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Financial and Economic Analysis of Ecological Sanitation in Sub-Saharan Africa

30 years wsp water and sanitation program

Richard Schuen

Introduction (1)

- Increasing interest in the potential of Ecological Sanitation (EcoSan)
- Increasing controversy about the viability of EcoSan at scale

School ecosan toilet, Kabale

The inside of a toilet chamber. Kabale

All pictures in this presentation are from Government of Uganda, Ministry of Water, Lands and Environment ,The Directorate of Water Development, Makerere University Department of Civil Engineering Documentation and Evaluation of EcoSan Experiences in Uganda, June 2005)

Introduction (2)

Aims, objectives and major features

- Financial and economic analysis taking into account financial and economic costs associated with construction and ongoing operational costs
- Data collection and analysis from various case studies
- Analysis of collected data in computer model
- Study results will be used by WSP to inform policy-makers and strategic programming in the sanitation sector about the financial implications of adopting different types of sanitation systems
- Research is done by field work, desk study, literature review

Focus of the Study

The study focuses upon the following types of sanitation technologies, which are really implemented on the ground:

- Ecological Sanitation - EcoSan
- Conventional on-site sanitation
- Conventional waterborne sanitation – Wastewater

Front and back views of model constructed - Uganda

Nutrient Fluxes and its Economic Costs and Benefits (1)

Proportion of nutrients in urine and feces (Earle, A, 2001. Ecological Sanitation. Water Web Management Ltd. www.africanwater.org/EcoSan_main.htm (accessed 12.04.08).

	Urine	Feces
Nitrogen	88%	12%
Phosphorus	67%	33%
Potassium	71%	29%

Nutrient Fluxes and its Economic Costs and Benefits (2)

Estimated calculations of yearly nutrient excretion per person

Country		Nitrogen kg/cap*year	Phosphorus kg/cap*year
Uganda	Total	3.4	0.5
	Urine	3.0	0.3
	Feces	0.4	0.2
South Africa	Total	2.5	0.4
	Urine	2.2	0.3
	Feces	0.3	0.1

(Jönsson, H. and Vinnerås, B. (2004). Adapting the nutrient content of urine and feces in different countries using FAO and Swedish data. In: EcoSan –Closing the loop. Proc. 2nd Intern. Symp. Ecological Sanitation, April 2003, Lübeck, Germany. P 623-626. (www2.gtz.de/EcoSan/download/EcoSan-Symposium-Luebeck-session-f.pdf

Modeling the Economic Benefit of Excreta Reuse

Generally high fertiliser prices in Africa, but

- excreta based (urine and feces) mixed fertilizer can produce the same benefits as nitrogen and mixed commercial mineralized fertilizers
- approach focuses on estimated yield increase

System Analysis

	CAPEX		OPEX	
	Financial	**Economic**	**Financial**	**Economic**
Household level	**Hardware**			
	Net latrine cost		None	
	Staff and labor costs			
	Cost of paying Laborers and Masons (and/or)	Cost of time involved construction	Cost of paying for someone to clean out the latrine (and/or)	Time involved in latrine „maintenance“
Project Implemen-tation Costs & Subsidies	**Hardware**			
	Potential costs associated with purchase of tools & equipment for latrine construction		None	
	Staff and labor costs			
	PM & promotion costs		Costs of ongoing PM and Promotion	

Financial and Economic Analysis (1)

- The main focus is upon the economic costs and gains associated with reuse of excreta and the NPV of financial costs
- Household is base unit for analysis (TACH)
- Costs and benefits frequently involve a transaction between the private domain (i.e. the household) and the public entity in the form of a subsidy in one direction or a tariff / payment for a service (such as pit empting or sewerage).
- NPV and IRR (only, where appropriate) are used for life cycle assessment

Financial and Economic Analysis (2)

Ranking of the Net Present Value (NPV) of costs and benefits will be used for option selection („Decision Criterion“)

Note:

An Internal Rate of Return (IRR) analysis will not be used in the financial analysis as it is only appropriate in situations where households pay an external agency for a sanitation service.

NPV formula:

$$NPV = \sum_{t=0}^{t=T} \frac{(B-C)}{(1+r)^t}$$

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Case Study Uganda
Case Study Area – Kabale town

FINDINGS ARE PRELIMINARY AT THIS STAGE AND HAVE TO BE VERIFIED AND TESTED FURTHER.

Case Study Uganda
Case Study Area – Kabale town (1)

- Approx. 40.000 inhabitants
- Situated in 1.800 – 1.900 meters altitude
- Main crops grown in households using EcoSan are potatoes (data from household interviews)

Case Study Uganda
Case Study Area – Kabale town (2)

- Approx. 500 EcoSan household toilets

  (initiated as Western Towns Water and Sanitation Project, by Austrian and Ugandan Govt., now WSDF)

- Approx. 300 households connected to sewerage network

- Other households (approx. 7.000) have conventional on-site sanitation (mainly PIT latrines)

Case Study Uganda
Case Study Area – Kabale town (3)

- Approx. 70% of EcoSan households reuse excreta by themselves
- No market for urine and feces (fertilizer)
- Additional crop is consumed at household level or sold to the market.

