

**7.4.3 Identification of measures for Rainwater Harvesting from Greenhouse tops**

Measures to overcome barriers and to enhance the deployment of RWHG are to be conducted on two main axes: i) increase the awareness of farmers and ii) ensure a sustainable agriculture land management. Barriers related to short land rental constitute a more general and historical problem in Lebanon, while barriers related to system cost-effectiveness cannot be changed.

For the first axis, efforts on different levels should be implemented, including service providers' sensitization, and research and development programmes improvement. This will overcome the absence of the technology on the market and ensure scientifically proven information diffusion to farmers.

For the second axis, the initiation of a land use planning zoning to preserve agriculture land will enable overcoming barriers related to land tenure, land availability and short-term rental.

The key barriers and their respective solutions are mentioned in Table 77.

**7.4.4 Cost Benefit Analysis for Rainwater Harvesting from Greenhouse tops**

The estimated costs mentioned below are extracted from the AgriCAL project (Agrical, 2012) document

and meetings with farmers (Sakr, 2012). Costs and assumptions are detailed as follow:

- Awareness raising - information transfer: USD 5,000.
- System Installation could be partially covered by Green Plan and be considered as public expenditure however these are site-specific and demand driven and cannot be accounted for at this stage.

Different scenarios are shown in Fig. 67 and Fig. 68:

- 100% pumping from ground water, in both high crop demand/low precipitation and low crop demand/high precipitation scenarios.
- 75% of Surface irrigation complemented by pumping in high crop demand/low precipitation scenario.
- 43% of Rainwater Harvesting from Greenhouse tops complemented either by surface water or pumping in high crop demand/low precipitation scenario.
- 100% of Rainwater Harvesting from Greenhouse tops in low crop demand/high precipitation scenario.

The deduced benefits are calculated by deducing only the cost of water from the revenue (USD 3,200/year/greenhouse).

Table 77 – List of barriers and measures to overcome them for RWHG

Category	Barriers	Measures	Stakeholders
Information and awareness	- Limited awareness. - Absence of dissemination.	Awareness campaign.	MoA, Green Plan, farmers, media
Institutional and organizational capacity	-Limited Research and development. - System ineffectiveness. - Limited quantity of harvested water.	Conducting research and development programmes on RWH on farm level, on different storage variances for: i) better cost effectiveness, ii) optimizing stored water use according to climate demand and iii) selecting crops according to storage capacity.	LARI Academic institutions
Market failure	Limited spread of Technology in market.	Integrating RWHG system within greenhouse infrastructures deployed by the service providers.	Service providers
Policy, legal and regulatory	Short term land rental due to inappropriate land tenure system; - Limited available land. - High cost of land rental. - Absence of land use zoning.	Initiating land use zoning process, namely to protect the remaining agriculture areas on the coastal zone, where most greenhouses are located.	MoPWT (DGUP), CDR, Municipalities

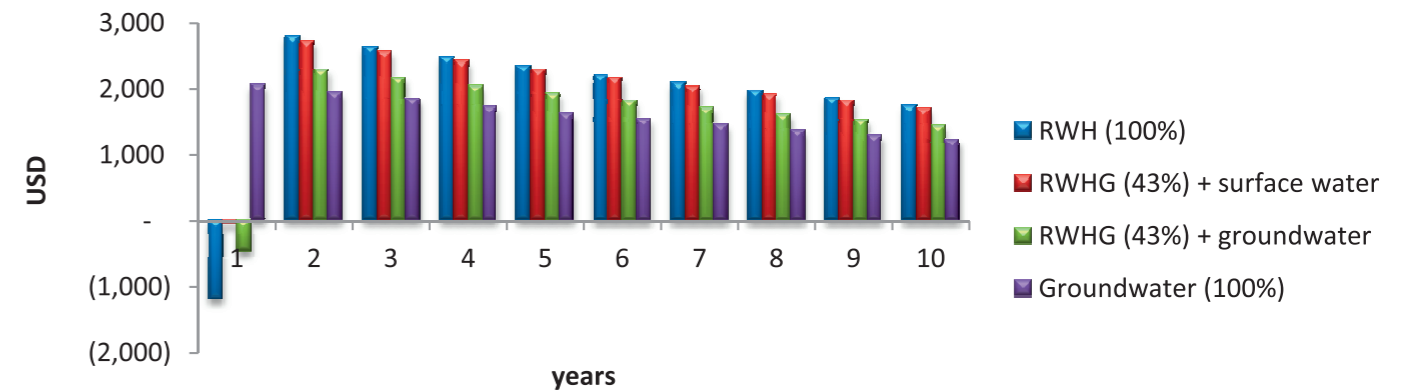


Fig. 67 - Discounted benefits over a period of 10 years for different water source scenarios

