressed in per capita terms.

Incremental income benefits by service level: Incremental income benefits were estimated taking the difference between income generated at each service level.

Costs

Based on available data, ranges of estimated costs were determined for identified technologies and service levels. Costs include hardware, software, and recurrent annual costs (see data at end of section for further details on what is included in each cost component as well as data used for the analysis).

Identified technologies: Based on review of available global data, several key technologies were selected for the cost analysis based on the following criteria: (1) prevalence of use in large segments of the rural population in South Asia and sub-Saharan Africa; (2) potential to support multiple-use services; (3) availability of data (on prevalence and cost). Main technologies evaluated for domestic+ and irrigation+ (estimated number of people currently receiving such services in South Asia and sub-Saharan Africa are listed in parentheses):

For domestic+

- Networked piped systems (500 million)
- Communal boreholes with hand pumps (500 million)
- Hand-dug wells (>150 million)
- Infrastructure add-ons to support activities such as livestock troughs, lifting devices and community gardens

Irrigation+

- Large-scale irrigation systems (450 million); infrastructure add-ons to support domestic and productive activities such as livestock troughs, cattle crossings, bathing facilities, canal steps, communal and household storage, home water treatment

Identifying technologies cont.

Although there is significant potential for rainwater harvesting to support multiple use approaches, we have not included rainwater harvesting in our analysis for two reasons. First, rooftop household level rainwater harvesting generally does not reliably meet water needs year round or provide sufficient water to support many productive activities. Second, surface collection of rainwater for productive uses must be used in combination with improved sources to provide domestic needs. More research is need on the potential for rainwater harvesting to support multiple uses.

Hardware costs

Reviewed literature and conducted limited primary research to identify range of hardware costs: Conducted an extensive literature review coupled with limited primary research and expert consultations to identify per capita hardware costs for selected technologies in rural South Asia and sub-Saharan Africa for both new services and incremental upgrades based on starting and ending water service levels (see selected data used for cost analysis at the end of the section).

Standardized estimates to allow comparison. Standardized estimated of hardware costs for each estimate to make them comparable:

Common units—per capita measures. All costs were converted, if needed, into a per capita basis.

Currency conversion to 2004 purchasing power parity international dollars (PPP $I). Because data was collected from several countries over many different years, country specific GDP deflators were used to inflate/deflate to 2004 local currencies and then converted into Purchasing Power Parity $US I (World Development Indicators, 1994-2006).

Estimated incremental hardware costs by technology and service levels for irrigation+ and domestic+. For each technology, estimated the average costs of new services and upgrades to existing services to support multiple uses.

Software costs
Software costs for domestic systems are typically on the order of 10% of hardware costs. For multiple use approaches, software costs are likely to be significantly higher because of the need for new management capacity, extension, and related inputs for productive uses and hygiene education, as well as cross-sectoral coordination and new management models to support implementing at scale. Based on the ongoing multiple uses research, the International Water and Sanitation Centre estimates that total software cost (technical assistance and program support costs) for multiple use approaches could be on the order of 30-50% of hardware costs. This estimate is corroborated by evidence from Winrock and IDE's implementation of over 60 multiple-use by design systems in Nepal where total software were on the order of 40-50%. For the purposes of the financial analysis, we assume 40%.

Recurrent annual costs: Recurrent annual costs include operation and maintenance, source water protection and capital maintenance fund and were estimated based primarily on Hutton and Haller (2004),

- Annual operations and maintenance costs were estimated at 5% of total hardware costs for all systems, except for household piped connections, which were estimated at 30%.
- Source water protection was estimated at 5% of hardware costs for boreholes and protected wells and 10% for piped schemes.
- Capital maintenance fund costs were estimated based on the estimated useful life of the capital investment. For example, 25% of capital costs per year for a useful life of 5 years, 15% for 10 years, and 10% for 20 years. In addition, for irrigation plus investments involving home water treatment and hygiene education programs, annual recurrent costs of $2 per capita were included for point-of-use home treatment costs.

Repayment periods were calculated based on the period of time it would take to cover hardware and software costs based on estimated average annual income benefits less annual recurrent costs.

Cost-Benefit ratios

Cost-benefit ratios for new services and incremental upgrades were calculated assuming a discount rate of 10% where:

- Costs were defined as the per capita full capital investment costs in year 1, including hardware and software costs
- Average useful lifetimes for infrastructure we estimated following Hutton and Haller (2004) and Brikke and Bredero (2003)
- Benefits were defined as the net present value of the stream of annual per capita mean income benefits less annual per capita recurrent costs (operation and maintenance , source water protection and capital maintenance fund) over the useful lifetime of the infrastructure.

Sensitivity Analysis: To evaluate how variations in net returns might influence the results, benefit-cost analysis was conducted under four net income scenarios, where net income equals annual per capita mean income less recurrent costs:

- Conservative (25% of estimated annual 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).

Non-financial benefits and poverty impacts

To capture non-financial benefits and impacts on poverty, the study analyzed a series of global poverty surveys and approximately 40 credible research studies (see preceding table for selected list of studies and bibliography). Drawing on the sustainable livelihoods framework, assessments were made of the non-financial incremental benefits and poverty impacts of multiple use water services verses single-use services in terms of four key factors known to impact poverty: food security, health and nutrition, vulnerability/livelihoods diversification and social equity and empowerment (Ravnborg, et al. 2007). Each of these factors can contribute to other improvements in financial, human, physical and social capital, simultaneously alleviating multiple dimensions of poverty," (Ravnborg, et al. 2007). The potential poverty impacts of home gardens, livestock, small-scale enterprises and domestic uses of irrigation water for each factor were qualitatively ranked (low, medium, high).

To accurately reflect the incomplete nature of the available evidence, the research team utilized a ranking system key findings based on the quality, quantity and consistency of available supporting data:

- **Well-supported**: significant number of high quality that consistently provide corroborating evidence
- **Partially-supported**: number of high quality studies, or numerous studies with only partial data, that provide consistent, but partial corroborating evidence.
- **Inconsistent evidence**: inconsistent findings from studies
- **Anecdotal evidence**: observed but not well-studied or documented

For each key finding, illustrative examples were provided. See Annex A for a detailed discussion of selected case studies for multiple-use by design, domestic+, and irrigation+ and Annex C for further examples by use and type of poverty impact.

Market entry points—domestic and irrigation systems

The research team identified and evaluated two market entry points for reaching the rural poor in sub-Saharan Africa and South Asia:

Domestic+. The study evaluated the potential for providing multiple-use water services through domestic water service models, either by providing new services for a portion of the **440 million people** without services or by upgrading existing systems for a portion of the **1 billion people** with services.

Irrigation Services. The research evaluated the potential for upgrading existing irrigation systems to support multiple uses through incremental improvements for a portion of the **450 million people** living in irrigated areas of South Asia and sub-Saharan Africa.

Overview of basic process used for identifying high potential markets

The research team used the following process to identify to identify high potential markets for multiple use services (further details are below):

Step 1: Assess potential markets based on existing service levels using available global data sets, including remote sensing, to identify attributes of water services (quantity, quality and distance) for populations by country based on market entry point (irrigation or domestic) and current service levels.

Step 2: Disaggregate potential markets by technology/water source for water service levels using available global data sets.

Step 3: Identify markets with highest potential using results from cost and benefit analysis.

Step 4: Assess socioeconomic characteristics of households in these markets to determine if they could benefit from multiple-use services, i.e. are characterized by poverty and malnutrition but with the necessary assets (land and livestock) to make productive use of water.

Data. Two global data sets were used to estimate populations who might benefit from multiple use approaches-- 2004 Joint Monitoring Program for Water Supply and Sanitation (JMP) and 2003 World Health Organization (WHO) World Health Surveys (an overview of the data sources are provided on the next slide).

Estimating populations by service level. The JMP data (located at http://www.wssinfo.org/en/watquery.html) provides data for rural populations in all countries of South Asia and sub-Saharan Africa on households with and without "improved" water services. Improved water services are defined as follows:

Quantity:	>20 lpcd
Quality:	"improved" source
Distance:	< 1 km (30 minutes round-trip) from the household.

Households with services were further disaggregated into those with and without household connections. No information is available on the type of water system used.

Intermediate Output*:* JMP data was used to estimate rural populations at the following service levels for each country:

Highest MUS—household connections from improved sources
Combined Intermediate MUS, Basic MUS and Basic Domestic—households with improved domestic water services (excluding household connections)
No Services—households whose water services are either of from an unimproved source, too distant (>1km) and/or <20 lpcd from an improved nearby source.

A primary limitation of the JMP data for the purposes of this study is that it does not provide sufficiently detailed information on domestic service levels (such as distance) to disaggregate the households into the three "intermediate multiple uses, basic multiple uses, and basic domestic" groups. In addition, the JMP global data set does not contain easily available and comparable data on types of technologies used to provide water services.

