ICARDA
Science for resilient livelihoods in dry areas

JULY 2020

POLICY BRIEF **2020/001**

Enhancing a Traditional Water Harvesting Technique in Jordan's Agro-pastoral Farming System

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Background

Water scarcity restricts agro-pastoral farming systems, and thus the development and economic growth of arid environments' communities, which face several challenges that are interconnected with water scarcity including land degradation, low productivity, and food insecurity. Providing sustainable water harvesting technique (WHT) is one option to ensure efficient use of scarce and fragile resources; to restore degraded lands in drought-prone areas, and to expand income generation opportunities and improved livelihoods.

What this Policy Brief is about

This Policy Brief draws lessons from research conducted by the International Center for Agricultural Research in the Dry Areas (ICARDA) and the National Agricultural Research Center (NARC) in Jordan, focusing on the development and monitoring of a scientific-driven WHT called "*Marab*[1]" in a participatory approach with the local community.

This Policy Brief has been developed for policymakers at national and local levels of government to highlight lessons learned and provide recommendations for policy, while also highlighting the principles of an effective adaptation and coping strategy to re-establish the productive functioning of Jordanian *Badia*[2] environments. The Brief also identifies how investing in *Marab* at the community level could improve the livelihoods of rural households and communities in the *Badia*, where water scarcity, land degradation, and food insecurity are widespread.

Box 1: Key messages

- An appropriate WHT for agriculture, such as *Marab*, can contribute to both poverty alleviation and climate change adaptation in agro-pastoral farming systems.
- Community and geographical contexts much be considered when reviewing the anticipated benefits of implementing *Marab*.
- The *Marab* innovation could enhance and sustain a range of various ecosystem services such as water purification, retention of sediments, enhancement of soil fertility, increased land cover, and reduction of downstream flooding to cities and villages.
- Economic and financial indicators suggest that this WHT approach, when implemented at the community level with barley, is profitable and cost-effective. This would contribute to secure fodder crops for small livestock keepers and at the same time also provides acceptable quality grain for human consumption.
- Given its profitability, it is recommended that the Jordanian government increase public investment in implementing *Marab* to continue to develop new pathways to raise water productivity, and production of fodder crops, and livestock products.

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1 *Marab* is an ancient and simple concept: the floodplain levelling and dam and spillway-based intervention distributes excess runoff received from upland watershed areas, generated during erratic rainstorms, over the downstream flatlands, and thus enhances local water availability for enhanced crop production. ICARDA has been working to optimize this concept through advanced land suitability assessment and design considering diverse local environmental factors. The upgraded *Marab* layout allows for optimized water collection, deep infiltration and soil water storage for targeted field crop support – considering downstream water requirements – and, therefore, sustainably embedding the *Marab* agro-pastoral technology into basin water management. Locally, the *Marab* helps dryland farmers to extend growing windows, raise productivity, and reduce pressure on fragile resources.
2 It is an area known to Jordanians as "al-Badia" (pronounced "BAD-yeah") — a classical Arabic word meaning both "arid area" and "the place where the Bedouin come from".

WHTs in Jordan's *Badia*: An appraisal

WHTs have recently gained prominence, especially in agro-pastoral farming areas and water-scarce countries. However, before applying WHTs to farming systems there is a need to identify barriers to implementing them effectively and enhancing rural communities' awareness and acceptance of these technologies with the support of rigorous policy and institutional mechanisms. An appraisal on the key advantages for adopting these innovations reveals that the first and foremost advantage is conserving water and soil resources. In dry areas, adopting WHTs diminishes unproductive evaporation from the bare surface, excessive surface runoff and consequential flooding, and sediment transport downstream, and helps groundwater to be recharged and preserved. WHTs therefore also enhance soil moisture and vegetation growth. These potential ecosystem services would be further improved if WHTs were coupled with well-planned rangeland and grazing management strategies in an integrated watershed context. Therefore, to scale up WHTs to land and water users, decision-makers at different levels must tackle several challenges:

- Inadequate public investment resources to develop new WHTs that raise total productivity of water, crops, and animal production, especially in the Jordanian *Badia*.
- Inefficient public-private partnerships and lack of common vision and effective coordination, perception, and assessment of generated benefits of ecosystem services to promote and engage farming communities in water harvesting activities and innovation.
- Landholdings in the Jordanian *Badia* are undergoing fragmentation, thereby accelerating the pace of degradation and constraining agricultural development.
- Low adoption rates of proven WHT practices and limitations of farmers technical knowledge, resources, and their involvement in the innovation system.
- Lack of effective policy instruments and mechanisms, strong institutional options for extension services, technical assistance, training, and capacity building that facilitate the adoption of WHTs in a participatory manner.