(Ref.: Government of Uganda, Ministry of Water, Lands and Environment ,The Directorate of Water Development, Makerere University Department of Civil Engineering - Documentation and Evaluation of EcoSan Experiences in Uganda, June 2005)

Case Study Uganda
Basic Household data

- Sample consists of 20 households.
- Average monthly income UGX 546.000 (US$ 336,00)
- Wide range within the sample

  (reported values range from UGX 100.000 to UGX 1,0 mln,)
- GDP per capita approx. US$ 560,00 p.a. against US$ 300,00 p.a. countrywide
- Average composition: 7.2 persons per household
- Different types of household business

Case Study Uganda
Definition of scenarios – base scenario

- The cost of an EcoSan facility is US$ 587,00.
- The cost of a on-site sanitation facility is estimated at US$ 550,00..
- We have assumed OPEX for the on-site option at US$ 25,00 per year per facility.
- For capacity building measure we have included a sum of US$ 30,00 per EcoSan facility.
- No subsidies are applied in either option.
- The market price for the main commoditiy remains at today's levels.
- Wages also remain at today's level.
- The agricultural conditions are average.

Case Study Uganda
Model input data –base scenario (1)

General

		Strong	
Land Tenure			3
Region (East or West Africa)		East Africa	1
Planning Horizon		10	years
Average people using facility		7,2	people
Local currency		Ugandan Shillings	
Conversion rate to 1 $		1626	Ugandan Shillings
Average productive land per household		1,1	Hectares
Local wage for 1 hour labor		100	Ugandan Shillings
Local wage for 1 hour labor		0,06	$
Financial Costing Factors			
Inflation Rate		5%	
Local level Interest Rate p.a. (used for Ecosan and On-site		22%	
National Level Interest Rate p.a. (used for sewerage)		18%	0,15
Economic Costing Factors			
Discounting Rate for NPV		10%	
Fertilizer			
% of defecation/urination outside of these facilities		20%	
Urine	Nitrogen produced	2,2	kg/cap/yr
	Phosporus produced	0,3	kg/cap/yr
	Nutrient Losses	20%	*spillage, etc.*
Feces	Nitrogen produced	0,3	kg/cap/yr
	Phosporus produced	0,1	kg/cap/yr
	Nutrient Losses	8%	
Retention period for humification		1	year
Health Benefits			
Economic Health Benefits		31,58	$/cap/yr (2000 prices)
Base Year		2008	
Average US Inflation Since 2000		2,5%	%/yr
Economic Health Benefits		277,04	$/facility/yr (base yr prices)

Cost Summary

	EcoSan		On-Site		Sewerage	
Asset Life (years)	10		10		50	
	Financial	Economic	Financial	Economic	Financial	Economic
Capex ($)	647	649	500	501	365	366
Opex ($)	0	12	0	0	43	43