B.3 Market Mapping: Domestic+—overview of data used for analysis

Data Sources	Services levels	Entry-points: Type of system	Comments	Usefulness in mapping exercise
JMP*	**Quantity**: households >20 lpcd & < 20 lpcd **Quality**: improved & unimproved sources* **Access**: <1km (30 minutes) **Reliability**: ?	No information on how services are provided (e.g., wells, surface water, etc.), except hh connections	Full geographic coverage for sub-Saharan Africa and South Asia, including rural and urban populations	•Identification of populations with existing domestic services and those without by country: •Identification of possible domestic + market (domestic to intermediate) •Identification of high-level mus potential (household connections)
DHS**	**Quantity**: no information **Quality**: no **Access**: % hh <15 minutes to source & median time to source **Reliability**: no	Sources of drinking water: piped, wells, surface, rainwater, tanker but doesn't distinguish between improved and unimproved	Good geographic coverage for most of sub-Saharan African and South Asia, including regional and provincial data for all countries, including urban and rural. Some data is dated (<2000).	•Identification of sources of water and time to source (% < 15 minutes & median time to source •Provides basis to estimate of populations with access (e.g. physical proximity to source) to support MUS
WHO	**Quantity**: households >20 lpcd & <20 lpcd **Quality**: improved and unimproved sources **Access**: hh/yard connections plus distance in time RT for others (<5 min, 5-30 min, 30-60 min, > 60 min **Reliability**: no	Sources of water by type of source (piped to hh/ yard tap, well, spring, rainwater, etc.) disaggregated by improved and unimproved sources	Most geographic coverage—13 countries in sub-Saharan Africa and all of South Asia.	•Possible to map data into defined domestic plus service levels, allowing estimates of populations for no access, basic domestic/basic mus, intermediate mus and high mus. Because of data limitations, basic domestic & basic mus are estimated together. •In addition, the data permit disaggregating populations considered" by JMP data—limited basic domestic (those having access to nearby improved sources but less than 20 lpcd) and productive (those having access to nearby unimproved water sources with >20lpcd that could be used for productive activities.

*Joint Monitoring Programme between WHO and UNICEF, 2004; **Demographic and Health Surveys, 2007

Further disaggregating service levels using WHO data.

The World Health Survey data (see http://surveydata.who.int/webview/index.jsp), which provides much more detailed information on the nature of water services and technologies, was used to further refine estimates of rural populations by service level for South Asia and sub-Saharan Africa and technology source. World Health Survey data was available for all countries in South Asia and the following 15 countries in sub-Saharan Africa: Burkina Faso, Chad, Congo, Cote d'Ivoire, Ethiopia, Ghana, Kenya, Malawi, Mali, Mauritania, Namibia, Senegal, South Africa, Swaziland, and Zimbabwe.
For surveyed countries, most contain representative surveys of several thousand rural households.

Using searchable database options, the survey data was disaggregated into the following 4 categories by type of water source/technology, allowing estimates of the percentage of rural population with the following service levels:

Highest Level MUS – household connections, >20 lpcd from an improved source, piped sources
Intermediate MUS – > 20 lpcd from an improved source that is < 5 minutes (150 m round-trip) from household
Basic MUS/Basic Domestic – > 20 lpcd from an improved source that is 5-30 minutes roundtrip (150-1km) from household
No Services – same as JMP definition

Because data on distance to source is aggregated to 5-30 minutes roundtrip (instead of 5-15 and 15-30 minutes), separate population shares for the basic multiple-use and basic domestic service levels cannot be estimated.

Intermediate Output: **Percentage of rural households by service level and technology for South Asia and 15 countries in sub-Saharan Africa.**

Linking WHO and JMP datasets to estimate populations for each service level and technology.
Estimates of rural populations by service level and technology are estimated by multiplying the WHO percentages developed above with 2004 rural population data from JMP data for each of the surveyed countries.

Validating WHO estimates. Country level estimates were validated by comparing population estimates based on WHO Health Survey information with JMP estimates, as follows:

JMP Highest MUS = WHO Highest MUS
JMP Improved = WHO Intermediate MUS + WHO Basic MUS
JMP Unimproved = WHO No services

For all but a few countries, the WHO estimates were within 5% of JMP estimates, corroborating the validity of the WHO estimates.

Disaggregating service levels for JMP data based on WHO analysis.
JMP data for each country was disaggregated into the four multiple use service level categories by applying the distribution calculated for the corresponding WHO data. For instance, to find the JMP Intermediate MUS category, we multiplied JMP Improved by the fraction for WHO Intermediate category:

JMP Intermediate = JMP Improved x [WHO Intermediate MUS/ (WHO Intermediate MUS+ WHO Basic MUS)]

In this way, for the 15 countries with WHO data, we were able to estimate populations for JMP Intermediate MUS and JMP Basic MUS based on the JMP general categories and WHO distribution.

For the 28 sub-Saharan countries that have JMP data but do not have WHO data, we applied an averaged distribution derived from the 15 WHO countries. First, the WHO countries were divided based on the Highest MUS category. This category was trimodal – most countries (9 out of 15) had Highest MUS for only 5% or less of the rural population, with the remaining in the 10 to 20% range (4 of 15), and the greater than 30% range (2 of 15).

For each of these three ranges of Highest MUS, we calculated the average fractional distribution of the other three service level categories. We then applied this WHO distribution to the JMP data to find the JMP Intermediate MUS and JMP Basic MUS breakdown, based on each country's Highest MUS value.

Of the 28 continental sub-Saharan Africa countries and Madagascar, 24 countries had Highest MUS values in the 0 to 5% range. For Gabon and Lesotho, which have a Highest MUS level of about 8%, we used the distribution found by the overall average (over all 15 WHO countries), which corresponds to a Highest MUS level of 9.7%. Only Sudan fell in the 10 to 20% Highest MUS range at 13%. For Botswana, which had a Highest MUS of 28%, we used the distribution for the "Greater than 30%" range, which had an average Highest MUS proportion of 32.5%.

Assumptions. For each of these data sets, we use the JMP 2004 Rural Population as the population basis. The WHO and JMP data sets, however, are not necessarily from 2004. For a limited number of countries, some of the data dates back to the 1990's. Even though the year may not correspond, we assume the relative proportion stayed the same.
In estimating the MUS populations based on the JMP data, we use the relative fractions determined by the WHO data. Thus we assume that, within the JMP Improved category, the relative proportion of Intermediate MUS and Basic MUS is the same as for the WHO data.

B.3 Market Mapping: Domestic+—Disaggregating domestic market based on service level

Burkina Faso Example: The table shows the how rural populations were disaggregated into various service levels

	< 5 minutes		5 - 30 minutes		> 30 minutes
>20 liter water available:	**yes**	**no**	**yes**	**no**	
Main source of drinking water	**Rural population**				
Piped water through house connection or yard	0	0	0	0	2,879
Public standpipe	227,422	25,909	1,019,081	198,634	466,359
Protected tube well or bore hole	210,150	11,515	1,105,444	339,694	575,752
Protected dug well or protected spring	259,088	14,394	469,238	57,575	120,908
Unprotected dug well or spring	924,082	25,909	1,163,019	135,302	575,752
Rainwater (into tank or cistern)	0	0	5,758	0	2,879
Water taken directly from pond-water or stream	2,879	0	0	0	2,879
Tanker-truck, vendor	14,394	0	109,393	20,151	31,666
Total	**1,638,015**	**77,727**	**3,871,933**	**751,357**	**1,779,074**

Color	Service Level
	Highest MUS
	Intermediate MUS
	Domestic/Basic MUS
	No Services

The methodology used to estimate rural populations living in irrigated areas in Sub-Saharan Africa and South Asia rely on products derived from remote sensing (a graphical illustration of the process is shown on the next slide).

Data. Three datasets were used along with GIS techniques to estimate the rural irrigated area and population per country in both regions.

- Global Map of Irrigated Area 1999 (GMIA) version 2.0 created by the International Water Management Institute (IWMI) (Thenkabail et al, 2006a). This dataset identifies 28 classes of major crop types and cropping pattern at 10 km resolution. The dataset is created using various remote sensing data (AVHRR – 10-km monthly data from 1997-1999, SPOT vegetation 1-km data for 1998, GTOPO 1-km DEM data) and validate with ground truth data.
- Global Rural-Urban Mask. This dataset is produced by the Columbia University Center for International Earth Science Information Network (CIESIN) in collaboration with the International Food Policy Research Institute (IFPRI), The World Bank, and Centro Internacional de Agricultural Tropical (CIAT), (2004). The spatial resolution is 1 km. The datasets represents the urban areas with a population of 1,000 people or more and rural areas with population less than 1,000 people.
- Gridded Population of the World, version 3. This dataset is also produced by the Columbia University Center for International Earth Science Information Network (CIESIN) in collaboration with the International Food Policy Research Institute (IFPRI), Centro Internacional de Agricultura Tropical, and The World Bank (2004). The population count grid contains the estimated number of people living in area of 1 km2.

