Rehabilitation of degraded hillslopes of agro-pastoral areas through a mechanized in-site water harvesting technique and out-planting of native plant species

An exploratory assessment of the Scaling Readiness of a revegetation innovation to restore degraded hillslopes in the drylands.

An innovation of the International Centre of Agricultural Research in Dry Areas (ICARDA).
This assessment is carried out by the Monitoring, Evaluation, and Learning team (MEL) of ICARDA.

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ICARDA
Science for resilient livelihoods in dry areas

MEL
monitoring evaluation and learning

Innovation at a glance

Revegetation measure to restore degraded hillslopes in dry areas

Environment

Jordan

- degraded land (rangeland ecosystem – Badia area)
- low rainfall areas (less than 200 mm annual rainfall)
- soil depth of >30 cm
- land use: grazing- rangeland
- land cover < 30% of vegetation cover
- slopes between 3% and 15%

The Goals

13 CLIMATE ACTION

15 LIFE ON LAND

17 PARTNERSHIPS FOR THE GOALS

Working principle

1. Plough pits along the contours to collect rainwater run-off.
2. Plant native shrub seedlings in the pits.
3. Shrubs are nourished by the collected water.
4. Undertake sustainable land management and grazing.

=> These lead to improved ecosystem services (eg., runoff and soil erosion rates, soil moisture content, plant growth, biodiversity, and soil health).

Advantages and Disadvantages

PROS

- ✓ Land revegetation (using local native plant species)
- ✓ Improved opportunities for native and rare plant species' upgrowth
- ✓ Increased milk quantity and quality production.
- ✓ Improved livelihoods

CONS

- Precision design (e.g., pits dimensions and spacing)
- Expensive inputs
- Difficult to reach farmers
- Lack of financial support
- Initial grazing restriction

Partners

- Government
- Agro-Pastoralists
- Local CBOs

Donors

1. Background:

Source: WOCAT

Jordan's arid climate with limited rainfall greatly challenges agricultural production and vegetative growth. Land mismanagement exacerbated by climate change has degraded the lands alarmingly. The International Centre of Agriculture in Dry Areas (ICARDA) has been researching ways to cope with these problems. Water harvesting is a way to revitalize the land and its ecosystems. In 2016, ICARDA introduced mechanized micro water harvesting based on breaking up the crusted and compacted soils and digging pits that foster the capture, retention, and/or the deep infiltration of surface runoff generated during heavy rainfall events. The micro water harvesting pits store water and provide soil moisture to out-planted shrub seedlings and emerging seeds, thus boosting the development of resilient vegetation patches towards the eventual rehabilitation of degraded rangelands.

This technology was used in a watershed context close to Al Majeddyeh village in the Middle Badia zone, approximately 30 km southeast of Amman. The climate is arid and warm (Palmer, 2013). The average annual rainfall is around 130 mm. The natural environment is classified as steppe, Bsh in the köppen classification. The human environment is characterized by semi-nomadic agro-pastoralists living in villages around the watershed, such as Al Majeddyeh village. Badia is home to 85% of the country's livestock (Haddad et al., 2022).

The purpose of the technology is to break the land degradation cycle by retaining and encouraging deep infiltration of surface runoff, which supports native vegetation growth. The stored soil moisture boosts the growth of out-planted shrub seedlings and emerging local seeds towards healthy and resilient vegetation patches. Over time, the plowed pits degrade, but vegetation takes over the dryland hydrological functions of rainfall interception, runoff deceleration, and fostering infiltration (See Figure 1). The developing shrubland provides various ecosystem services, predominately fodder for livestock of local agro-pastoralists.

