Technology Development and Transfer to Small Farmers in Low Rainfall Areas in Jordan: Approaches and Perspectives

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Summary

The low rainfall areas in Jordan are inhabited by the poorest sector of the population, resulting in spontaneous migration to the highly populated areas in the cities. These areas faced problems and impediments that resulted in the degradation of natural resources due to mismanagement, and signs of desertification are evident.

Given the constraints to production in these areas, investment has been less attractive for governments and donors compared to higher potential areas, and investment in technology development has been even lower.

Jordan realized the importance of these areas and placed emphasis on the development of appropriate technologies to address these problems. This has been done through several regional projects implemented during the last 12 years such as the Mashreq project, the Mashreq/Maghreb project and the Barley Improvement project. These projects realized that technologies suitable for low rainfall agriculture should have special features which might be different from those developed for high rainfall areas, in order for such technologies to be widely adopted. The improved technologies included barley production technologies and technologies for the improvement of the production of small ruminants within a barley-small ruminant production system. Farmer adoption rates were found to be very promising.

This paper presents new approaches to deal with farmers, based on community participation and taking into consideration the technology options as well as the policies and institutional issues that constraint technology adoption and impact. The paper also gives suggestions on how to overcome some of these constrains.

Keywords: Technology Development; Transfer to Small Farmers; Jordan.

1. Introduction

Agriculture in Jordan was the most important sector of the national economy during the 1950s. This status has declined due to the nature of subsequent socio-economic development resulting in the rapid development of other economic sectors, especially services and industry.

While this decline can be partially attributed to poor rainy seasons, as the ratio of low rain years to high rain years was 5:1 during 1991-2000, there was a decline in the absolute value of agricultural products. This coincided with the economic reform program which resulted in liberating the agricultural commodity trade by stopping agricultural supports, decreasing customs duties on agricultural imports, and canceling non-customs protection.

1.1 Rainfed Agriculture and the Low rainfall Areas In Jordan

Rain-fed agriculture is focused on the highlands where most of the Kingdom's population is found. It contributes to the income of 80 thousand families most of whom are of limited or low income. This adds social and environmental aspects to the economic nature of the problem.

Rain-fed agriculture face several factors that result in the deterioration of land production and consequently low contribution to agricultural products and to the GDP. The decline of cereal production in rain-fed areas coincided with increasing import of wheat, barley, lentils and chickpeas. Imported quantities are expected to increase with the increasing population rate.

Rain-fed agriculture has a low return of field crops because on one hand, it basically depends on the amount of the annual rainfall and its distribution during the growing season. On the other hand, it depends upon traditional crops that are facing serious competition on the local market, as the government seeks to liberalize markets.

The low rainfall areas in Jordan are inhabited by the poorest sector of the population, resulting in spontaneous migration to the highly populated areas in the cities. In these areas the natural resources of soil and vegetation are suffering from heavy degradation due to mismanagement, and signs of desertification are evident.

The new agriculture strategy recognized the importance of rainfed agriculture and developed a future vision for its improvement, based on an integrated approach that leads to sustainable rainfed agriculture. This approach, takes into consideration the conservation of natural resource including soil and water with focus on conservation biodiversity and combating desertification. The strategy calls for a governmental policy that designates agriculture as the focus of rural development adopting policies to develop the infrastructure and auxillary integrated services as they relate to agriculture and rural areas, and direct the distribution of development gains to the rural people.

1.2 Low Rainfall Areas and High Rainfall Areas

While framers in the higher rainfall areas have been able to benefit from intensification of production, diversification of cropping patterns and commercialization, the scope of such progress is more limited in the lower rainfall environments. Rural populations in these less favored areas are often forced to implement production strategies which, while meeting short-term requirements, are in the long term destructive and unsustainable.

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Past research has identified available, or potential, technologies and management strategies for developing improved crop-livestock production systems, based on the integration of local (on-farm) feed production, combined with a more efficient use of the alternative feed sources and improvement of livestock management, health, nutrition and reproduction. However, adoption of such technical innovations has been slow.

1.3 Investment in the Low Rainfall Areas

Given the constraints to production in LRAS, investment has been less attractive for governments and donors compared to higher potential areas. The classical government intervention in LRAS has come in the form of relief programs in response to drought, in order to help inhabitants to survive. By comparison investment in technology development has been even lower. This is due to several factors including: low economic returns to investment, the high risk involved, poor infrastructure and governmental attention to sustainable development in these areas and, finally, a diversity of problems and disputes among the inhabitants who claim ownership of the land (mainly rangeland) and between them and the government over the rights to common property.