GIS Methodology. The GIS methodology for estimating rural irrigated area and population in these areas in Sub-Saharan Africa and South Asia include the following steps:

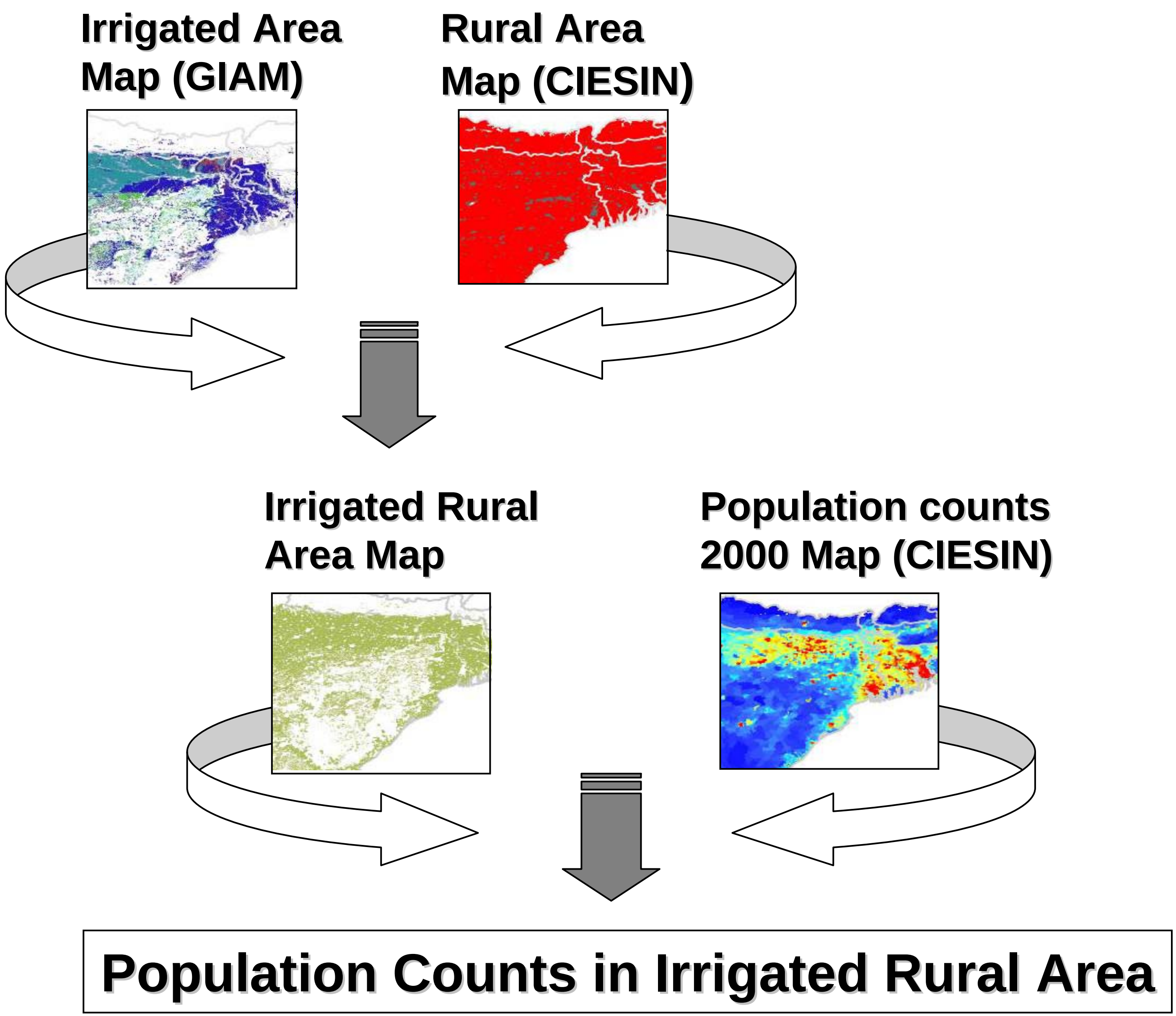
Identifying rural irrigated areas in Sub-Saharan Africa and South Asia

- The extent of rural area in both regions was extracted from the Global Rural-Urban mask dataset and combined with the 28 classes of the GIAM dataset for both regions to create a base rural irrigated area map. The base rural irrigated areas were corrected with an Irrigated Area Fraction (IAF) to estimate the total rural available area for three types of irrigation (surface, ground and conjunctive) per country.

Estimating the population in total rural irrigated areas in Sub-Saharan Africa and South Asia.

- The base rural irrigated area map was combined with the population count grid map to extract the population in the rural area with surface, ground and conjunctive irrigation types. The total population estimates were adjusted according the total rural area available for irrigation.

B.3 Market Mapping: Irrigation+—overview of methodology



B.4 Data: Financial Benefits of Home Gardens

Country	Context	As reported (PPI)	PPI$ m^2 garden/yr	$m^3 water			Reference
				3l per m^2/d	5 lpm^2/d	8 lpm^2/d	
Zimbabwe	Community garden: 60m^2 per member; splash garden from public standpipe (check)	Avg gross income per member for 6 month season is $32.80	1.09	1.00	0.60	0.37	Waughray, Lovell, Mazhangara (1998)[1]
		Gross income per member (high) for 6 month season is $96.73	3.22	2.94	1.77	1.10	
		Gross income per member (low) for 6 month season $9.79	0.33	0.30	0.18	0.11	
South Africa	Home gardens: 60-600 m^2, average 300 m^2; network w/ yard & house tap –vs.-unreliable public tap	Gross income/yr: network system: $324.59	1.08	0.99	0.59	0.37	Perez de Mendiguren et al. (2003)
		Gross income/yr: unreliable tap: $179.45	0.60	0.55	0.33	0.20	
Cambodia	Community garden: (median ranged from 750-1000 m^2)	Average for 3 project areas	0.25	0.23	0.14	0.09	HKI-Cambodia, Round Report, 1,1, (2000)
	3 village: median size: 885 m^2	Average gross income (after home cons) $13.76 per 3 months	0.06	0.06	0.03	0.02	
	8 villages median size =984 m^2	Average gross income (after home cons) $27.51 per 3 months	0.11	0.10	0.06	0.04	
	3 villages median size =750 m^2	Average gross income (after home cons) $110.06 per 3 months	0.59	0.54	0.32	0.20	

[1] 7 schemes participated; multiplier effect--income generated from home gardens used in other income generating activities such as small livestock, free trees, pottery, knitting, selling clothes. Gross margins from these activities ranged from $10-$262/yr

B.4 Data: Financial Benefits of Home Gardens (cont.)

Country	Context	As reported (PPI)	PPI$ m^2 garden/yr	\$$m^3$ water			Reference
				3l per m^2/d	5 lpm2/d	8 lpm2/d	
Cambodia[1]	Community garden: avg size 800-1000 m^2	Traditional: Average income after home cons. $6/4 mo	0.02	0.02	0.01	0.01	HKI-Cambodia, Round Report 4,2,1, (2001)
		Mixed: Average income aft. Home cons. $27/4 month	0.09	0.08	0.05	0.03	
		Year round: Average income aft. Home cons. $57/4month	0.19	0.17	0.10	0.07	
Nepal	Home gardens:	62 m^2/ per hh (median)—avg income $51/3 months	3.30	3.03	1.82	1.13	HKI-Nutrition Bulletin 2,1, (2004)
		90 m^2/ per hh: $47/3 month	2.10	1.92	1.15	0.72	
	Community gardens:		0.5	0.48	0.29	0.18	
			0.9	0.79	0.48	0.30	
Bangladesh	Home garden: average size 40 m^2	Overall: Average hh income: $16 per 2 months	2.41	2.20	1.32	0.83	HKI, Monitoring of activities in villages and hh gardens (2001) **(note: survey of 45,164 households)**
		Winter: Average hh income: $14.26 per 2 months	2.14	1.96	1.17	0.73	
		Summer: Average hh income: $17.87 per 2 months	2.68	2.45	1.47	0.92	

[1] Sampled 136 community gardens of 230; 30 minutes per day average time spent gardening; can generate $2-5/month plus consumption; increased income $10/month; annual household income is $82/year in Cambodia. 80% hh spent additional income on food, 80% on fish or fish paste & 5 % on pork

B.4 Data: Financial Benefits of Home Gardens (cont.)