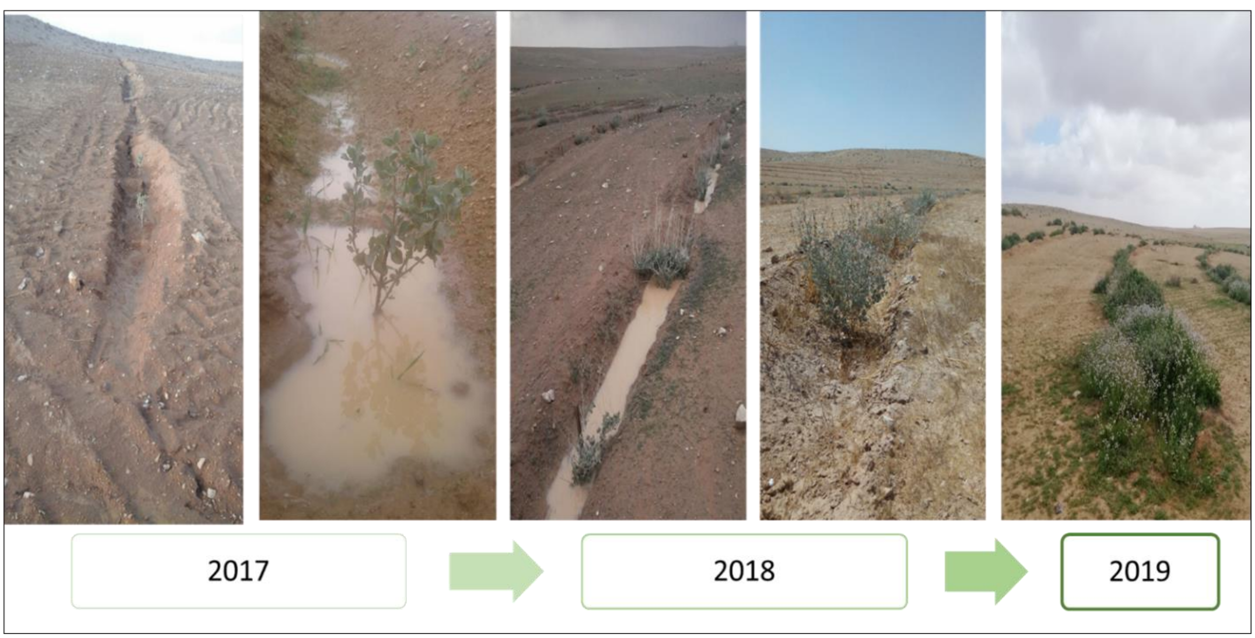


Figure 1: Progression of vegetation growth along Badia's Al Majeddyeh village watershed from 2017 to 2019

Implementation is done by plowing the field to create the pits (Figure 2), where native seedlings (either Atriplex Halimus, Retama, or Salsola) are planted, which are well suited for the climate. The land is then limitedly grazed for two years. This implies retaining certain resting areas for a period of time so that vegetation cover can naturally expand.

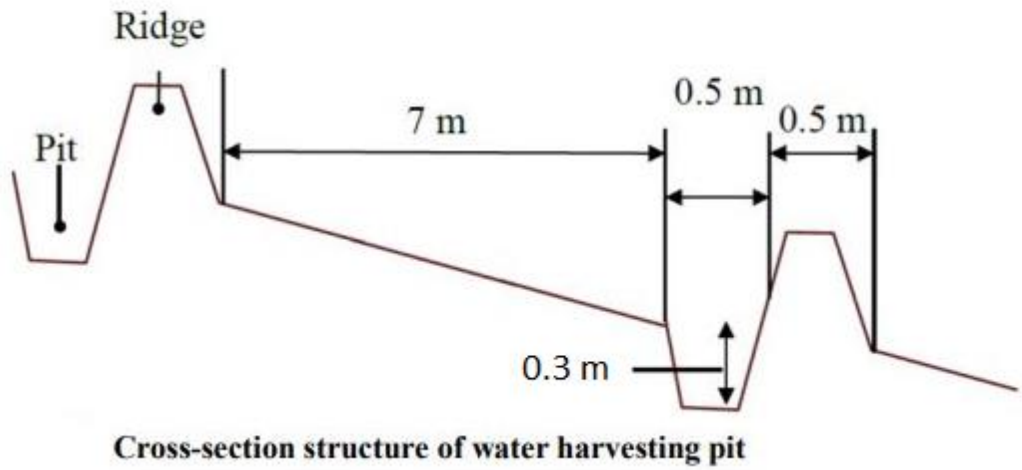


FIGURE 2: CROSS-SECTIONAL DIAGRAM OF PITS ALONG A HILLSLOPE

Land users evaluate the technology ambivalently. In the short term, landowners are often skeptical because the rehabilitation requires a recovery time and strict non-grazing/resting for (usually) the first two rainy seasons. After that, the rehabilitated lands require sustainable management. Most landowners are convinced of the improvements and understand vegetation development's economic and environmental value. The acceptance strongly depends on the social and cultural context – many farmers prefer the already established barley monoculture, mainly due to the lack of sustainable rangeland management options and land ownership. However, well-targeted awareness campaigns can be supportive.

Scaling Readiness and Concepts

Scaling Readiness (SR) is a conceptual approach used to improve the scalability of an innovation package within a specific context by guiding users in identifying the barriers to scaling, i.e., bottlenecks. It is a dynamic process where innovation packages, bottlenecks, and SR scores change over time and place due to changing contexts or innovations. This exploratory SR assessment includes two steps. The first is to <u>characterize</u> the innovation, and the second is to <u>diagnose</u> the components of the innovation.

This chapter starts by briefly describing the concepts and logic used in SR, followed by the characterization and diagnosis of the innovation, i.e., the application of SR concepts.

Characterization

Characterizing an innovation consists of defining the innovation, the target for its scaling, the novel components (aka., complementary innovations), and the innovation package. This relates to the following concepts:

- <u>The Core Innovation</u>: the innovation to be scaled. This is context-independent, hence more general, and broadly formulated.
- <u>The Target:</u> the aspired goal from scaling the innovation (SDGs)
- <u>The Complementary Innovations</u>: co- (or sub-) innovations that are indispensable for successfully scaling the core innovation. These are context-specific and can be viewed as the enabling environment.
- <u>The Innovation Package</u>: a comprehensive statement of the interaction between core and complementary innovations, featuring the context (country + subnational level), the target beneficiaries, and targeted SDGs.