Source: Author's own design

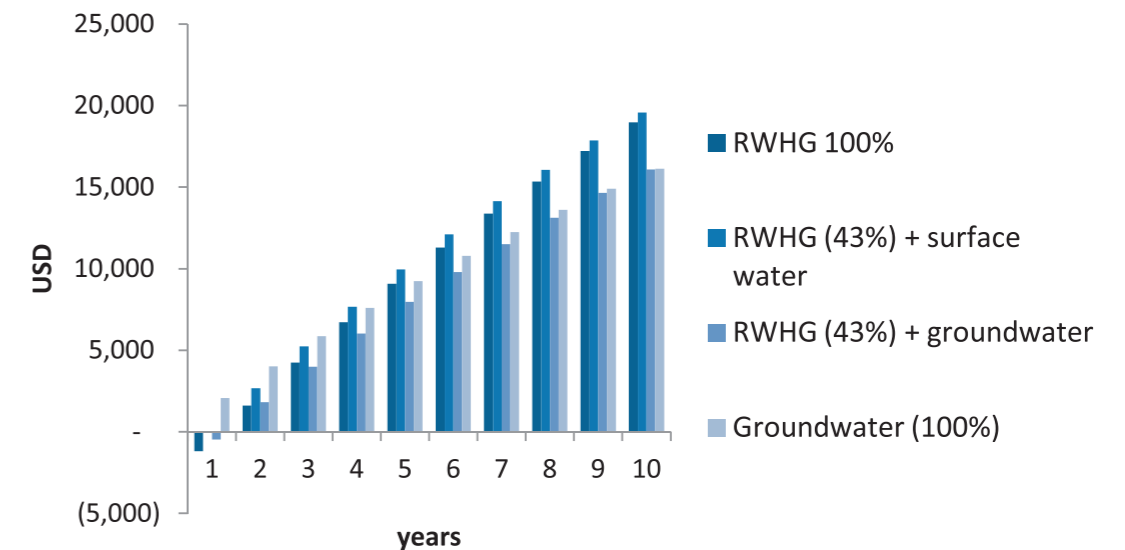


Fig. 68 - Cumulated discounted benefits over a period of 10 years from different water source scenarios

Source: Author's own design

Under all scenarios, RWHG is cost efficient to farmers, except if the farmer has a sustainable source of surface water of a standard quality all year round. Even if RWHG does not cover all the water demand, 43% of the water demand will keep the system cost-effective.

Beside the reduced costs from pumping, GHG emission is significantly diminished and the risk of water pollution and soil degradation is minimized if compared to other water sources. In addition, the farmer is more autonomous in terms of water supply and relies less on other fluctuating resources, which increases his resilience and reduces conflict risks among users. The farmer will preserve his water resources under future climate, which enables him to keep producing, and consequently sustain his revenue and food security.

Costs and benefits of RWHG are drawn in the figure below. From what is mentioned above, RWHG is

feasible whenever it ensures a minimum of 50% of plant water requirements. RWHG is not cost-effective in areas where surface water is available for free.

**7.4.5 Technology action plan for Rainwater Harvesting from Greenhouses**

**Target for technology transfer and diffusion**

The target of the action plan is to be able to collect rainwater from 25,000 greenhouses (standard single span), between 2015 and 2025 considering that 50% of the total cost is subsidized.

The technology action plan for the diffusion of the Rainwater Harvesting from Greenhouses technology is presented in Table 78.

**Assumptions for Rainwater Harvesting from Greenhouse tops**

- An annual average rainfall of 600mm are necessary to cover from RWHG, water demand for the crops inside a greenhouse.
- A storage unit can be used for irrigation before being totally filled, which supposes that a storage unit could be filled twice a year.
- The annual demand of a standard greenhouse of 400m<sup>2</sup> is between 360 and 550m<sup>3</sup> depending on the crop type and microclimatic conditions.
- The collected water from a standard greenhouse is 240m<sup>3</sup> for an area with average precipitations of 600mm/year, up to 400m<sup>3</sup> in areas having 1,000mm/year of rainfall.
- The storage unit of a greenhouse should have a minimal capacity of 125m<sup>3</sup> (half of the annual water demand) in exploitations with limited land available.
- Cost of storage unit is USD 16/m<sup>3</sup> in earth reservoirs. The economy of scale is not accounted.
- Cost of drainage system (USD 30/m) or USD 1,200/greenhouse. This can be reduced by half in "Chappelle" system. To add USD 180/greenhouse for service providers' technical assistance.
- Current maximal cost of land rental (value of area dedicated for earth reservoir): USD 1/m<sup>2</sup>/year. The economy of scale is not accounted.
- Pumping cost is USD 1.833/m<sup>3</sup> at 500m altitude, on a deep water Table.
- In this exercise we consider that the price is the same even next to sea level where water Table is shallow, in order to value the poor quality of water (salinity).
- Surface water annual fees in a common irrigation scheme are USD 100/year. We assume that this water is rarely available all year round due to several reasons (water shortage, leakage problems, water pollution, etc.).
- A greenhouse produces 4 tonnes of crops, sold at USD 800/tonnes, generating a revenue of USD 3,200/ha/year.