2. Technologies for Low Rainfall Areas

The low rainfall areas in Jordan cover two main production systems; the barley-livestock based production system and the rangeland-livestock based production system.

Jordan realized the importance of these areas and put emphasis on the development of appropriate technologies to address the problems. This has been done through several regional projects implemented during the last 12 years such as the Mashreq project, the Mashreq/Maghreb project and the barley improvement project. These projects realized that technologies suitable for low rainfall agriculture should have special features which might be different from those developed for high rainfall areas, in order for such technologies to be widely adopted.

An appropriate technology needs to be:

- Simple and easy to apply to users.
- Stable over years and locations.
- Low risk.
- Socially acceptable.
- Economically sound; and
- Able to maintain and conserve the resource base.

In our present review we will focus on the barely-livestock based system because this system has been addressed by several governmental projects, and significant results have been achieved especially in the area of technology development and transfer to farmers and sheep owners. However, some of the presented ideas will be of relevance to the rangeland-livestock based system, especially as related to land tenure, policies and integrated resource management.

Successful Experiences

2.1 Approaches in Technology Transfer to Farmers

2.1.1 Technology Packages and demonstration Program

Jordanian researchers have devoted considerable efforts to developing an improved barley production technology package suitable to the drier areas. The package promises to increase yield and stability performance under low and uncertain rainfall conditions. The package recommended by researchers consists of a combination of improved inputs and agronomic practices. In terms of inputs, the most important are recently released improved varieties with high genetic potential than the commonly used local landraces, and chemical fertilizers containing nitrogen and phosphate.

Agronomic practices recommended in combination with these inputs are: early sowing, before the onset of the winter rainy season; a seeding rate of 80-100 kg per ha; and planting with a mechanical seed drill that place seed at a uniform depth and alignment within the field. It should be noted that the prevailing traditional practice among farmers is the use of landrace cultivars, no fertilizer, plant with a seed rate substantially lower than that recommended for the broadcasting method, and often to plant after the early rains have fallen. Late sowing is often cited as a risk avoidance practice to insure sufficient soil moisture for plant germination, but research indicates that it may result in reduced total moisture availability during the season.

The technology transfer strategy that was followed was direct farmer participation through an extensive program of on-farm technology demonstrations. Local extension service played a vital role in contacting farmers, explaining the benefits of the improved technologies, recruiting farmers to host the demonstrations, working with them to implement the demonstrations, and conducting field days at the demonstration sites during the growing season for farmers living in the surrounding communities.

Barley Improved production Technologies

For example, in Jordan, the average increase in grain yield due to fertilization was around 43 percent and 36 percent for straw. Fertilizer application to the improved cultivar, gave 42 percent higher grain yield than when unfertilized and 33 percent in straw yield. On the other hand, fertilizer application improved the grain yield of the local barley by 44 percent and its straw yield by 40 percent (Table 1).

Table1. Effect of fertilizer on grain and straw yield of improved and local barley cultivars in Jordan, 1989/90-1994/95.

	Grain Yield Kg/Ha		Straw Yield Kg/Ha	
	+Fertilizer	-Fertilizer	+Fertilizer	-Fertilizer
Local Cultivar	1041	718	2008	1427
Improved Cultivar	1146	805	2409	1806
Incr. due to improved cv	10.9%		22.7%	
Increase due to fertilizer	43.6%		36.6%	

Crop rotation and crop-livestock integration

The introduction of forage legumes such as the bekia crop (Vecia sativa) received good attention in the research and technology transfer work in the low rainfall areas of Jordan. This is because farmers usually apply a monocropping system by planting barley after barley in the same land. This system resulted in the depletion of soil nutrients and in low crop productivity. Introducing bekia in the rotation with barley provide good animal feed for the small ruminant and strengthens crop-livestock integration in these areas.