➢ Complementary innovations can be of different types. They are distinguished as:

  - Feature: a modification of something, e.g., cash crops to a cropping system, lightweight tractors, etc.
  - Tool: a thing used to support a process, e.g., machinery, phone app, etc.
  - Product: an input such as material or supplies, e.g., seeds, fuel, seedlings, etc.
  - Principle: a change in belief, behavior, or assumptions (something intangible), e.g., gender equality or farmer perception.
  - (Institutional) Arrangement: an arrangement between entities, e.g., strategy, cooperatives, contracts, meetings etc.
  - Service: a service provided to stakeholders, e.g., capacity development, loan systems/ micro-financing, extension, agricultural mechanization hiring, etc.
  - Technique: how to do something, e.g., rainwater harvesting or raised seedbeds.

➢ Complementary innovations are often related to one or more of the eight enabling aspects:

1. Awareness: to make relevant people aware of the innovation, e.g., a radio broadcast
2. Funding: to have sufficient funding for research or use improvements, e.g., a proposal framework or stakeholder collaboration
3. Availability: to have sufficient supply to meet demand, e.g., enough seedlings
4. Accessibility: to make the innovation accessible for users, e.g., a phone number or contact person
5. Affordability: to make the innovation affordable, e.g., subsidies, loans, or cheaper designs
6. Simplification: to simplify the science complexity so it is understood, e.g., a simple grazing calendar rather than formulas for grazing capacity.
7. User Friendliness: to make the innovation user-friendly, e.g., a plough suitable for the commonly used tractors.
8. Benefits for the targeted group: innovation to improve the benefits, e.g., seedlings that provide more fodder

Diagnosing

The complementary innovations are diagnosed so that the bottleneck hindering scalability is revealed. Diagnosing consists of calculating the Scaling Readiness Score – the product of multiplying the *Innovation Readiness Score* and the *Innovation Use Score*. These two concepts are defined and scored as follows:

Innovation Use is a metric used to assess the extent to which an innovation is already being used, by which type of users, and under which conditions, with a scale ranging from no use (lowest level – 0) to common use (highest level – 9). (source: MELCOP/ PRMF Glossary).

Innovation Use Levels	Generic level label	Generic level description
9	End-users/ beneficiaries (common)	The innovation is commonly used by end-users or beneficiaries who were not involved in the initial innovation development
8	End-users/ beneficiaries (rare)	The innovation is used by some end-users or beneficiaries who were not involved in the initial innovation development
7	Unconnected next-user (common)	The innovation is commonly used by organizations not connected to partners involved in the initial innovation development
6	Unconnected next-user (rare)	The innovation is used by organizations not connected to partners involved in the initial innovation development
5	Connected next-user (common)	The innovation is commonly used by organizations connected to partners involved in the initial innovation development
4	Connected next-user (rare)	The innovation is used by some organizations connected to partners involved in the initial innovation development
3	Partners (common)	The innovation is commonly used by partners involved in the initial innovation development
2	Partners (rare)	The innovation is used by some partners involved in the initial innovation development
1	Project lead	The innovation is used by the organization(s) leading the innovation development
0	No use	The innovation is not used

Innovation Readiness is a metric used to assess the maturity of an innovation (its preparedness for scaling) with a scale ranging from the idea (lowest level – 0) to validated under uncontrolled conditions (highest level – 9). (source: MELCOP/ PRMF Glossary).

Innovation Readiness Levels	Generic level label	Generic level description
9	Proven innovation	The innovation is validated for its ability to achieve a specific impact under uncontrolled conditions
8	Uncontrolled testing	The innovation is being tested for its ability to achieve a specific impact under uncontrolled conditions
7	Prototype	The innovation is validated for its ability to achieve a specific impact under semi-controlled conditions
6	Semi-controlled testing	The innovation is being tested for its ability to achieve a specific impact under semi-controlled conditions
5	Model/ early prototype	The innovation is validated for its ability to achieve a specific impact under fully-controlled conditions
4	Controlled testing	The innovation is being tested for its ability to achieve a specific impact under fully-controlled conditions
3	Proof of concept	The innovation's key concepts have been validated for their ability to achieve a specific impact
2	Formulation	The innovation's key concepts are being formulated or designed
1	Basic research	The innovation's basic principles are being researched for their ability to achieve a specific impact
0	Idea	The innovation is at idea stage

The complementary innovation (sub-innovation) that is scored with the lowest Scaling Readiness Score is considered the bottleneck, i.e., the one that prevents the core innovation from scaling. This logic is based on Liebig's law of the Minimum. This is illustrated in Figure 3 (Sartas, et al., 2020).