Country	Context	As reported (PPI)	PPI$ m^2 garden/yr	$m^3 water			Reference
				3l per m^2/d	5 lpm^2/d	8 lpm^2/d	
Zimbabwe	Home garden/Small scale irrigation: 100 m^2 (only 1 season of vegetables); rope pump plus drip	$75 for one season vegetables	0.88		0.80	0.50	Polak, et al. 2003
Nepal	Home garden/small scale irrigation: gravity system plus drip kit, 500 m^2	$250 for one season of vegetables	0.58	0.53	0.32	0.20	Polak, et al. 2003
India	Small scale irrigation: gravity system plus drip kit, 400 m^2 over 2 seasons	$800 for two seasons	0.73	0.67	0.40	0.25	Polak, et al. 2003

B.4 Data: Financial Benefits of Large Livestock

Country	Context	PPI$	Drinking Water Use		Reference
			lpcd	$/m3	
LARGE LIVESTOCK					
Kenya	Mixture of cattle and goats Laikipia –site 1	61.00	17.3	3.54	Mizutani, Muthiani, Kristjanson, Recke (2005)
	Laikipia –site 2	61.00	17.3	3.54	
	Laikipia –site 3	-8.00	10.9	-0.74	
	Amboseli	21.00	26.2	0.80	
	Average	**34.00**	**18.1**	**1.88**	
	Cattle/sheep and goats. Avg holding = 4.5 TLU/capita*	45.00	30.0	1.50	Radney (2007)
South Africa	Cattle	40.00	30.0	1.33	Dovie, Shackleton, Witkowski, (2006)
India	Adult male cattle	15.88	30.0	0.53	Priya Deshingkar, et. Al (2007)
	Adult Female cattle	13.24	30.0	0.44	
	Adult Female cattle cross bred	15.88	30.0	0.53	
	Cattle young stock	6.62	20.0	0.33	
	Buffalo	15.88	40.0	0.40	
	Buffalo young stock	6.62	20.0	0.33	
	Buffalo dairy (no water source)	89.00	20.0	4.45	Upadhyay (2004)
	Buffalo diary (secure water source)	317.00	71.0	4.46	
	Cow dairy (secure source)	109.00	54.0	2.02	
	Cow dairy (no source)	5.00	14.0	0.36	

TLU = total livestock unit, the standardized measure of livestock. All livestock can be converted into a standardized TLU.

Country	Context	PPI$	Water Use		Reference
			lpcd	$/m3	
LARGE LIVESTOCK					
Ethiopia	Don-irrigation			1.22	Ayalneh, et al (2005)
	Don-no irrigation			2.14	
	Bata-irrigation			0.98	
	Batt- no irrigation			1.67	
	C-irrigation			1.96	
	C- no irrigation			4.14	
	M-irrigation			3.34	
	M- no irrigation			2.14	

Country	Context	As reported (PPI)	PPI$	Water Use		Reference
				lpcd	$/m3	
India	Andhra Pradesh and Madhya Pradesh	Adult male cattle	15.88	30		Priya Deshingkar, John Farrington, Pramod Sharma, Laxman Rao Jayachandra Reddy, Ade Freeman and Dantuluri Sreeramaraju (2007)
		Adult Female cattle	13.24	30		
		Adult Female cattle cross bred	15.88	30		
		Cattle young stock	6.62	20		
		Buffalo	15.88			
		Buffalo young stock	6.62			
		Goat	1.32	4.5		
		Sheep	1.32	4.5		
		Poultry—100 adult poultry	0.07	.3		
	Compared two areas: one with secure water and another without					Upadhyay (2004)
	Source	Buffalo—dairy	317	71		
		Cow—dairy	109	54		
	No-source	Buffalo—dairy	89	20		
		Cow—dairy	5	14		

B.4 Data: Financial Benefits of Small Livestock – Goats and Chickens

Country	Context	PPI$	Water Use		Reference
			lpcd	$/m3	
GOATS					
South Africa	Goats	3.40	4.50	0.76	Dovie, Shackleton, Witkowski (2006)
India	Goats	1.32	4.50	0.29	Priya Deshingkar, et. al (2007)
India	Sheep	1.32	4.50	0.29	Priya Deshingkar, et. al (2007)

Country	Context	PPI$	Water Use		Reference
			lpcd	$/m3	
CHICKENS					
Bangladesh	Chicken (scavenger based systems –13 chickens): $10.90/mo	10.00	0.30	33.33	Alam (1997)
Tanzania	Family poultry flock comprised of five adults	7.60	0.30	25.33	Chitukuro and Foster (1997)
Senegal and Gambia	Out of an average flock size of 21 birds **$130/yr---$6/bird**	6.00	0.30	20.00	Balde (2006)

B.4 Data: Financial Benefits of Small Livestock (cont.)

Country	Type of livestock operation	As reported (PPI)	PPI$	Water Use		Reference
				lpcd	$/m3	
Kenya	Mixture of cattle and goats Laikipia –site 1		$61	17.25		Mizutani, Muthiani, Kristjanson, Recke, (2005)
	Laikipia –site 2		$61	17.25		
	Laikipia –site 3		-$8	10.88		
	Amboseli		$21	26.18		
	Average		**$34**			
South Africa	Cattle		$40	30		Dovie, Shackleton, Witkowski (2006) $688 cattle/yr; avg holding =19 cattle; $17.33/goats/yr; avg holding =5.6 goats
	Goats		$3.4	4.5		
Bangladesh	Chicken (scavenger based systems –13 chickens): $10.90/mo	$131/yr	$10	.3		Alam (1997)
Tanzania	Family poultry flock comprising five adult chickens enabled women to earn US$ 38.00 annually, which is about 10% of the annual income. **(5 chickens = $38/yr or $7.6/chicken)**	$38/yr	$7.6	.3		Chitukuro and Foster (1997)
Senegal and Gambia	Out of an average flock size of 21 birds **$130/yr--- $6/bird**		$6	.3		Balde (2006)

Country	Context	As reported (PPI)	PPI$	Water Use		Reference
				lpcd	$/m3	
Kenya	Cattle/sheep and goats Avg holding = 4.5 TLU/capita	Mean gross income per TLU=$73 (std $62), costs of prodn = $28 (std =$30), net returns=$45 (std $63) 12% hh negative returns. Increasing TLU by 10% increases income by 7.5%	$45	30		Radney (2007)
Ethiopia	Don-irrigation				1.22	Ayalneh, et al (2005)
	Don-no irrigation				2.14	
	Bata-irrigation				0.98	
	Batt- no irrigation				1.67	
	C-irrigation				1.96	
	C- no irrigation				4.14	
	M-irrigation				3.34	
	M- no irrigation				2.14	

Description of cost components [1]	Overview of what's included
Capital investments in fixed assets	Water supply specific: Water resources facilities, boreholes, piped systems, irrigation infrastructure. Other: Offices, IT systems, maintenance vehicles, depots and warehouses; land for protecting water quality; extension of the distribution (non networked)
Operating & maintenance expenditures (OPEX)	Labor; power costs, fuel, chemicals, cost of materials for operation and maintenance; Water source protection and conservation, point source water treatment, non network water distribution.
Capital maintenance fund (CapManEX)	Rehabilitation and replacement of infrastructure and catchment protection
Software costs	
Direct support costs	Community capacity building, overheads of intermediate support agencies, outreach and extension for productive uses, hygiene awareness and education campaigns, etc.
Indirect support costs	Institutional capacity building and skills training at local government and national government levels; Cross-sectoral coordination. Development and maintaining IWRM, water and wastewater management and development plans Regulation, development and maintaining monitoring and assessment information systems Ongoing development, refining and implementation of policy

[1]Sources: Cardone, R. and C. Fonseca. December 2003. "Financing and Cost Recovery" IRC Thematic Overview Paper. http://www.irc nl/page/7582; Franceys, R., C. Perry and C. Fonseca. June 2006. "Guidelines for User Fees and Cost Recovery for Water, Sanitation and Irrigation Projects." IRC/Cranfield report for the African Development Bank. Unpublished

Summary of costs per capita/per year for non-networked rural water (US$I PPP 2004)

Summary of data ranges	Capital investment		OPEX		Direct support costs		CAPManEX		Indirect support costs	
	min	max	min	max	min	max	min	max	min	max
Technology typology										
Global data on "rural water"	0.2	25	2.41							
Self supply well lining	1				2		1.7			
Self supply well lining and hand pump	2				3					
Spring catchment and protection	4	222			24		0.1	21		
Hand dug well with hand pump	9	82	2				0.4	12		
Shallow tube well	10		1		1		1			
Sub-surface dam with hand dug well	17						0.1			
Borehole with hand pump	18	199	1	2			20			
Rainwater harvesting	36	229	3	4						
Gravity flow	45		9		6		3			
Sand dam with standpipe	56						0.1			
Rock catchment	244						1.6			
Total ranges (excluding lower ranges of UN MP data as they are for the whole population)	1	229	1	4	1	24	0.1	20	0.3	
Point water treatment	0.1		0.3	0.4						
Institutional support for the whole population in one Region					1.2				0.3	

Costs per capita/per year for non-networked rural water (US$I PPP 2004)