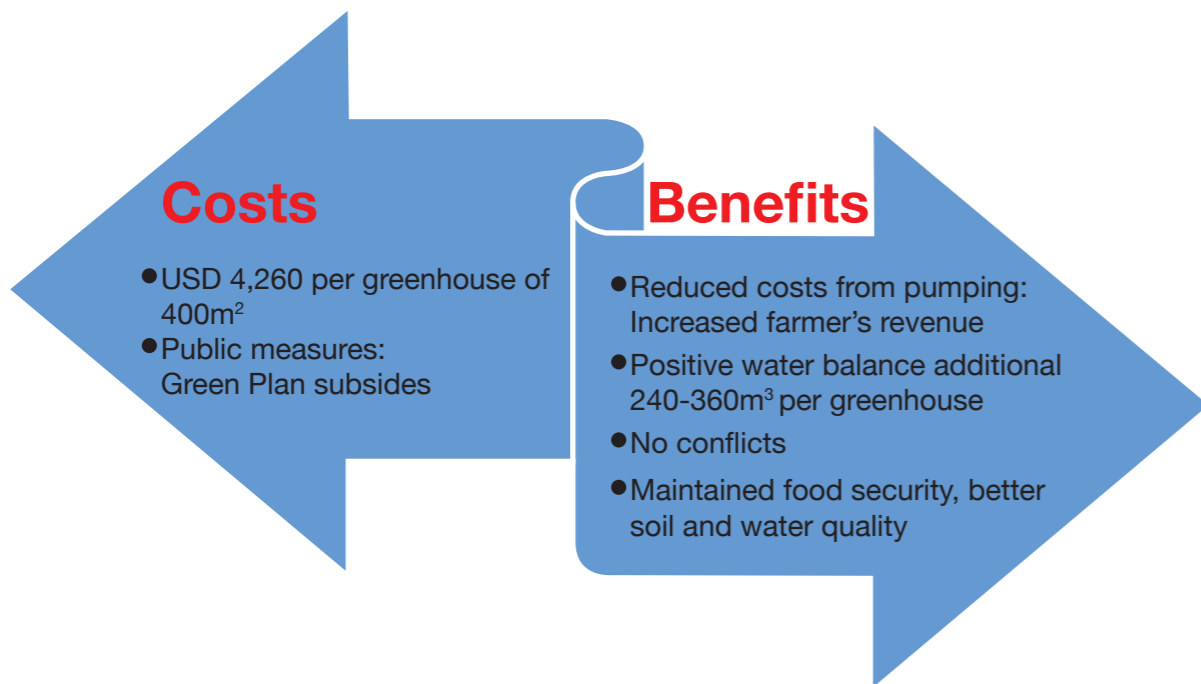


Fig. 69 - Cost and Benefits of RWHG

Source: Author's own design

Table 78 - Technology Action plan for Rainwater Harvesting from Greenhouses

Measures	Priority	Objective	Responsible parties	Beneficiaries	Time scale	Monitoring and Evaluation indicators	Estimated cost (USD)	Donors
Organizing awareness campaign through seminars, field visits and TV programmes	1	To disseminate the information and promote RWHG to farmers.	National experts, MoA extension service, media, Green plan	Service providers, technicians, farmers	Medium term	Number of farmers demands at Green Plan for installing RWHG system.	5,000 for 3 seminars, 3 field visits and a TV program.	World Bank Adaptation Fund GEF IFAD FAO Islamic Bank EU USAID Kuwaiti Fund Italian, Spanish Cooperation.
Conducting experiments on farm level, on different storage variances	2	To increase information about the optimal use of RWHG for better resilience to climate, better water efficiency and optimal cost effectiveness.	Research centers and academic institutions	Farmers	Medium term	Number of experiments conducted and number of publications; Increase in the number of greenhouses adopting RWHG according to the crop; calculation of water efficiency for different crops in greenhouses adopting RWHG.	15,000 to conduct research at farm level: a one-year full study for 3 type of crops in two climatic zones (two researchers plus inter students).	
Integrating drainage system in the design of greenhouse	2	To avoid market failure and reduce the cost of the infrastructure.	Service providers	Farmers	Short term	Number of greenhouses produced with drainage system by service providers.	0	
Initiating land use zoning process	1	To protect the remaining agriculture areas on the coastal zone, where most greenhouses are located.	DGUP	Farmers, municipalities	Long term	Number of municipalities having land use zoning agriculture surface preserved on coastal areas.	0	
Increasing Green Plan budget for implementing water reservoirs for RWHG	2	To avoid budget constraints at farmers level to implement RWHG.	Government, Green Plan	Green Plan, farmers	Medium term	Funds allocated for water reservoirs for RWHG; number and their capacity of achieved reservoirs.	2,000,000 annually covering 50% of the cost of reservoirs with a capacity of 500,000 m <sup>3</sup> .	