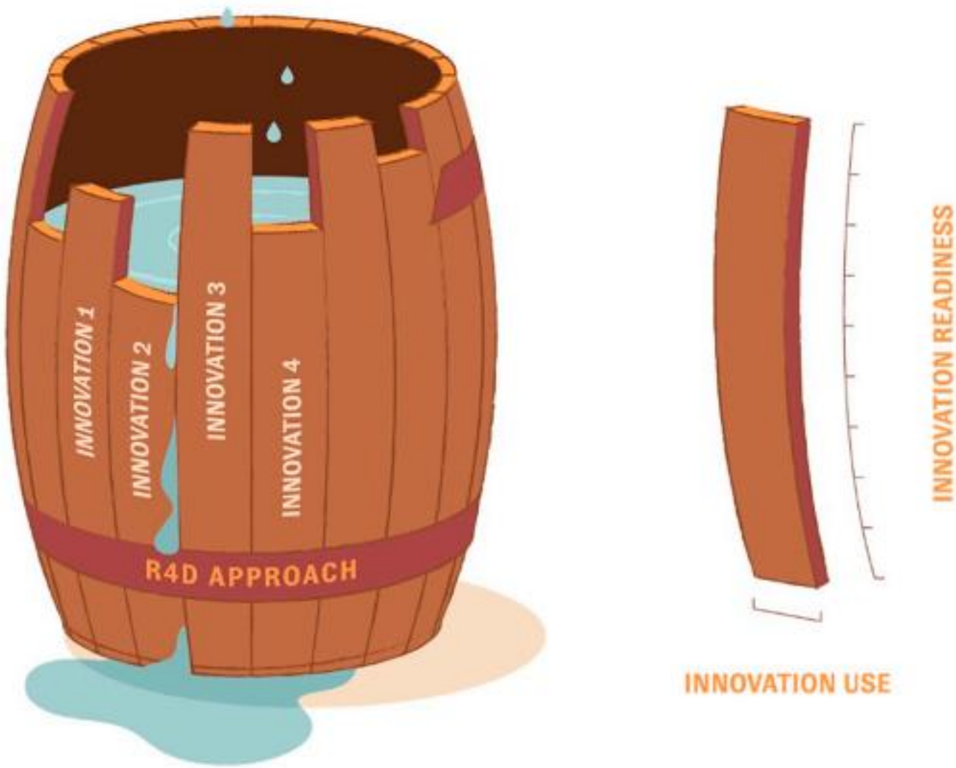


FIGURE 3: LIEBIG'S BARREL ANALOGY OF THE LAW OF THE MINIMUM DEPICTED HERE IN THE CONTEXT OF SCALING READINESS

Only experts who understand the innovations and the scaling context are qualified enough to score the core and complementary innovations for their innovation readiness and use (i.e., to serve as an informant). While rating an innovation, it is important to include references with the highest quality (e.g., scientific papers), else other reputable references (e.g., blogs). This is essential to support their scoring and base the Scaling Readiness.

Scaling Readiness Assessment of the Innovation

Characterizing

<u>Core innovation:</u>

A revegetation solution to restore degraded hillslopes in drylands

<u>Complementary innovations:</u>

a) Micro rainwater harvesting – a technique to collect water runoff from micro catchments (Figure 2).
b) Revegetation – a technique to rehabilitate degraded lands by planting grass, shrub, and tree species.
c) Vallerani plow – a tool to dig pits for rainwater harvesting.
d) Native seedlings – a product for revegetation. Atriplex Halimus, Retama, or Salsola were used in this project.
e) Community-based implementation – a principle to involve the local community in implementation. In one project, the local community planted seedlings in the pits.
f) Sustainable grazing – a feature to ensure the sustainability of the vegetation and fodder. It includes an initial grazing restriction period.
g) Collaboration strategy – an arrangement to strategize the innovations and their scaling with roles and responsibilities between stakeholders.
h) Online documentation – a product to share knowledge of the innovation with other (unrelated) people, such as the WOCAT documentation, ICARDA innovation page, or Monitoring, Evaluation, and Learning (MEL) platform.

<u>The innovation package:</u>

A revegetation solution for degraded hillslopes in the Jordan Badia through mechanized micro water harvesting, native seedlings out-planting, and promoting sustainable grazing to reverse land degradation and improve the livelihoods of local agro-pastoralists.

<u>Target:</u>

To reverse land degradation and improve the livelihoods of local agro-pastoralists in Jordan's Badia region.

<u>Geographic scalability:</u>

Figure 4: Suitability of the micro water harvesting technique. shows the bio-physical suitability conditions of the innovation.