The *Marab* – An adaptation innovation tool for Jordan's *Badia* and arid areas

Water-harvesting practices, which capture and concentrate surface runoff for a crop can help to re-establish the productive functioning of Jordanian *Badia* environments. In Jordan's *Badia* (*Al Majeddyeh*), ICARDA and NARC implemented an improved promising technology – the *Marab* – as a strategy for sustainable land and water management in ago-pastoral farming system areas, focusing on the adaptation of this innovation with the aim to ensure efficient use of scarce and fragile resources; to restore and reverse degraded and drought-prone areas, and to expand income generation opportunities for improved livelihoods.

Figure 1. Marab enables high yield crop production (barley) under local average annual rainfall of 130 mm (2020).

Marab experimental setup in *Al Majeddyeh*

The *Marab*, established near *Al Majeddyeh* village, is an integral part of an agro-pastoral watershed. The integrated watershed rehabilitation approach includes several upland measures mimicking healthy rangeland hydrological response through e.g. micro water harvesting and plantation of native shrub seedlings, as well as localized and high-yield *Marab* establishment and agro-hydrological management downstream. Thus, the *Marab* enhances the overall productivity and health of the watershed (e.g. livestock fodder production), and rehabilitation of degraded land simultaneously, especially when coupled with sustainable nature-based rehabilitation of vast upland areas. The experiment recorded rainfall-driven soil moisture and surface runoff processes, which eventually yielded water to downstream areas (*Marab*), and carried out agronomic assessments, including land cover and barley yield monitoring. Local community inclusive monitoring merged with advanced hydrological modelling eventually support the water balance assessment as well as *Marab* (water) productivity analyses, which serve the evidence based out-scaling.

Environmental benefits and services from the *Marab*: Categories and characteristics

The valuation and assessment of environmental benefits associated with implementing the enhanced *Marab* innovation provide encouraging justification for public investment in scaling-out of these techniques in the dry areas of Jordan, and consequently their replication in other similar contexts, both locally and globally. These benefits include food (provisioning), carbon sequestration (regulation), recreation and spiritual values (cultural), among others. Such benefits validate the need for the wide dissemination of this technology:

- Enhanced dryland hydrology: interception, retention and buffering of surface runoff; increased soil water storage for an extended agricultural season and occasional deep infiltration (potential groundwater recharge) of excess soil water.
- Increased biomass, nutrition through grain production, and extended vegetation cover through prolonged growing seasons.
- Enhanced support and regulation of ecosystem services, such as photosynthesis and carbon storage, though increased biomass and cover.
- Interception of sediments and bio-residues from the uplands for better soil health: fertility and soil structure.
- Adaptation to climate change through bridging of intra-seasonal dry spells and retention of flood events – and protecting downstream infrastructure.
- Applied in a watershed context: enabling large areal land rehabilitation (through high yields at the *Marab* location, enabling the withdrawal of ineffective upland agriculture activities such as ploughing for winter barley cultivation), provides plentiful ecosystem services including the improvement of biodiversity, native habitat quality, etc.

Box 2: Economic and financial viability of *Marab*: Enterprise budget indicators

- Scenario I: 10-year life cycle of *Marab* planted with barley
  - CBR = 1.64
  - IRR = + 36%
  - PBP = 2 years
- Scenario II: 20-year life cycle of *Marab* planted with barley
  - CBR = 1.28
  - IRR = + 20%
  - PBP = 2 years

Economic and financial viability of *Marab*: Enterprise budget indicators

To analyse the economic and financial viability of the enhanced *Marab* innovation, the research teams deployed the enterprise budget tool. This tool provides estimates for returns, costs, and net returns associated with crop-production activities (i.e. barley in this case). The data revealed that the internal rate of return (IRR) of planting barley with this WHT was 36% and 20%, for a life cycle of 10 and 20 years respectively. IRR is an important indicator which determines the validity of *Marab* by calculating when it exceeds the opportunity cost of capital. It appears that under the two scenarios (10 and 20 years), IRR indicators exceeds the opportunity cost of capital[3]. The analysis also determined that the Net Present Value (NPV) of cultivating barley using *Marab*, at a 6% discount (or interest) rate, was 39.74 JD[4] ha^{-1} under a 10-year life cycle of *Marab* and 82.73 JD[4] ha^{-1} under a 20 years life cycle. It is evident from these results that considerable increases in NPV from production of barley are obtained by considering a 20 years life cycle for this WHT. The overall Cost Benefit Ratio (CBR) of planting barley is 1.64 under scenario I (10 years) and 1.28 under scenario II (20 years). This indicates that the costs could rise by 64% before the benefit-cost ratio would be driven to 1. Therefore, the result shows that the performance of *Marab* is good under both scenarios, with a small advantage if the life cycle of the innovation is shorter.