Crop Production

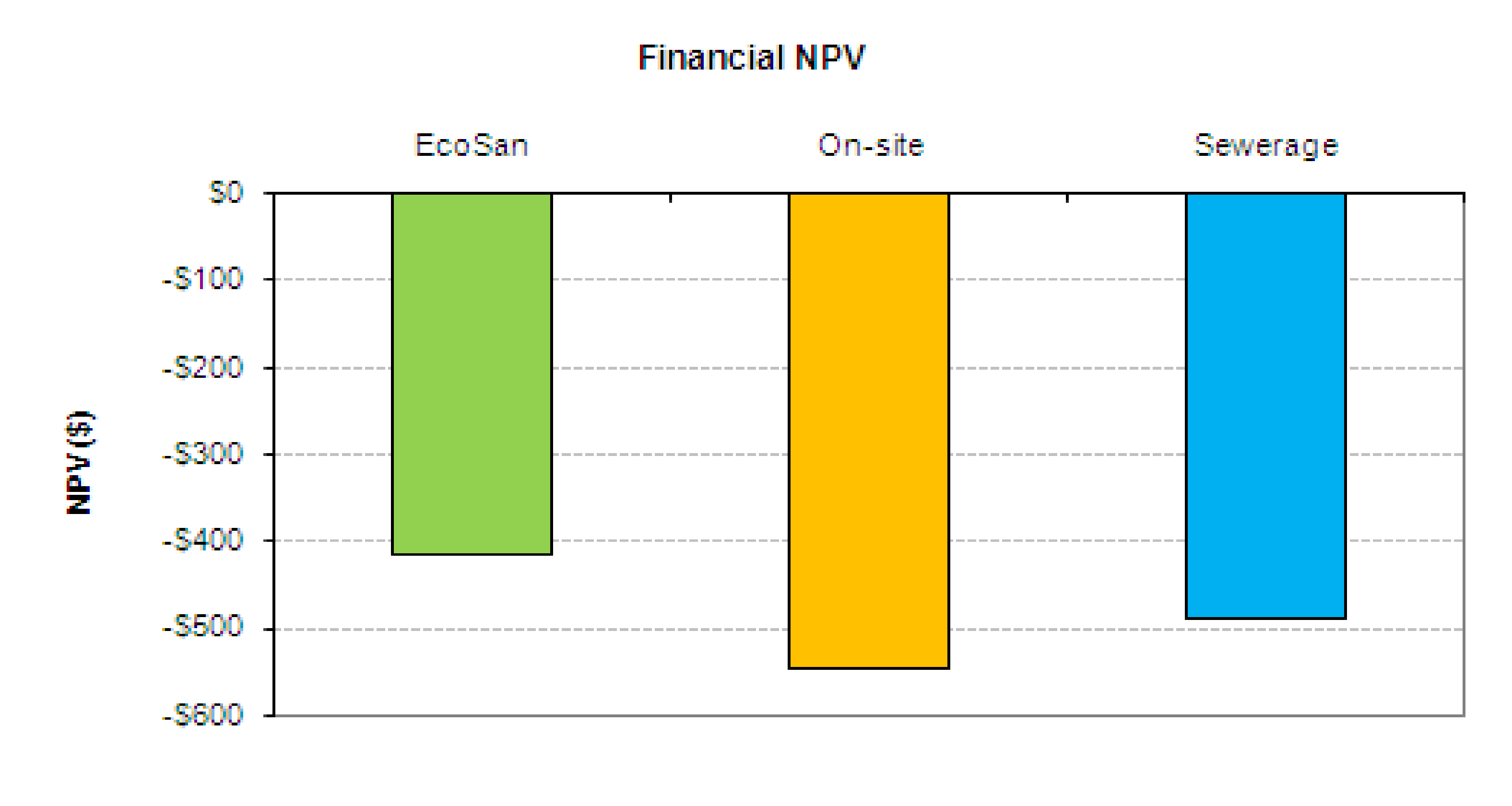
	Potato		
Main Crop			
Agricultural Conditions	Average		
World Market Price for Main Crop	290		
Local Price for Main Crop per kg	290	Ugandan Shillings	$ 0,178 $
% of crop realised	100%		

Fetilizer Produced		
Yield Response	12,00	kg output / kg Nutrient
Urine Fertilizer Produced	11,52	kg / yr
Faeces Fertilizer Produced	2,11	kg / yr
Total Fertilizer	13,63	kg
Max Fertilizer Application	100,00	kg / ha
	12,39	kg / ha