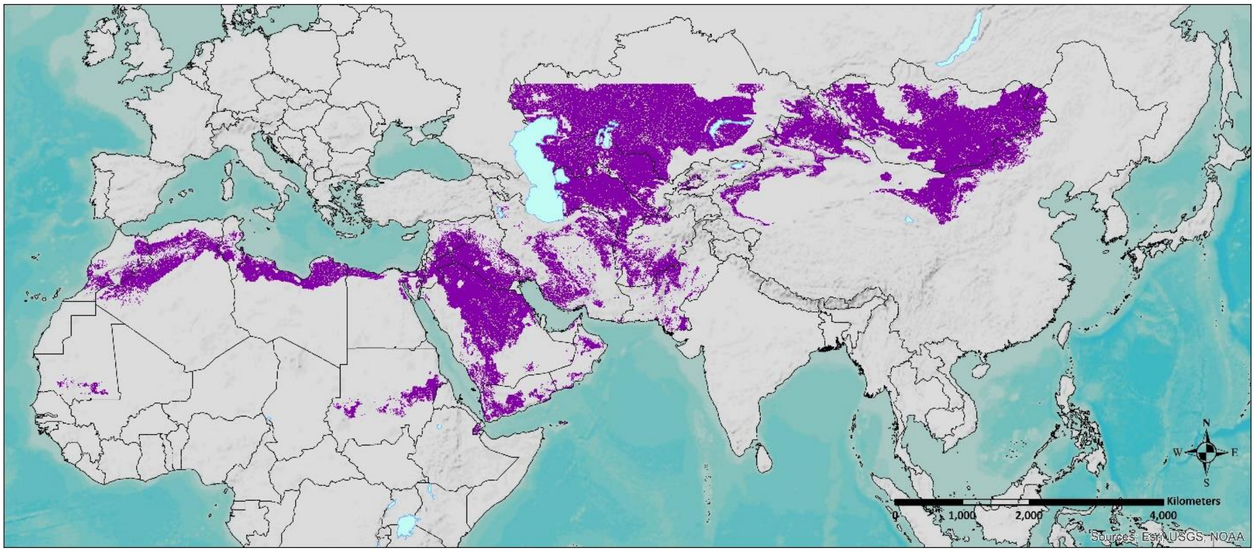
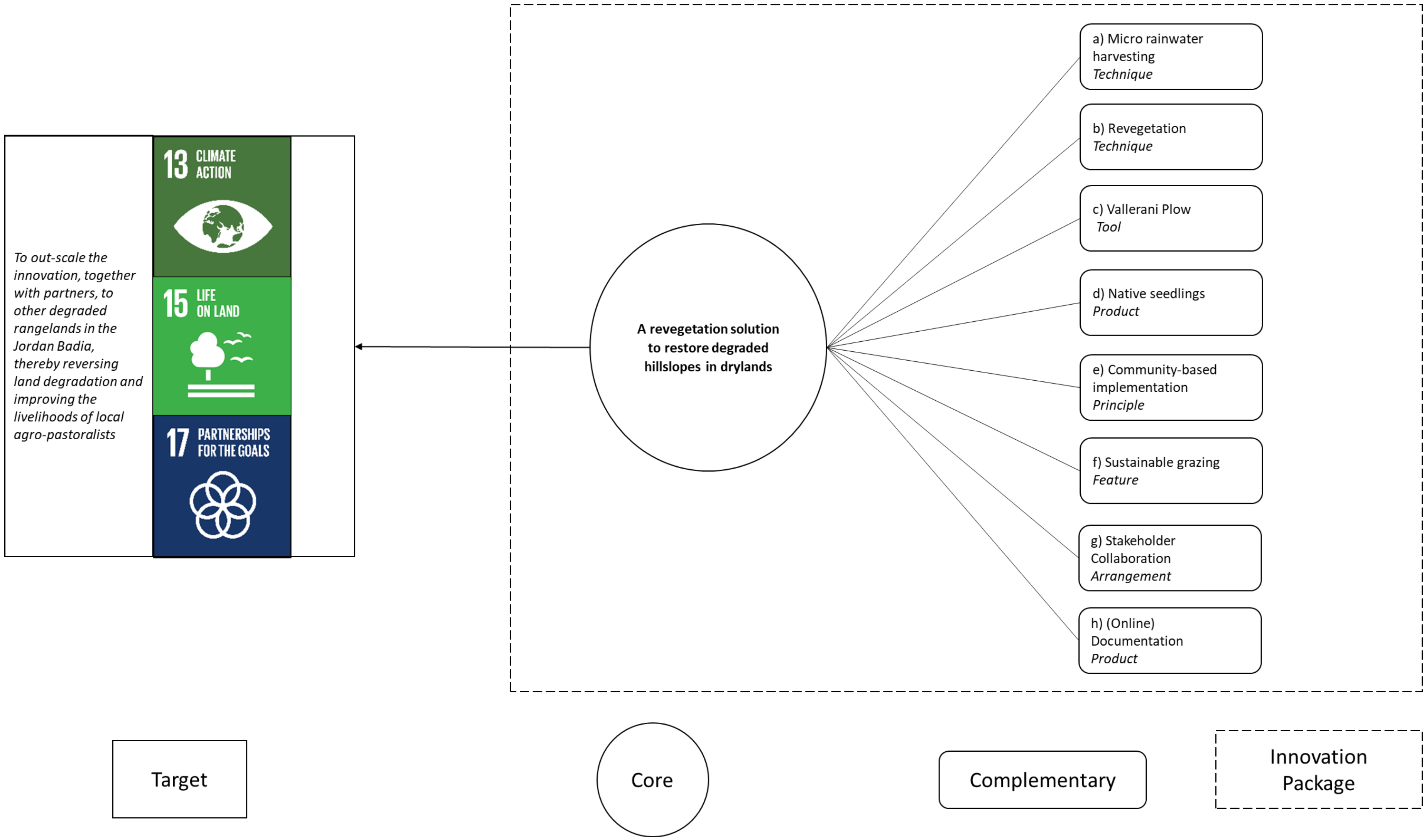