Technologies for Small ruminant productivity Improvement

Research on reproductive physiology and in nutrition and management is receiving attention in Jordan. Extensive work on farmers flocks is being conducted with very promising results. The areas that have been covered include:

- The use of sponge and PMSG hormone for ewe synchronization and increasing twinning rates shows good results. Synchronization assists in having ewes give birth during a specific period, which facilitates flock management and orderly marketing of the lambs. Twinning rates showed substantial increase over the control.
- Early weaning of lambs has resulted in increased milk production and has attracted farmer attention due to its low cost.
- Injection with vitamin A during drought years (when there are no green fodder) has resulted in the improvement of ewe fertility.

In the area of nutrition, several on flock owner research activities were conducted and resulted in substantial improvement. These activities included:

- The production and utilization of feed blocks from agricultural and industrial by-products. Resulted in reduced costs of feed and improved productivity. This technology is now being adopted by many farmers and sheep owners in the country.
- Urea treatment of straw, which improves its digestibility and nutritive value increased slowly. More effort is still needed.

2.1.2 Technology Adoption and Impact

After five years of demonstrating these technology packages, farmers survey was conducted and covered the farmers who had participated in the demonstrations and field days to assess the impact of the project on their production practices. Included in the survey are randomly selected barley producers who had not participated in project activities. This last category served as a control group to estimate technology adoption trends without the project.

Table 2 shows how production practices and technology use changed among all categories of farmers during the project. The effect of participation on individual component use is obvious. Although non-participants had substantial rates of adoption for each component, participants had much higher rates of adoption. The differences are particularly marked for input especially for fertilizer and seed drill use as companed with management components.

Table 2. Impact of Mashreq project on technology adoption (Percentage of farmers in category).

Farmer category	Farmers using technology at the end of the project*.				
	Cultivar	Fertilizer	Seed drill	Seed rate	Early planting
Demonstrations(n==159)	57	57	37	74	94
Field days (n==71)	52	49	38	80	90
Non-participants (n=55)	42	33	18	64	89
Total (n==285)	53	51	33	74	93

* (1994).

Analysis of individual component adoption tells only part of the story. The full package was assembled by researchers because of the benefits derived from using components in combination. The interaction effects between, for example, improved cultivars and fertilizer application, are greater than the effect of using them separately. If the package performance in the farmers fields to the level at which it was designed to perform, then it could be expected that multiple component adoption among farmers exposed to the package would be greater than among farmers exposed to only a single component. Moreover, it should be expected that multiple component adoption by participating farmers would be greater than among non-participants. The validity of these assumptions is substantiated by the results presented in table 3.

Table 3. Adoption and type of participation (percentage of farmers in categories).

Farmer category	Percentage adopting during project				Percentage using full package	
	No new adoption	1-2 Components	3-4 Components	Full Package	1989	1994
Full Package	18	32	33	17	2	33
2 components	29	31	23	23	0	27
1 component	31	30	21	18	0	18
Field day	30	24	26	20	0	26
Non-participant	49	16	22	13	0	13
Total sample	30	27	25	18	0	25

Farmers housing full package demonstrations had the highest rate of adoption during the project, and this, combined with recommended components in use prior to the project, resulted in this group having the highest percentage of complete package use at the end of the project. It should be noted that there was no great difference in adoption between hosts of full package individual demonstrations and host of full package demonstrations on consolidated plots. This is a most encouraging result in terms of overcoming land fragmentation through collective management.

An unanticipated result of the technology transfer activities was the high rate of multiple component adoption among field day attendants. This indicates a willingness among these farmers to accept new technologies as packages, rather than a preference to accept only one component at a time. The indication is that the full package demonstration was particularly effective in showing the benefits of the interaction effects among components. In this regard, the field day associated with full package demonstrations appear to have been more effective in achieving farmer adoption than the more costly single component demonstrations. Nevertheless, single component demonstrations still achieved higher rates of adoption among their hosts than otherwise would been the case, judging from the lower rates of adoption among non-participants.

In the introduction of bekia in rotation with barley, several demonstrations were conducted with farmers in these areas and the adoption results were promising as indicated in table 4.

Table 4. Adoption rate of "bekia" according to type of participation.

Type of participation	% of farmers	Adoption rate (%)
Demonstrations	30.7	47.6
Field days	18.2	40
Non participants	51.1	12.9
Total	**100**	**28.5**
The overall adoption rate = 28.5 %		

Similar results were achieved with technologies aimed to improve small ruminant production and to produce low cost high quality feed. An example is presented in table 5 which showed high adoption rate. However, the sample size is rather small to give conclusive results regarding such technology.