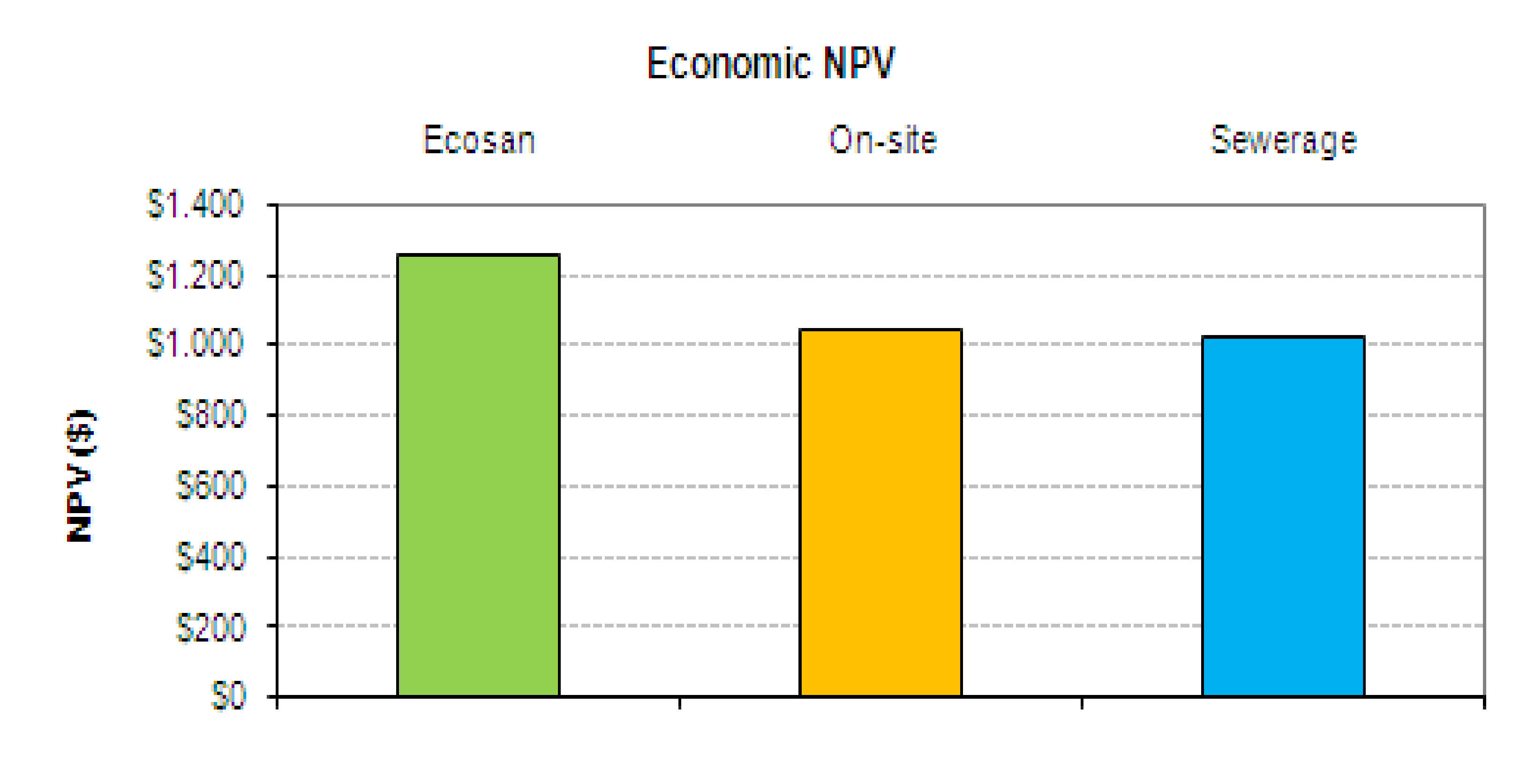
Additional Crops	163,59	kg

0,15 T/hectare
6,9 typical yield
2,16% increase

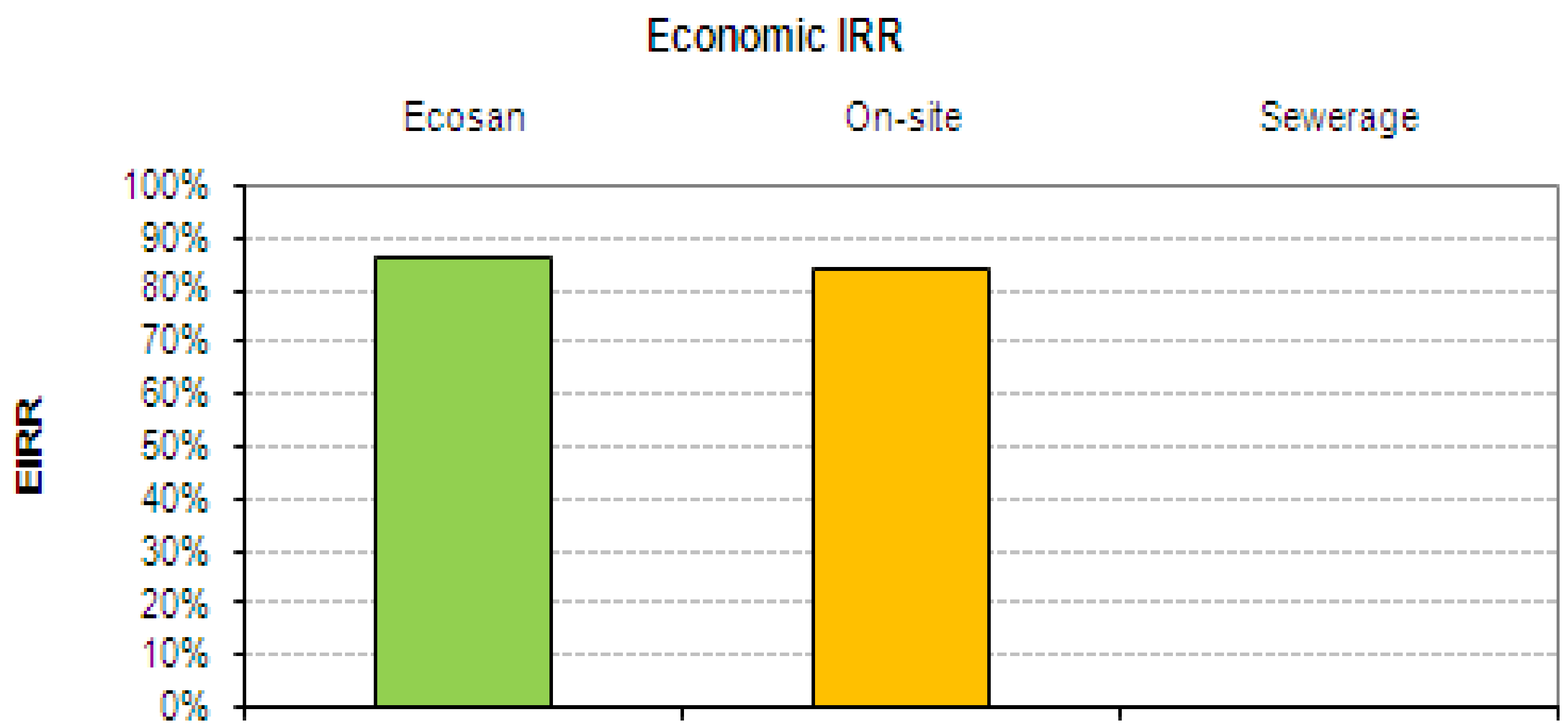
Case Study Uganda
Model results base scenario (1)