FIGURE 4: SUITABILITY OF THE MICRO WATER HARVESTING TECHNIQUE.


To out-scale the innovation, together with partners, to other degraded rangelands in the Jordan Badia, thereby reversing land degradation and improving the livelihoods of local agro-pastoralists
13 CLIMATE ACTION
15 LIFE ON LAND
17 PARTNERSHIPS FOR THE GOALS
A revegetation solution to restore degraded hillslopes in drylands
a) Micro rainwater harvesting Technique
b) Revegetation Technique
c) Vallerani Plow Tool
d) Native seedlings Product
e) Community-based implementation Principle
f) Sustainable grazing Feature
g) Stakeholder Collaboration Arrangement
h) (Online) Documentation Product
Target
Core
Complementary
Innovation Package

Diagnosing

The following tables show the complementary innovations, the rationale for their use and readiness, their scoring (on the ascending order of 1 to 9) within the context of the innovation package, and the evidence that supports their scoring.

Innovation Use

Complementary innovation	Type	Rationale	Sources	Use Score
a) Micro rainwater harvesting	Technique	Micro water harvesting, in general, has been widely used. Example: by Jordan government projects such as the Badia Rehabilitation Project and the Hashemite Fund for Development of Jordan Badia.	2, 3	9
b) Revegetation	Technique	Revegetation to rehabilitate degraded lands has been widely used.	4, 5	9
c) Vallerani plow	Tool	The Vallerani Plow has been used (for different) purposes outside this project. Example: by Jordan government projects such as the Badia Rehabilitation Project and the Hashemite Fund for Development of Jordan Badia.	6, 8	9
d) Native seedlings	Product	Native seedlings have been used outside the project but with partners related to Wadi.	7	9
e) Community-based implementation	Arrangement	This kind of arrangement has been used widely, but often within other projects.	9	4
f) Sustainable grazing	Feature	Grazing plans are used outside the project but are unknown for this specific grazing plan. Grazing plans are often introduced within projects only.	11	4
g) Collaboration strategy	Service/Arrangement/ Principle	Clear restoration strategies among partners are used outside this project but are used little within the project.	12	6
h) Online documentations	Product	Documentation of projects is performed for many other innovations. For this innovation, it is mainly limited to English and scientific community hence little reach to farmers or landowners.	13, 14	6

Innovation Readiness

Complementary innovation	Type	Rationale	Sources	Readiness Score
a) Micro rainwater harvesting	Technique	Scientifically proven to work in the region, improving soil moisture, supporting vegetation, and more.	1	9
b) Revegetation	Technique	Scientifically proven to work in rehabilitating degraded lands	1	9
c) Vallerani plow	Tool	Is a cost-efficient tool for implementing micro water-harvesting pits	1,6,8	9
d) Native seedlings	Product	The seedlings were able to survive and flourish in the conditions and were able to provide fodder, stabilize the soil, and naturally regenerate from the produced seeds.	1	9
e) Community-based implementation	Service/Arrangement/ Principle	Although expensive, community engagement worked well in this project.	9	6
f) Sustainable grazing	Feature	This specific scheme works well but is not compared to other systems	10,11	7
g) Collaboration strategy	Arrangement	Has been shown to work in other projects, but this strategy has proven to be a big challenge in the context of this project.	2	6
h) Online documentations	Product	Enables proper monitoring and evaluation and decision making.	14	7

Scaling Readiness Scores

Figure 5 shows a scatter plot of Innovation Use and Innovation Readiness for the complementary innovation. When the Innovation Use and Innovation Readiness scores are multiplied, the Scaling Readiness Score is calculated. This is summarized in figure 6.