Details of technology, country, program	Population served	Currency	Date costs collected	Capital investment	OPEX	CAPManEX	Direct support costs
Africa				Costs per capita/per year PPP (US$I)			
Hutton & Haller - borehole		USD	2000	25	2		
Hutton & Haller - disinfection point use		USD	2000	0.1	0.4		
Hutton & Haller - dug well		USD	2000	23	2		
Hutton & Haller - rainwater		USD	2000	53	4		
Smits - rural areas		USD	2004	25			
SNNPR Ethiopia - Community hand dug well (10m)	75	ETB	2005	35			
SNNPR Ethiopia - Lined standard dug well (15m)	270	ETB	2005	82.1		12	
SNNPR Ethiopia - Medium scheme spring development	3978	ETB	2005	222		21	
SNNPR Ethiopia - Motorized deep borehole	3313	ETB	2005	199		20	
SNNPR Ethiopia - Shallow borehole	589	ETB	2005	108		16	
SNNPR Ethiopia - Spring development	338	ETB	2005	99		14	
UN Millennium Project (2004) Ghana		USD	2000	0.4	0.4		
UN Millennium Project (2004) Tanzania		USD	2000	0.4	0.4		
UN Millennium Project (2004) Uganda		USD	2000	0.4	0.2		
WHO/UNICEF - borehole		USD	2000	25			
WHO/UNICEF - dug well		USD	2000	23			
WHO/UNICEF - rainwater collection		USD	2000	51			

Costs per capita/per year for non-networked rural water (US$I PPP 2004) cont.

Details of technology, country, program	Population served	Currency	Date costs collected	Capital investment	OPEX	CAPManEX	Direct support costs
Africa cont.				Costs per capita/per year PPP (US$I)			
WSP Kenya - Rock Catchment (1.5m3/day)	200	Kshs	2005	244		1.6	
WSP Kenya - Roof Rainwater Catchment (30l/day)	10	Kshs	2005	229		1.7	
WSP Kenya - Sand-dam w/ standpipe (3m3 /day)	500	Kshs	2005	56		0.1	
WSP Kenya - Spring Catchment/protection (20m3/day)	500	Kshs	2005	4		0.0	
WSP Kenya - Sub-surface Dam w/ HDW (3m3 /day)	500	Kshs	2005	17		0.0	
WSP Zambia - improving self supply - well lining	100	USD	2004	1			2
WSP Zambia - improving self supply - well lining plus hand pump	100	USD	2004	2			3
WSSCC Vision 21 - basic levels of service		USD	1999	16	2		
Asia							
Hutton & Haller - borehole		USD	2000	18	1		
Hutton & Haller - disinfection point use		USD	2000	0.1	0.3		
Hutton & Haller - dug well		USD	2000	24	2		
Hutton & Haller - rainwater		USD	2000	36	3		
UN Millennium Project (2004b) Bangladesh		USD	2000	0.3	0.5		
UN Millennium Project (2004b) Cambodia		USD	2000	0.2	0.1		
WaterAid Nepal - Deep tube well		USD	2004	45	8	3	6

Costs per capita/per year for non-networked rural water (US$I PPP 2004) cont.

Details of technology, country, program	Population served	Currency	Date costs collected	Capital investment	OPEX	CAPManEX	Direct support costs
Asia cont.				Costs per capita/per year PPP (US$I)			
WaterAid Nepal - Gravity flow		USD	2004	45	9	3	6
WaterAid Nepal - Shallow tube well		USD	2004	10	1	1	1
WHO/UNICEF - borehole		USD	2000	18			
WHO/UNICEF - dug well		USD	2000	24			
WHO/UNICEF - rainwater collection		USD	2000	36			
Global							
GWP - water supply		USD	2000	16	2.41		

B.4 Data: Costs for domestic+ analysis

Summary of costs per capita/per year for networked water supply (US$I PPP 2004)

Technology typology	Capital investment		OPEX		Direct support costs		CAPManEX		Indirect support costs	
	min	max	min	max	min	max	min	max	min	max
Urban water	0.3	100	0.1	8						
Large scheme spring development	17						6			
Standpipe	33	69	2.57	8.04						
Household connection - small town	40		2.4		5.15		2.78			
Improvement and expansion town water supply	66		0.3							
Household connection	99	214	4.27	32.16	6.4					
Piped system borehole with chlorination	116		11				4.35			
Household connection - large town	312									
New town water supply	429									
Total ranges (excluding lower ranges of UN MP data as they are for the whole population)	17	429	0.3	32	5.15	6.4	2.78	6		

Costs per capita/per year for networked water (US$I PPP 2004)

Details of technology, country, program	Pop. served	Currency	Date costs collected	Capital investment	OPEX	CAPManEX	Direct support costs
Africa				Costs per capita/per year PPP (US$I)			
Hutton & Haller - house connection		USD	2000	109	4.73		6.40
Hutton & Haller – standpipe		USD	2000	33	2.57		
Smets - urban areas		USD	2004	100			
SNNPR Ethiopia - Improve and expansion town	11000	ETB	2005	66			
SNNPR Ethiopia - Large scheme spring development	28756	ETB	2005	17		6	
SNNPR Ethiopia - New town water supply scheme	15000	ETB	2005	429			
UN MP (2004) Ghana		USD	2000	1.2	1.2		
UN MP (2004) Tanzania		USD	2000	0.5	1.0		
UN MP (2004) Uganda		USD	2000	0.3	0.3		
WHO/UNICEF - household connection		USD	2000	109			
WHO/UNICEF - standpipe		USD	2000	33			
WSP Kenya - Piped System BH Source Chlorination	100,000	Kshs	2005	115.90	11.01	4.35	
WSSCC Vision 21		USD	1999	55	8		

Costs per capita/per year for networked water (US$I PPP 2004) cont.

Details of technology, country, program	Pop. served	Currency	Date costs collected	Capital investment	OPEX	CAPManEX	Direct support costs
				Costs per capita/per year PPP (US$I)			
Asia							
Hutton & Haller - house connection		USD	2000	99	4.27		6.40
Hutton & Haller - standpipe		USD	2000	69	5.31		
UN MP (2004b) Bangladesh urban water		USD	2000	0.5	0.1		
UN MP (2004b) Cambodia urban water		USD	2000	0.4	0.2		
WaterAid Nepal - large town household connection		USD	2004	312			
WaterAid Nepal - small town household connection		USD	2004	40	2.4	2.78	5.15
WHO/UNICEF - household connection		USD	2000	99			
WHO/UNICEF - standpipe		USD	2000	69			
Global							
GWP - household connection		USD	2000	214	32.16		
GWP - standpipe		USD	2000	54	8.04		
Kariuki - small independent network		USD	2005?	101			
Kariuki - small independent network		USD	2005?	304			

Costs for irrigation+ infrastructure add-ons (US$)

Added Structure	Capacity/Dimensions	Approx. Capital Cost (USD)	Source
Home storage (excludes stand and fittings)	Cement jar 0.1-1.2m^3	10-100	SWI
	Covered plastic tank 1-2 m^3	140-250	IWMI
	Covered aluminum tank 1-2m^3	410-820	IWMI
	Covered fiber glass tank 1-2 m^3	280-510	IWMI
	Covered cement ground tank 2 m^3	140	IWMI
	Plastic tank on steel tower 2 m^3	450	IWMI
	Covered cement overhead tank 2 m^3-3m^3	470/100-300	IWMI/SWI
Stand and fittings	Overhead water storage	650	N/A
Community storage small (exclude stand and fittings)	Cement 8-10m^3	810	IWMI
	Covered plastic tank 10m^3	1180	IWMI
	Covered aluminum tank m^3	4050	IWMI
	Covered fiber glass tank 10m^3	2030	IWMI
	Circular masonry 10m^3	1180	IWMI
Community storage medium	Circular masonry 50m^3	6000	IWMI
	Covered cement ground tank 50m^3	2250	IWMI
	Covered cement overhead tank 50m^3	7090	IWMI
Community storage large	195 m^3 excavated	1080	HCS
	Underground open trapezoidal masonry 500 m^3	23,400	IWMI
	Underground open trapezoidal masonry 1000 m^3	47,700	IWMI

Costs for irrigation+ infrastructure add-ons (US$) cont.

Added Structure	Capacity/Dimensions	Approx. Capital Cost (USD)	Source
Pump (electricity or generator needed)	Electric, 32 mm diameter	35	IWMI
	1.5 HP submersible, 2 l/s	910	IWMI
	2.4 HP submersible, 4 l/s	1230	IWMI
	Electric pump 2 inch diameter, 1620 l/s	35-60	HCS
Generator	4.0-5.5 kV for electric pumps	960-1,550	IWMI
Pipe connection	Steel, 2 inch diameter, 6m long	40	IWMI
	Plastic, 2 inch diameter, 1m long	25	IWMI
	Plastic, 20 mm diameter, 4 m long	3	IWMI
Connection tap	Plastic 20 mm tap	2	IWMI
Cattle trough	For 4-10 animals	450/820	IWMI/HCS
Laundry basin	For 3 people	150/525	IWMI/HCS
Washing room	Enclosure with cement floor, corrugated iron and wood pole walls and roof, soak pit (bucket excluded)	450	HCS
Bathing and laundry steps in canal	Concrete steps in main canal	4060	IWMI
	Concrete steps in secondary canal	610	IWMI

B.4 Data: Costs for Irrigation+ infrastructure add-ons

Costs for irrigation+ infrastructure add-ons (US$) cont.