Case Study Uganda
Model results base scenario (2)



Case Study Uganda
Model results base scenario (3)



Case Study Uganda
Alternative scenarios

- Scenario 1:

  Introduction of a subsidy in the EcoSan option for CAPEX and capacity building measures.
- Scenario 2:

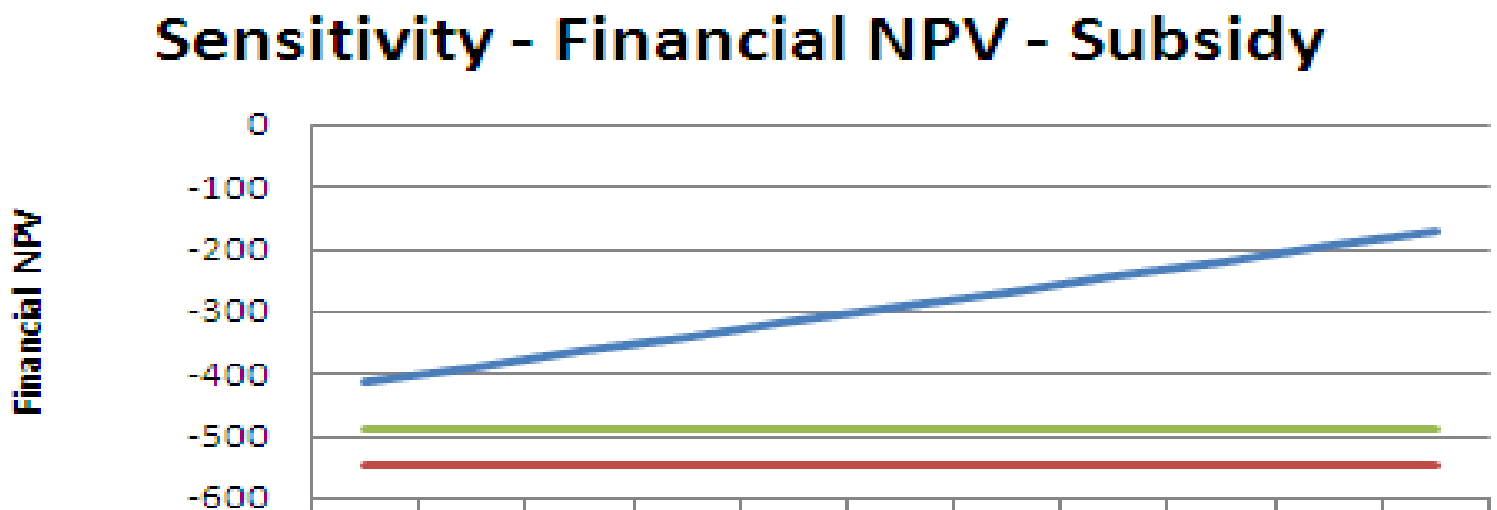
  Increase of the price for the main commodity.
- Scenario 3:

  Increase of the cost of labor.
- Scenario 4:

  Worsening of agricultural conditions.

Case Study Uganda
Model results – scenario 1

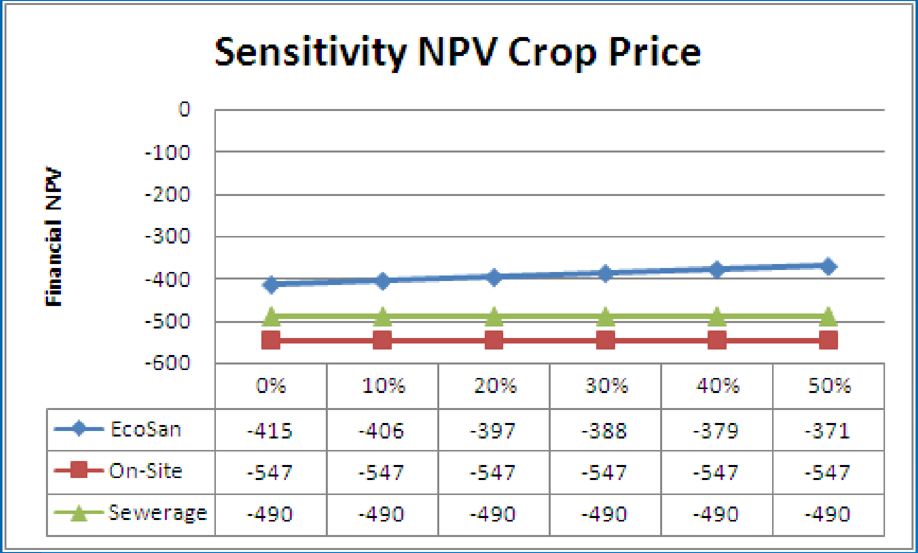
Subsidy in the EcoSan option for CAPEX and capacity building measures