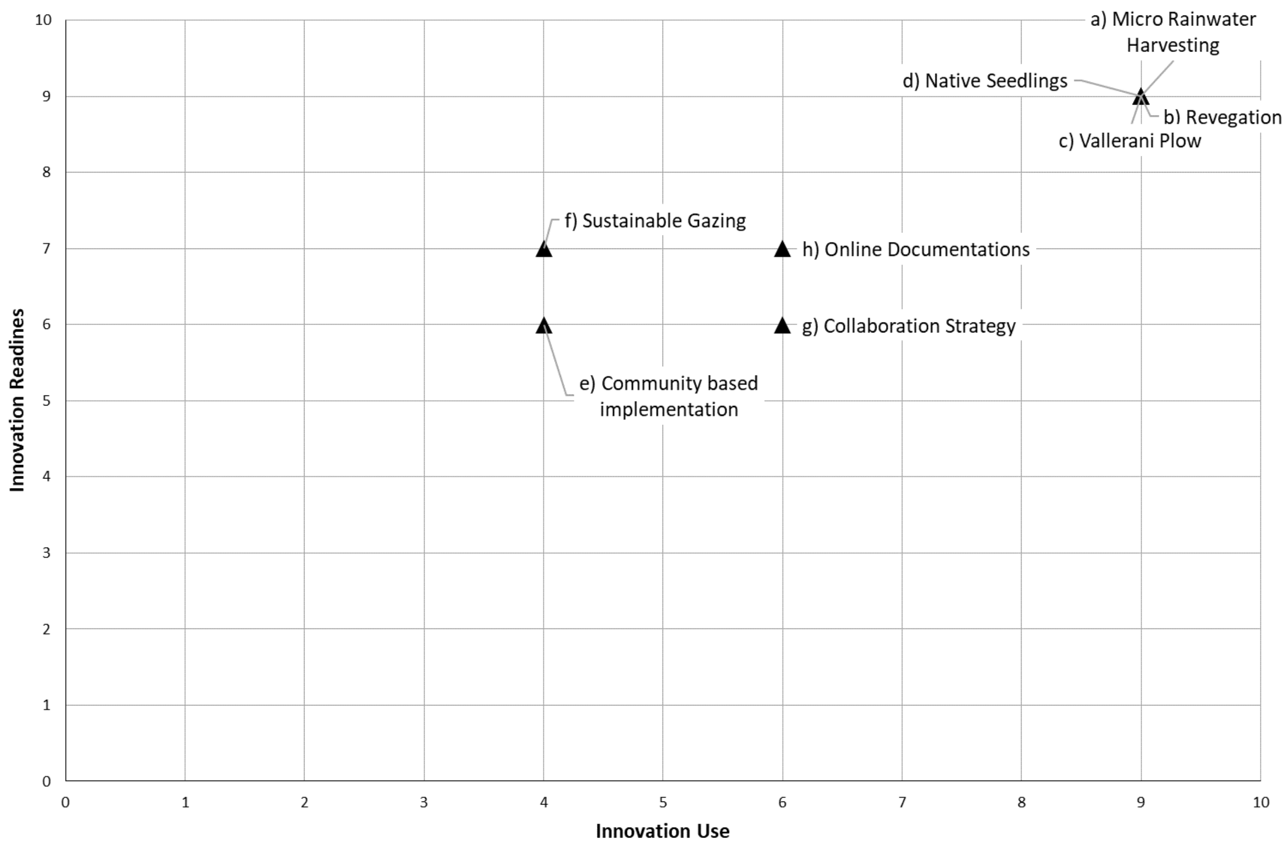


FIGURE 5: SCATTER OF DIAGNOSIS SHOWING THE INNOVATION USE SCORES PLOTTED AGAINST INNOVATION READINESS

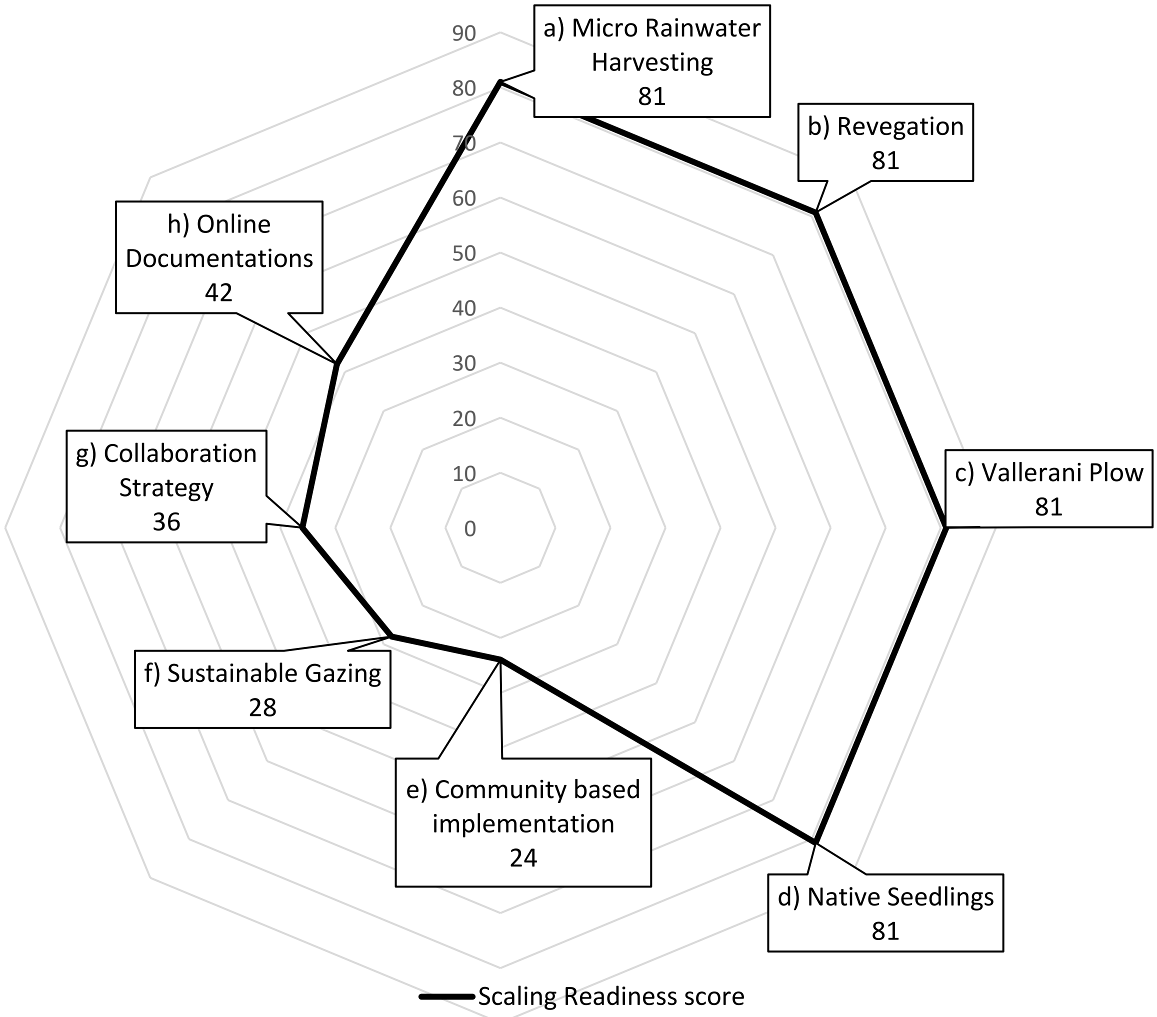


FIGURE 6: RADAR GRAPH OF THE SCALING READINESS SCORES OF EACH COMPLEMENTARY INNOVATION

Discussion and Recommendations

This document presents an exploratory Scaling Readiness assessment of a revegetation solution to restore degraded hillslopes in Jordan's Badia region. Only one informant provided the diagnostic scoring for the complementary innovations for this assessment. Ideally, the scaling readiness assessment should involve a diverse team of informants who score independently and complement innovations first, followed by a group discussion to scrutinize the similarities and differences. This ensures accurate scoring, broadens the scope, and prevents the omission of critical complementary innovations. As such, it is advisable not to limit the assessment to the expertise of one informant.

In addition, a single characterization and diagnosis of an innovation is a snapshot of the innovation at a specific time and context and is subjected to the informant's biases. SR assessment is a dynamic process hence the characterization and diagnosis may change over time or space.

Nevertheless, valuable observations and recommendations can be drawn from this assessment:

- The technical and conventional aspects of the innovation, precisely the micro rainwater harvesting technique, the revegetation practice, and the use of plowing machinery and native seedlings, were all shown to function well and have reached the highest SR score possible. This suggests that these innovations do not present bottlenecks in scaling the innovation package within Jordan's Badia region. The high SR scores of the raised seedbed technique and the non-lightweight RBM show that innovation is indeed working and used in a semi-to un-controlled environment, indicating the legitimacy of the innovation package for other stakeholders to collaborate.