Structure Description	Short Description	Approx. Capital Cost (USD) Based on 2 liters of clean drinking water/capita/day	Recurrent cost/capita/ Year (USD)	Source
Centers for Disease Control and Prevention (CDC) Safe Water System – component 1	Chlorine treatment	1.5-8	1-5	CDC
CDC Safe Water System – component 2	Safe storage; 50 liter; can filter	2-5	1	CDC
Cement/bamboo sand filter	300 l/day	35	<1	Arbaminch University
Ceramic filter		N/A	25-100	
Clay pot with sand filter	18 liters	5	<1	IWMI
Coagulation/filtration/chlorination	Sachets	5-10	7-11	CDC
Disinfection filter	Treats 475 l	<1	15	SWI
Electric disinfection	Treats 45 l/h	200	10-30	SWI
Solar Water Disinfection (SODIS)	Plastic bottles on black surface exposed to sunlight	<1	1	CDC
Solar stills	0.5-12 liter/day	55-450	100	SWI
Solar oven	7-11 l/day	10-50	<1	SWI
Water disinfection tablets	Emergency treatment	<1	5-10	SWI

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C.1 Financial returns by use
C.2 Poverty impacts
C.3 Market mapping

Estimated annual income generated per m2 of home garden: $0.03 - $3.30/m2

- Median: $0.67/m2
- Mean: $1.08/m2
- St. Dev: $1.06/m2

For traditional or seasonal gardens or where home consumption is very high, the annual returns may be reduced by 60-70% or more

Amount of income generated depends on a number of factors:

- Extent of home consumption
- Intensity of production
    - traditional garden to highly developed garden
    - seasonal –vs.- year round garden
    - availability of water and method of water application
    - availability, cost and quality of other inputs (land, fertilizer, seeds)
- Market access and local prices

Water use and returns:
Home gardens require between 3 - 8 liters per m^2 per day during the growing season.

Estimated returns: $0.01 - $1.82/$m^3$ of water
Median: $0.37
Mean: $0.61
St. Dev: $0.58

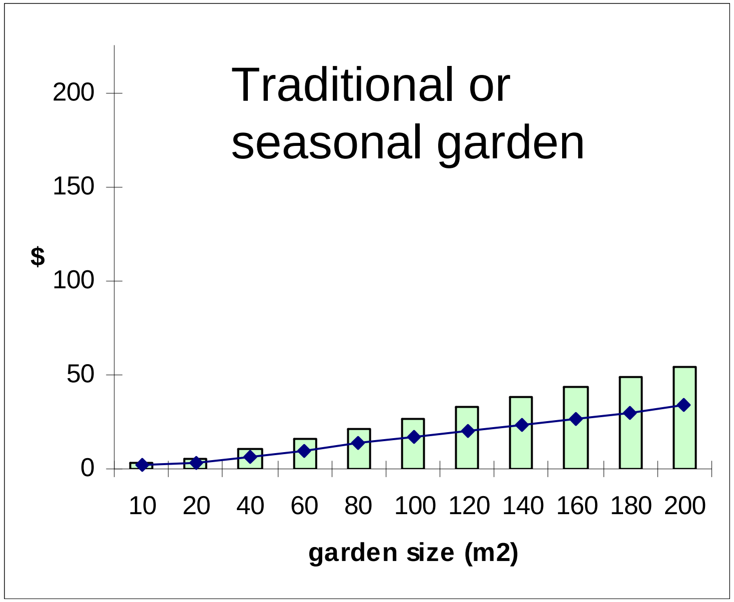
Home gardening has the potential to generate income to pay for water services while improving food security and nutrition.

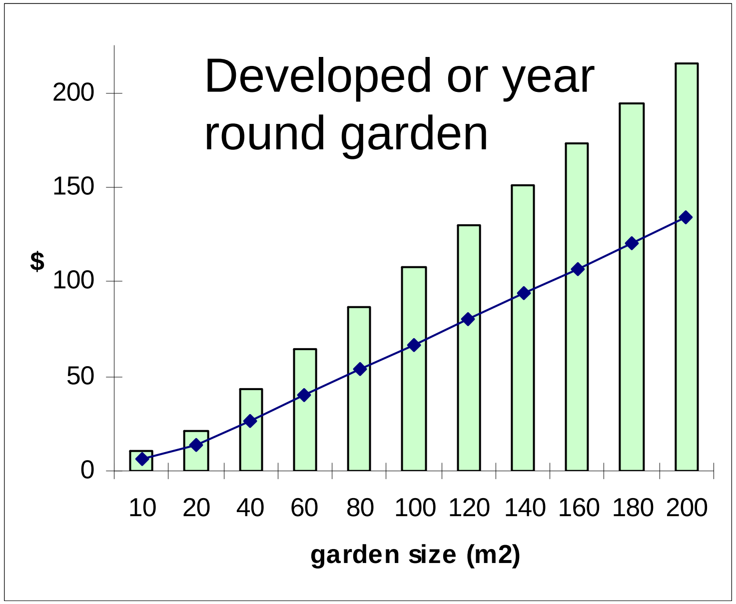
In many areas, home gardening is a seasonal activity, while in others it's a year round activity.

Access to water influences the extent and productivity of a home garden:

- Vietnam: 48% of households in water secure villages (Basic MUS service level) had household gardens, while only 11% in water scarce villages had them.
- South Africa: 45% of households in water secure villages (intermediate MUS service level) had households gardens while only 14% in water scarce villages had them.

In a survey of over 45,000 households in Bangladesh, Heller Keller International found that an average-sized home garden of 40 m2 generated $16 income per 2 months ($96/year) plus provided for home consumption. The average cost per garden was $3 per year (plus, if needed, an additional $12 for water-related investments such as treadle pumps)





Sources: Bangladesh: HKI (2001)
Vietnam: Noel (2007))
South Africa: **Perez de Mendiguren (2003)**

C.1 Financial returns: Water service levels and home gardens

Bushbuckridge, South Africa:

Characteristics	**Basic domestic**: Unreliable public taps, some distant and w/ long waits Average use: 23.3 lpcd	**Basic/Intermediate MUS**: Reliable household and yard taps, some communal taps Average use: 40.4 lpcd
Percent of households with home gardens	14%	45%
Average annual gross returns to home gardens & fruit trees	$0.60 m2	$1.08 m2

In Bushbuckridge, improved access to water increased both the number households with home gardens and average return (see Annex A for further details)

Uda Walawe Irrigation scheme, Sri Lanka

Characteristics	**Intermediate MUS**: Mostly shallow groundwater wells in yard recharged from irrigation system
Percent of households with home gardens	28% (estimated)
Average annual gross returns to home gardens & fruit trees	$0.11 m2 ($435/yr for typical .405 homestead area)

In Uda Walawe irrigation scheme, water from unlined irrigation canals provide both the opportunity for shallow homestead wells. These wells combined with sub-surface drainage from the irrigation system provide water for homestead gardens, generating an average of $400/yr of additional income. This income is under the control of women, who use it for education, health care and to generate savings for major expenditures such as dowries. (see Annex A for further details)

Sources: Sri Lanka: Molle and Renwick (2005)
South Africa: **Perez de Mendiguren (2003)**

C.1 Financial returns: Livestock

Estimated annual income generated for livestock based on a review of the literature:

	Mixed cattle, sheep & goats	Goats	Chickens
Range	-$8-61	$1.30-$3.4	$6-$10
Median	$18	$1.30	$7.60
Mean	$25	$2.00	$7.60
StDev	$21	$1.20	$2.00

Amount of income generated depends on a number of factors:

- Intensity of production
    - extensive vs. intensive production
    - availability, cost and quality of other inputs (including water)
- Market access and local prices
- Extent of home consumption

Water use and returns:

Type	water use	mean ($/m3)	median($/m3)
Mixed cattle/	25 lpcd		
Goats/sheep	5 lpcd	1.11	0.67
Goats		0.45	0.29
Poultry	0.3 lpcd	26.22	26.33

C.1 Financial Returns: Water service levels for livestock

Gujarat, India:

Avg. net returns (excluding non-cash costs for labor and fodder)	**Basic/ Intermediate MUS**	**No Service**
Dairy cow:	109/yr	5/yr
Dairy buffalo:	317/yr	89/yr

In Gujarat, India, access to water was a critical determinate in income generation for dairy production. Households with better access to water generated returns more than 300% greater than those without.