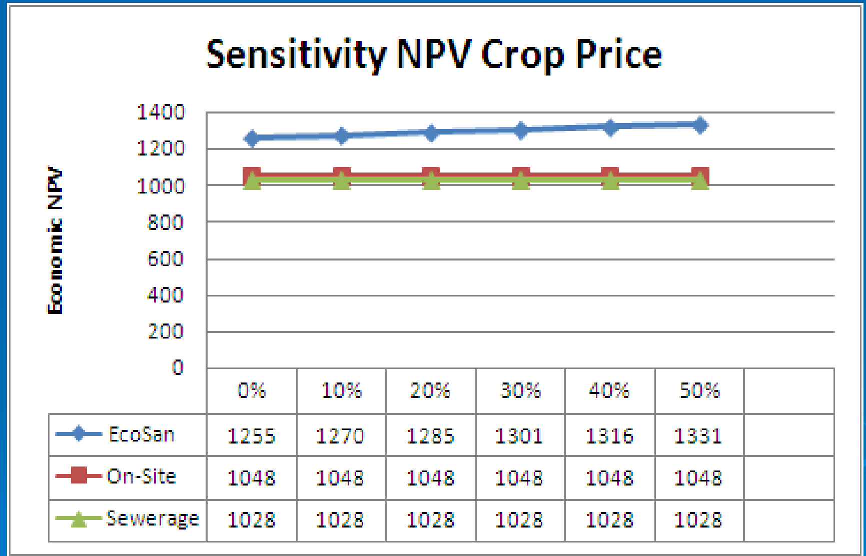


	0	30	60	90	120	150	180	210	240	270	300
EcoSan	-415	-391	-366	-342	-317	-293	-268	-244	-219	-194	-170
On-site	-547	-547	-547	-547	-547	-547	-547	-547	-547	-547	-547
Sewerage	-490	-490	-490	-490	-490	-490	-490	-490	-490	-490	-490

Case Study Uganda
Model results – scenario 2 (1)

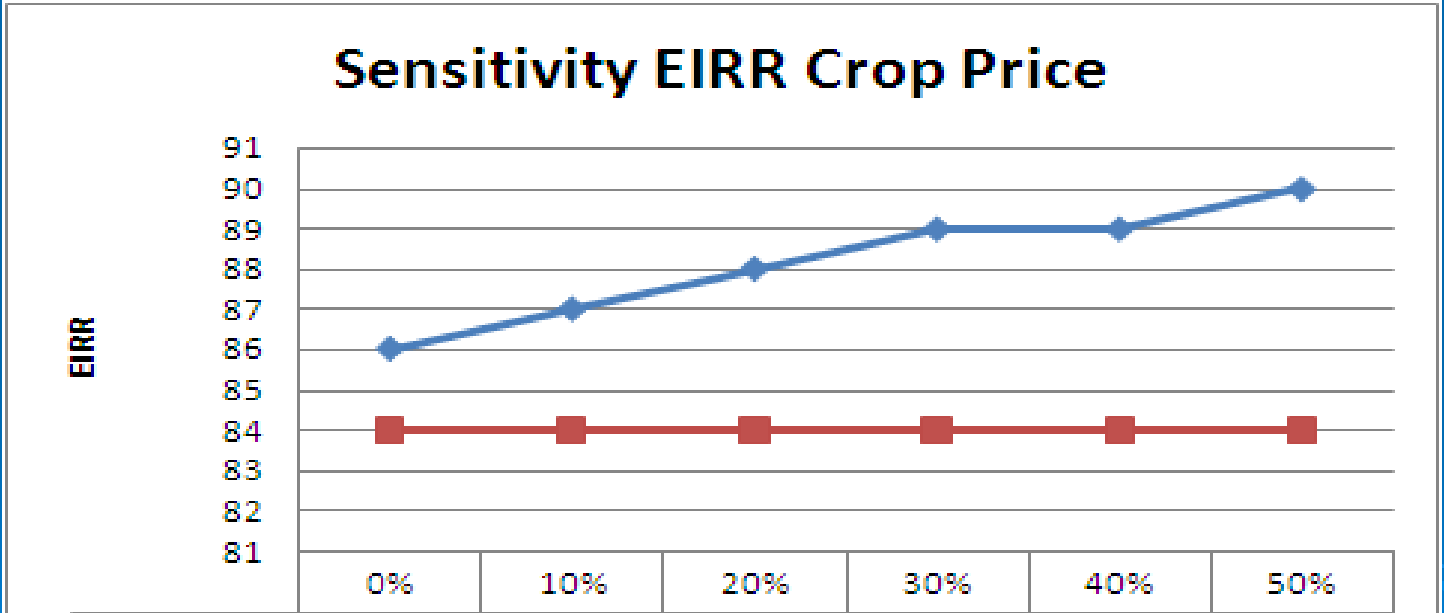
Increase of the price for the main commodity