Table 5. Adoption rate of feed blocks according to type of participation.

Type of participation	% of farmers	Adoption rate (%)
Demonstrations	8	80
Field days	24.8	41.9
Non participants	67.2	6
Total	**100**	**20.8**
The overall adoption rate of feed blocks (regardless of the type of participation) =20.8 %.		

3. Suggested Means to Alleviate Constraints

For facilitating wider adoption of existing and promising new technologies in the low rainfall areas the author (Haddad, 1999) suggested the following ideas that may help alleviate the constraints facing wider adoption of the technology, which are of technical or of policy and socio-economic nature.

- Greater investment in research and extension is needed both for solving the problems of LRAs, and for wider adoption of the solutions.
- Feed subsidies should be lifted and replaced with a farmer support program, to be implemented when needed.
- Low rainfall, high rainfall, and irrigated agricultural production programs should be planned and implemented as integrated, complementary systems.
- Alternative and compatible crops for the low rainfall system are limited and so is the adoption of a more productive cropping system. Lack of market alternatives for crops produced in the LRAs further limit the options, therefore more work is needed in this direction.
- Diversification of crops and cropping systems is needed for LRAs. Tree plantations with the use of water harvesting and supplemental irrigation techniques should, wherever possible, be introduced to the LRAs. This will reduce risk and give more production and income stability to land users.
- Biotechnology should play an important role in the LRA through the development of drought tolerant plant species and varieties, and for the improvement of livestock productivity.
- Technology transfer for rangeland improvement needs to be refined and new approaches should be initiated. However, without solving property rights issues in the rangeland, technical solutions may not be adopted and overuse of the resources by their inhabitants will continue.
- Farmers' and land users' participation in the development and transfer of the technology of LRAs is minimal and needs to be strengthened.
- To facilitate the development, adaptation, and adoption of low rainfall farming technology, a network of national and international organizations is essential.

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تطوير التقانة ونقلها إلى صغار الـمُزارعين في المناطق قليلة الأمطار في الأردن

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الخلاصة

يقطن المناطق قليلة الأمطار في الأردن أفقر قطاعات السكان مما نتج عنه الهجرة إلى المدن المكتظَّة بالسكان. ولقد واجهت تلك المناطق مشاكل ومُعوِّقات أدَّت إلى تدهور الموارد الطبيعية نتيجة لسوء استخدامها وبدأت بوادر التصحُّر بالظهور فيها.

وفي ضوء مُعوِّقات الإنتاج في هذه المناطق، لم يكن الاستثمار مُشجِّعاً للحكومة أو الـمُستثمرين مُقارنةً بالمناطق ذات الإنتاجيات العالية، كما كان الاستثمار في تطوير التقنية بدرجةٍ أقلَّ.

ولقد أدركت المملكة الأردنية الهاشمية أهمِّية هذه المناطق، فكان التركيز على الجوانب الـمُتعلِّقة بتطوير التقانة الـمُناسبة والتصدِّي للمشاكل التي تواجه تطبيقها من خلال عدة مشاريع إقليمية تمَّ تنفيذها خلال الإثني عشر عاماً الأخيرة مثل مشروع المشرق ومشروع المشرق المغرب، ومشروع تحسين محصول الشعير. وفي إطار سعيها لتبنِّي التقانات الـمُناسبة على نطاقٍ واسع، توصَّلت تلك المشاريع إلى أنَّ مظاهر التقنية الـمُناسبة للمناطق قليلة الأمطار تختلف عن نظيرتها في المناطق ذات الأمطار العالية. ومن بين التقانات التي تمَّ تطويرها تقنية إنتاج الشعير وتقنيات تحسين إنتاج الـمُجترَّات الصغيرة ضمن نظام زراعي مُتكامل لإنتاج الشعير والـمُجترَّات الصغيرة، وكانت مُستويات تبنِّي الـمُزارعين لهذه التقانات عالية.

يطرح هذا المقال توجُّهات جديدة للتعامل مع الـمُزارعين، تستند إلى الـمُشاركة الجماعية والأخذ في الاعتبار خيارات التقنية المعنية بجانب السياسات والجوانب الـمُؤسَّسية التي تُعيق تبنِّي التقانة ومردودها، كما يطرح المقال بعض الاقتراحات لتجاوز الـمُعوِّقات.

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