Finally, the research shows that there is also an acceptable break-even point for investment in the technology which would occur in year two. After this initial Pay Back Period (PBP), there would be some ongoing costs, but increased adoption of the technology would reap the benefits.

Policy recommendations and strategic actions

These findings have considerable relevance for agricultural policies in Jordan and other water-constrained countries. The applied technology (*Marab*) gives strong evidence to the role of the research for development in supplying this type of technology to sustain agriculture and enhance livelihood strategies in arid zones and accelerate growth in *Badia* communities in Jordan. The assessment indicators of this technology suggest that it is economically viable, socially acceptable, and environmentally sound. Such Indicators provides a means of valuing water that considers not only its marginal contribution to the final output (i.e. barley) but also the opportunity cost of capital to deliver water to produce crops (i.e. barley). This opportunity cost could be high if public funds were used to invest in the technology.

At the national level, the scaling out of this innovation on a large scale could reduce the value of barley imports. It is estimated that implementing 1,000 *Marab* in rangeland and/or rainfed agroecosystems with 10 ha surface area each, and with an average production of 5 t/ha of barley, could reduce the total value of barley imports by 5.6% per year. Suitable areas for *Marabs* in Jordan can be identified using geospatial information and incorporating the knowledge of biophysical

3 The opportunity cost of capital is normally the interest rate on borrowed capital that is available in the economy at the time project implementation (6%, in this case).
4 JD: Jordanian Dinar (1 JD=1.41 US$).

parameters/variables, and the improved ecosystem services obtained from the site in Al Majeddyeh. This could be achieved by:

- Providing greater political and institutional input into this technology.
- Implementing public (funding)-private (construction of the systems) partnerships, thereby enhancing the implementation and adoption of *Marab* across Jordan's *Badia* areas.
- Involving rural communities and increasing their knowledge and perception of the merits of this innovation through better access to technical information, know-how, effective extension delivery system, credit services, and training.
- Including *Marab* within the government's development agenda for integrated land and water management, and climate action plans.

Acknowledgements

This Policy Brief was elaborated as part of a research collaboration agreement between the International Center for Agricultural Research in the Dry Areas (ICARDA - https://www.icarda.org) and National Agricultural Research Center (NARC - http://www.narc.gov.jo) in Jordan, undertaken within the project "Strengthening Innovation and Technology Adoption towards Sustainable Agricultural Productivity in Arab Countries" funded by the Arab Fund for Economic and Social Development (AFESD – http://www.arabfund.org). The authors would also like to express their gratitude to the people of the village of Al Majeddyeh who provided unstinting cooperation and shared their experiences and knowledge for the purpose of this brief.

Further reading

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Web-links

- Enhancing a traditional water-harvesting technique | ICARDA. (n.d.). Retrieved July 1, 2020, from https://www.icarda.org/media/news/enhancing-traditional-water-harvesting-technique.

Box 3: Lessons learned

Key lessons have emerged from experiences in employing *Marab*. Consideration of the complexity of the *Badia* agro-ecology context that faces challenges related to water scarcity, land degradation, low productivity, and food security-related issues, the diversity of impacts must be central (from different perspectives) to the application of any technology for adaptation in these agro-pastoral farming systems

- ***Lesson 1***: The use of a meso-catchment WHT – *Marab* – in the arid zones must consider the complex systems that encompass interrelated issues (grazing, community growth, the common use of the *Marab*, etc).
- ***Lesson 2***: Community and geographical contexts much be considered when reviewing the anticipated benefits of implementing *Marab*. These benefits and associated costs should be computed comprehensively to certify the functionality and sustainability of the technology after its introduction at scale in other similar local and regional contexts.
- ***Lesson 3***: Farmer engaged with this WHT can be encouraged through the creation of community-based watershed management. This will allow for more coordination, better coherence, and effective use of resources (land and water) which lead to support the ecosystem and economic (barley and sheep production) functions of this WHT.
- ***Lesson 4***: Community-driven sustainable management could be a critical nature-based solutions initiative to sustainable development challenges providing comprehensive knowledge management, (for other uses of the technology such as fodder crops, cereal grains, legumes, etc.), transfer, and diffusion of the WHT for adaptation and replicability in other similar contexts.

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ISSN 2708-8081
00120
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