Case Study Uganda
Model results – scenario 2 (2)

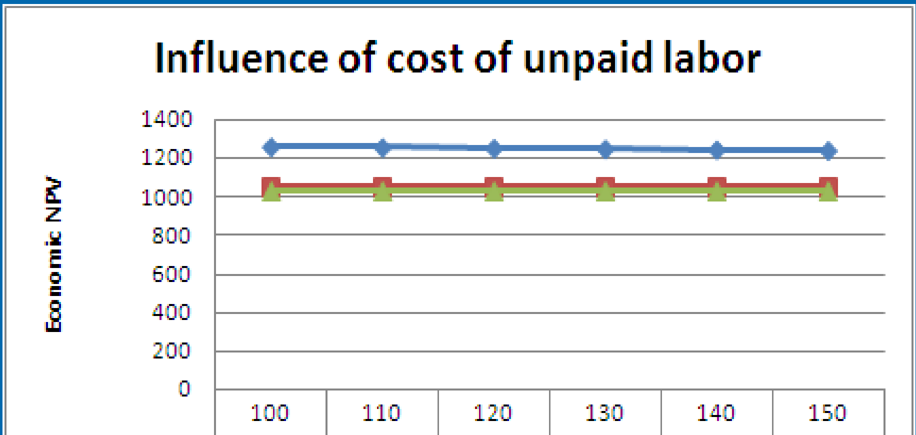
Increase of the price for the main commodity



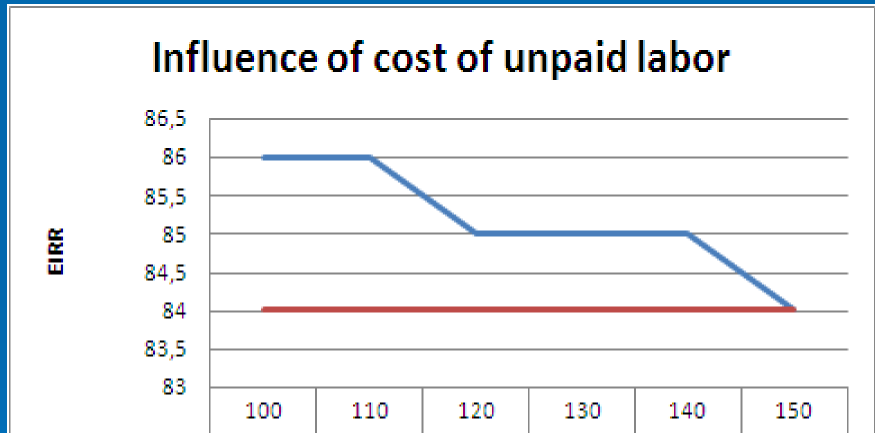
	0%	10%	20%	30%	40%	50%
EcoSan	86	87	88	89	89	90
On-Site	84	84	84	84	84	84

Case Study Uganda
Model results – scenario 3

Increase of the cost of unpaid labor



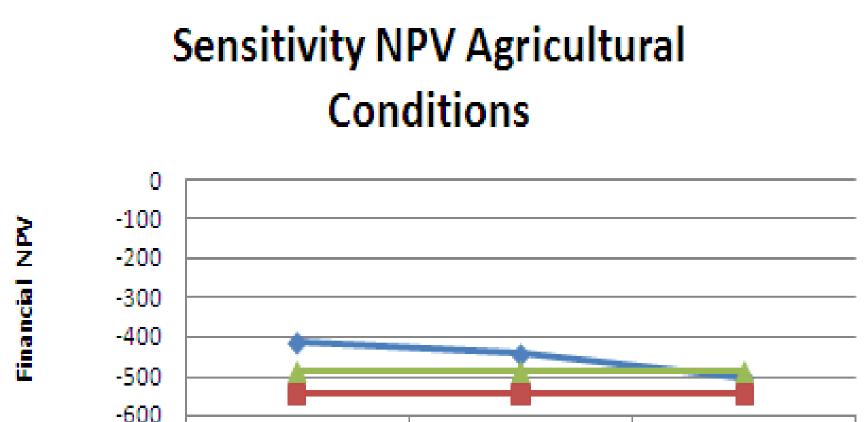
	100	110	120	130	140	150
EcoSan	1255	1251	1247	1243	1239	1235
On-site	1048	1048	1048	1048	1047	1047
Sewerage	1028	1028	1028	1028	1028	1028