Access to water may increase productivity and income generation potential, however, the evidence on linkages between access to water and livestock holdings is mixed.

For irrigated areas, the density of livestock holdings is higher than rainfed areas. However, among communities relying on domestic schemes for water, the picture is less clear. Two examples typify the findings. A survey of productive uses of water in Vietnam reveal that 53% of households in water secure villages had livestock versus only 22% in water scarce villages (Noel, 2007). However, in similar type of study in South Africa, both water secure and unsecured households were equally likely to have cattle (20%) but water insecure households were more likely to have goats (31% of households) than water secure (20%).

Sources: India: **Upadhyay, 2004**
South Africa: **Perez de Mendiguren (2003)**
Vietnam: **Noel (2007)**

C.1 Financial returns: Small scale enterprises

Estimated annual income from small scale enterprises*

- Range: $21-150
- Median: $67
- Mean: $76
- St. Dev: $41

Small scale enterprises tend to be seasonal and generate low returns, but they are crucial for income security, especially for the poorest

Income for example small scale enterprises

- Beer brewing: $90 – 120/yr
- Ice block making: $22 – 56/yr
- Tea making: $34 – 113/yr
- toddy tapping $150/yr
- Rice wine/cakes: $4-7/day
- Brick making: $90 – 122+/yr

Income generation and small scale enterprises:

- Tend to be informal seasonal (2-4 month/yr) or intermittent (weekly or monthly) activities, although some year round that provide supplemental income
- Usually require limited investments, relying heavily on non-cash inputs (such as labor, feral materials) and generally operate at a loss if non-cash costs are included
- Based on case studies reviewed, 5-15% of households were engaged in small-scale water dependent activities
- Higher returns per unit of water than livestock or home gardens

* Estimated returns should be interpreted with caution as they are based on a very small sample

Bushbuckridge, South Africa:

Water service level	**Basic domestic**: Unreliable public taps. Average use: 23.3 lpcd	**Basic/Intermediate MUS**: Reliable household and yard taps, some communal taps. Average use: 40.4 lpcd
% of households engaged in SSEs		
Brewing	2%	2%
Ice blocks	6%	13%
Brick making	40%	57%
Water use (avg lpcd)		
Brewing	17	28
Ice blocks	1.3	0.5
Brick making	3.3	5.5
Income generation (yr)		
Brewing	$91	$122
Ice blocks	$56	$22
Brick making	$34	$57

Income Benefits: Vietnam

- Basic MUS villages make higher profits from water-dependent micro-enterprise such as griddle cakes and rice wine. Although these profits are still small they are crucial to income security and use labour that would otherwise be idle.
- Griddle cakes: profits from US$4.83 to US$11.17/day
- Rice wine: profits from US$3.50 to US$6.52/ day

Livelihood Benefits

Presence of water source of adequate quantity and quality almost quadrupled the number of water-dependent micro enterprises. On average:

- Basic MUS villages have 4.6% of HHs involved in micro-enterprises
- No Service villages have 1.2% of HHs involved in micro-enterprises

Examples of types of businesses:

- Food Items: rice-based wine, noodles, cakes; tofu and tofu juice, tea, ice
- Services: hairdressers, motorbike washing, tea shops and small eateries

Sources: South Africa: **Perez de Mendiguren (2003);**
Vietnam: **Noel (2007)**

Food Security	Home gardens increase total consumption, improve nutrition, reduce the duration of periods of under-consumption, and otherwise improve food security. ➢'Improved' home gardens **meet more than 50% of household vegetable and fruit needs** (Marsh, 1998). ➢Assured irrigation and/or integration with livestock rearing multiplies the food security and nutrition value of home gardens (HKI, 2001; Pant et. al., 2005). ➢In Nepal, daily vegetable **consumption increases by 70%** in poor households with less than 0.5 ha of land that participate in MUS by Design schemes (Pant et. al., 2005). ➢Irrigated communal gardens improve food security in drought prone areas in Zimbabwe with large numbers of HIV-AIDS affected and/or landless households: member households **consume vegetables 5.5 days a week as compared to 2 days** prior to the scheme (Waughray et. al., 1998; Matthew, 2003). ➢In Vietnam, home gardens enable a more balanced diet and ensure minimum food availability ,especially in pre-harvest "hungry" seasons or when field crops fail (Noel et. al., 2007).
Livelihoods Diversification	Water services upgrades for home gardens free up labor inputs for other productive activities. ➢In Nepal, 43% of women who received upgraded water technologies for home gardens used the time they saved in other production activities (Pant, 2005; WI, ongoing) ➢In South Africa, the poorest households in 13 villages doubled the number of economic activities they participated in when they upgraded to intermediate-level multiple-use schemes (Perez de Mendiguren, 2003; Perez de Mendiguren and Mabalane, 2001; Soussan et. al., 2002) ➢Communal gardens are a **critical source of livelihood** for the landless poor, especially in sub-Saharan Africa, where communal farming is a common practice (Waughray et. al., 1998; Marsh, 1998)

Health & Nutrition	➢In Nicaragua, households with the smallest farms (0-0.70 ha) and the lowest incomes (US$102.80/capita) achieved the greatest benefits in food security and nutrition (Alberts and van der Zee, 2003). ➢Income from improved home gardens in Zimbabwe provides enough income for a family of five to purchase **83% of the recommended cereal ration** for a month (Mathew, 2003). ➢Home gardens integrated with poultry production improve nutrition and increase consumption of micro-nutrient rich foods in the most vulnerable and food insecure regions in Bangladesh (HKI, 2001). ➢In multiple-use services project areas in Bangladesh, year-round **dietary diversity increased by 20% for women and 29% for children** under 5 and **night blindness decreased by about 50% for children** under 5 (HKI, 2001).
Social Equity & Empowerment	Home gardens provide the greatest benefits to women, poor households, and other vulnerable groups. ➢In Nicaragua, the poorest households consume the most home garden produce and save the most on household food expenditures. In sub-Saharan Africa and Bangladesh, home gardens provide the greatest benefits to marginal farmers (those with less than 0.5 ha), the elderly with grandchildren (in HIV/AIDS-affected households in South Africa and Zimbabwe), and women in poor households (Alberts and van der Zee, 2003; Mathew, 2003; HKW, 2001; Waughary et. al., 1998; Marsh, 1998). ➢Household food security and income from home gardens lead to positive gender outcomes. Women in Zimbabwe said: “If I give up my plot, I’d be giving up my future” (Waughary et. al., 1998). ➢Improved community ownership and management of garden systems is both a process and achievement in social empowerment. In Zimbabwe, 80% of project participants identified themselves as decision-makers regarding water scheduling and allocation and maintenance requirements (Waughary et. al., 1998).

Food Security	Livestock activities improve food security, especially during periods of food deficits. ➢In Nepal, dairy buffalo rearing supported by improved water supplies **reduced periods of food deficits from eight months to two months** per year, and **inadequate food intake for villagers fell from 50% to 18%** during the year (Thomas-Slayer and Bhatt, 1994). ➢ Providing water to support livestock-keeping enhances food security during lean times in Ethiopia (Ravnborg et. al., 2007). ➢In Bangladesh, 40% of children in households with integrated home gardens and livestock rearing consumed eggs on three or more days per week, 25% higher than the national average (HKI, 2001).
Livelihoods Diversification & Well-Being	Livestock activities made possible by water services improve women's well-being and diversify their livelihoods. ➢Improved access to higher quality water increases livestock productivity and reduces the amount of time women spend fetching water. In Ethiopia, improved water systems **saved women four to six hours**, enabling them to organize into women's milk groups and conduct business in the market (van Hoeve and van Koppen, 2005). ➢Female heads of households use livestock to cover larger expenditures like medical care, school fees, or bride prices for marrying daughters (van Hoeve and van Koppen, 2005). ➢In India, families use extra money from livestock to upgrade basic living conditions (Upadhyay, 2004).

C.2 Poverty Impacts: Livestock Example Evidence

Health & Nutrition	➢Multiple-use approaches that provide separate livestock water supplies **reduce the incidence of diarrhea among children** in Ethiopia by eliminating cross-pollution of water sources (van Hoeve, 2004). ➢When pasteurized, the milk of cows, goats, sheep, and camels provide an **important source of nutrition** for people in Ethiopia, improving physical health (van Hoeve and van Koppen, 2005). ➢Evidence from India suggests that cash income from livestock has a multiplier effect in its use for children's medical needs, thus improving their health (Upadhyay, 2004).
Social Equity & Empowerment	➢Experience from women's dairy cooperatives in India demonstrates that livestock rearing **can increase household bargaining power**, leading to self-empowerment. Women, however, continue to bear a disproportionate share of the livestock rearing burden (Upadhyay, 2004). ➢In Nepal, close proximity of the water tap has led to men starting to fetch water and manage livestock. Previously, women had to fetch water even for use by men (Pant, et. al., 2006). ➢Where livestock is the only asset of the poor, animal water provisions **benefit the poor disproportionately** and contribute significantly to poverty reduction (Ali, 2000).