- Online documentation that reports on the innovation package can be improved to reach a higher score and win legitimacy. This can be done by broadening the target audience to include farmers and landowners and making a point to translate all knowledge products into Arabic. Implementing such strategies will result in higher readiness and use scores.
- The bottleneck for this innovation package consists of two innovations: community-based implementation and collaboration strategy. Being interrelated, they equally hinder the scaling readiness of the innovation package. If stakeholders, including the various government agencies, farmers, landowners, and land users, become aligned, they can catalyze the scaling of the innovation package. Establishing a joint strategy that outlines the responsibility of each agency *vis-a-vis* the scaling of the innovation package can engender a sense of responsibility, ensure accountability, and alleviate this bottleneck. Furthermore, including farmer organizations in the collaboration and implementation strategies can enhance the uptake of the innovation and promote scaling. Farmers' active involvement increases farmer awareness of the long-term benefits of the innovation package and helps address the "unready" innovation that closely follows the common bottleneck –sustainable grazing. While resource-poor farmers tend to favor quick solutions that yield instant benefits that gratify their immediate needs, which in most cases prove unsustainable, their active participation in the project can help them focus on the big picture and reach for the ultimate goal, which meets not only their current needs but also those of future generations.

This exploratory assessment showed that scaling a revegetation solution to restore degraded hillslopes in Jordan's Badia region is possible. However, due attention must be given to overcoming the barriers to scaling.

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