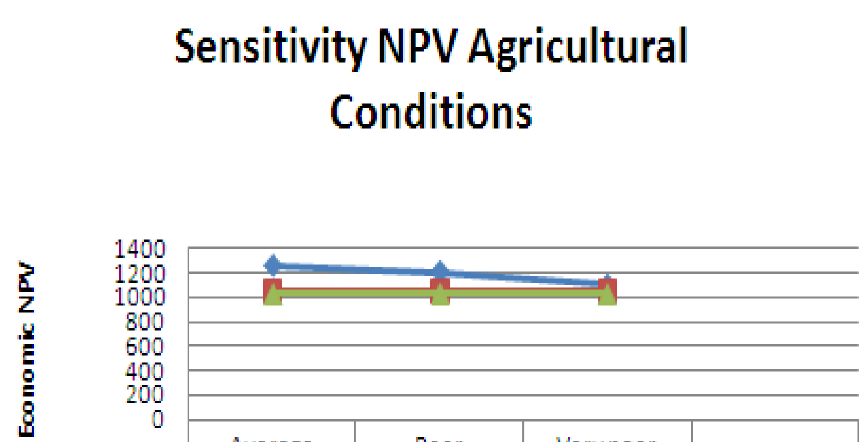
	100	110	120	130	140	150
EcoSan	86	86	85	85	85	84
On-Site	84	84	84	84	84	84
Sewerage						

Case Study Uganda
Model results – scenario 4 (1)

Worsening of agricultural conditions



	Average	Poor	Very poor
EcoSan	-415	-445	-505
On-Site	-547	-547	-547
Sewerage	-490	-490	-490

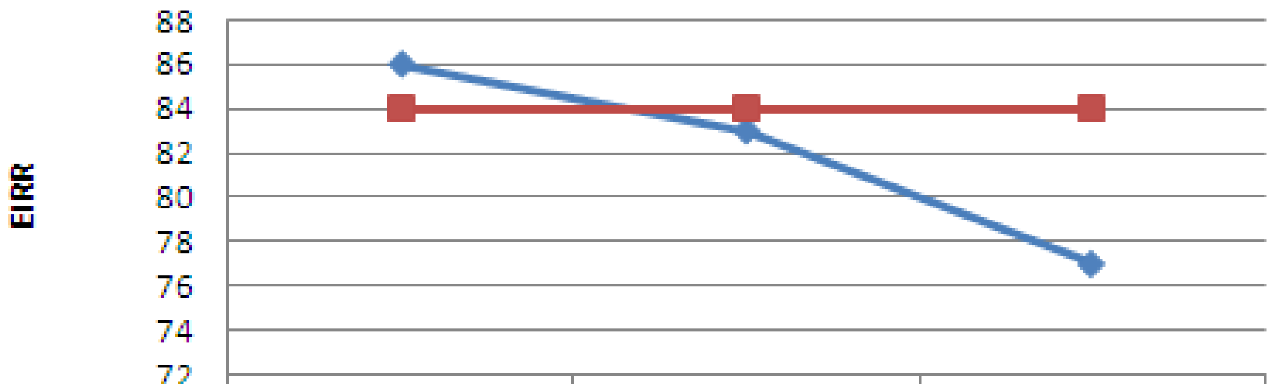


	Average	Poor	Very poor
EcoSan	1255	1204	1102
On-Site	1048	1048	1048
Sewerage	1028	1028	1028

Case Study Uganda
Model results – scenario 4 (2)

Worsening of agricultural conditions

Sensitivity EIRR Agricultural Conditions



	Average	Poor	Very poor
EcoSan	86	83	77
On-Site	84	84	84

Case Study Uganda
Preliminary conclusions (1)

1. At this stage EcoSan appears to be the best performing option by all three parameters in the base scenario ***under the current assumptions (a.o. availability of land for actual reuse).***

2. Not surprisingly, CAPEX have a significant impact. The lower the CAPEX, the better the performance of each option.

3. The introduction of a subsidy in the EcoSan option for CAPEX and/or capacity building measures makes this option more attractive. However, in principle this is true for the other options as well.

4. Also the OPEX have an impact on the overall financial and economic performance. This issue has to be investigated further, especially in the on-site option.

Case Study Uganda
Preliminary conclusions (2)

5. An increase in the price of the crops influences the performance of the EcoSan option. The net benefits can be achieved in both cases

(i) if the crop is sold on the market and

(ii) if the crop is consumed by household and purchases on the markets can be reduced.

In general, EcoSan lowers the impact of rising food prices on the household budget, since more consumption needs can be satisfied with “home grown” products.

Case Study Uganda
Preliminary conclusions (3)

6. The increase of the opportunity costs, in case of unpaid labor, has a negative impact on the EcoSan and on-site option. This impact is bigger in EcoSan, since more unpaid labor is involved. A drastic increase can even lead to equal EIRR in the EcoSan and the on-site option. However this has to be investigated further.

7. The agricultural conditions are a key factor when comparing the different sanitation options. Since the excreta reuse for agricultural purposes is a key factor in determining the performance of EcoSan, there have to be decent agricultural conditions. Low productivity gains can bring no benefit at all. The performance in terms of the EIRR can even be lower then in the other options.

Further research

- Case studies in South Africa and Burkina Faso
- Verification of data and assumptions
- Fine tuning of scenarios for analysis
- Local market for fertilisers for the on-site and EcoSan options

Thank you!

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30 years wsp water and sanitation program

Richard Schuen