C.2 Poverty Impacts: Small-scale Enterprises Example Evidence

Livelihoods Diversification	➢In India, women use extra income from SSEs for household expenses, education, childcare, and to serve as a buffer during crisis times (James et. al., 2002). ➢Irrigation water stored in tanks in Morocco (Boelee and Laamrani, 2003), and yard taps in South Africa (Perez de Mendiguren, 2003) increases the number of small-scale brick-making enterprises, which provides housing construction and repair services that would otherwise have to be bought ➢Improved water supply in India **saves 1.1 hours of women's time** in the summer and **3.6 hours** in non-summer, freeing up time for livestock rearing, garment making and other micro-enterprises (James, 2003). ➢Intermediate-level multiple-use services in South Africa enables households to conduct high-productivity small-scale home enterprises and rely less on poor-production livelihoods (Soussan et. al., 2002). ➢SSEs often use labor that would otherwise be idle. In Vietnam , SSEs **provide livelihoods for 9 months** out of the year (Noel et. al., 2007). ➢Higher service levels enable households to engage in **more micro-enterprises**. In Vietnam, villages with basic-level water services have four times as many micro-enterprises as villages with no services (Noel et. al., 2007). ➢Storage tanks added to irrigation canals allow **diversification of agricultural activities** (fisheries, duck rearing, social forestry, etc.) in India (Palanisami and Meinzen-Dick, 2001). ➢In India, local brick-making is a **predominant livelihood for the asset-less rural poor**, especially during periods when agriculture requires little or no labor. Brick-making requires low cash investments and has assured returns (Palanisami and Meinzen Dick, 2001). ➢Higher service levels in Zimbabwe led to the traditional revolving fund being used for **200 livelihood and income diversification initiatives** like tree-growing, pottery, knitting, and clothing sales. Originally, the fund was used only for basic needs (Waughray et. al., 1998) ➢Some SSEs (such as beer brewing in South Africa) are perceived as an **indication of poverty**, so households would only conduct them if no other income option existed (Perez de Mendiguren, 2001).

C.2 Poverty Impacts: Small-scale Enterprises Example Evidence

Health & Nutrition	➢Safe water for food-based SSEs **has multiplier effects on household and community health** in South Africa. For example, sorghum porridge, made and sold by women, provides good nutrition at low cost (Perez de Mendiguren, 2001).
Social Equity & Empowerment	➢Women gain proportionally more from SSEs made possible by improved water services. In Zimbabwe, most women involved in SSEs such as beer-brewing, brick making and food shops are family heads or widows (Matthew, 2003). In Malawi, women heads of household conduct brick making and beer making activities (Mulwafu, 2003). ➢Women in enterprise households in India are more involved in the management of community water resources and have greater control of financial and social resources. Small-scale enterprise production also encourages **social networking** (Verhagen et. al., 2004)

Distance to water source is an important determining factor for multiple uses. As distance increases, the quantity of water used for productive activities decreases.

Service level	**sub-Saharan Africa**	**South Asia**
	(population by 1,000s)	
Water source w/in 15 minutes roundtrip (improved and unimproved sources)	153,297	654,778
Total rural population	467,135	1,068,873
Percent of rural population within 15 minutes roundtrip	(33%)	(61%)

Source: DHS, various years

•DHS survey data show the percent of households with access to their primary domestic source within 15 minutes round trip (including any waiting time to fill)—less than 500 m.

•Percentages for rural populations based on DHS survey data were used in conjunction with 2004 rural populations to estimate populations

•These data suggest that distance may be a significantly more limited factor for multiple uses in sub-Saharan Africa than South Asia.

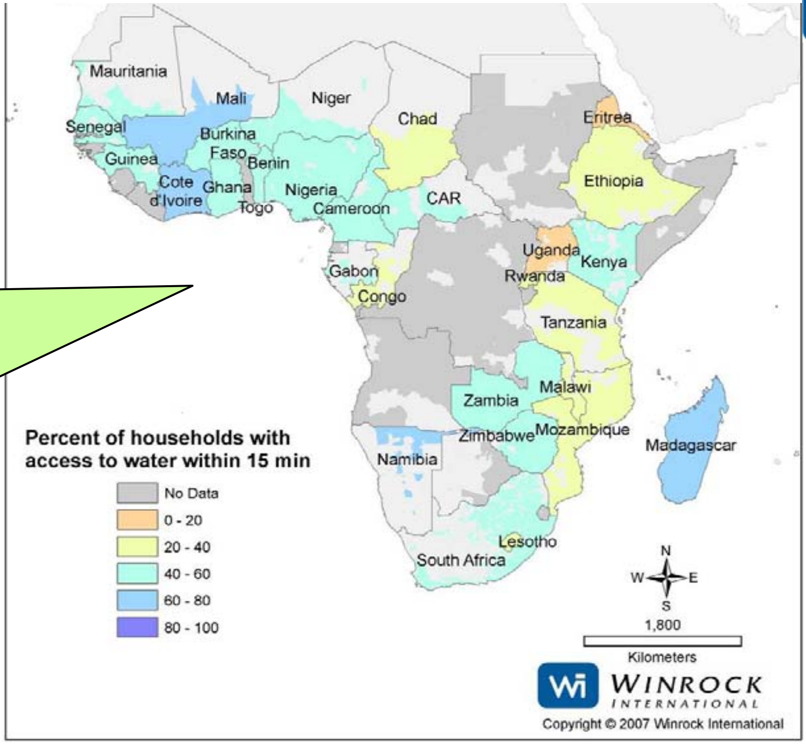
Note: DHS data don't distinguish between improved and unimproved sources, so these data are not directly comparable to JMP data.

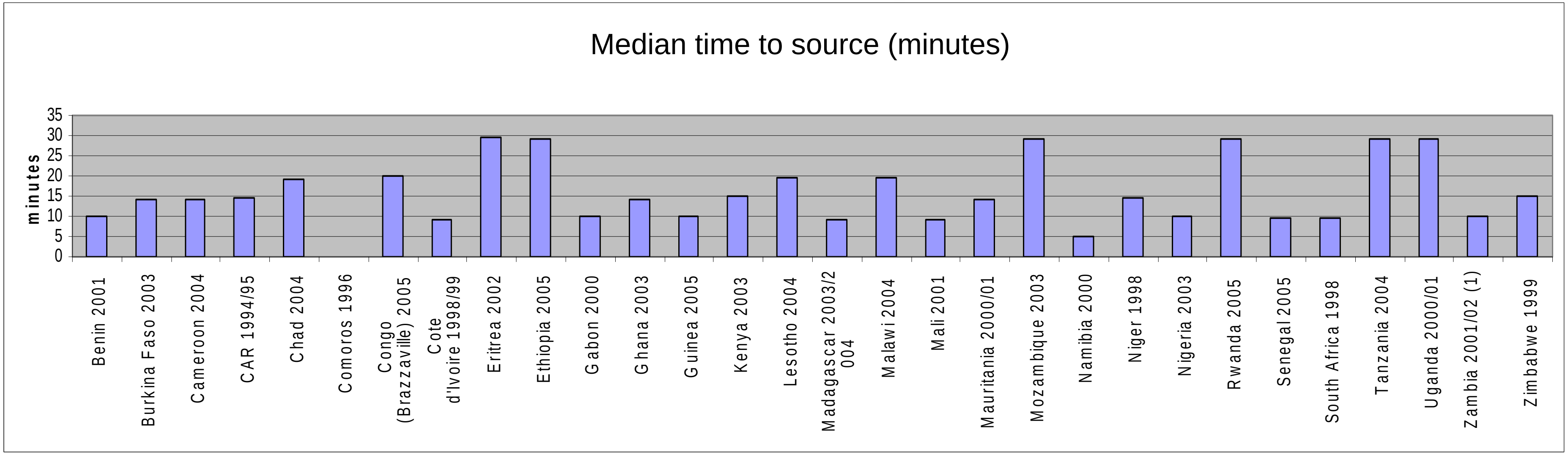
C.3 Market Mapping: Domestic+ time to source

While in South Asia, over 60% of households have water within 15 minutes (and median time to source 5 minutes), in sub-Saharan Africa, 30% of households have access to water within 15 minutes (< 500 m). Overall, there is much more variability in median time to source in sub-Saharan Africa. As distance increases, multiple uses of water will decrease. Transporting 200 liters/day takes 50 minutes at distance of 5 minutes RT and 200 minutes at a distance of 15 minutes RT.

A significant knowledge gap is a good understanding of how much water people are willing to haul to support productive activities.

Percent of households with access to water within 15 minutes roundtrip





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