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LITANI RIVER BASIN MANAGEMENT SUPPORT PROGRAM

DEMONSTRATION DRIP IRRIGATION SYSTEMS FOR SELECTED POTATO AND TOMATO FARMERS IN THE BEKAA VALLEY OF LEBANON
FINAL REPORT-ROBINSON AGRI

November 2011
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FINAL REPORT
(NOVEMBER 2011)

Contract No.: EPP-I-00-04-00024-00 order no 7.

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FOREWORD

This final Report of the study on 'Demonstration Drip Irrigation Systems for Selected Potato and Tomato Farmers in the Bekaa Valley of Lebanon' was prepared by Eng. Ziad Farhat of Robinson Agri under subcontract with International Resources Group (IRG), the main contractor under the Litani River Basin Management Support (LRBMS) Program, an USAID-funded program in Lebanon (Contract EPP-I-00-04-00024-00, Task Order No. 7 under the Integrated Water and Coastal Resources Management Indefinite Quantity Contract - IQC II).

The study represents a step within the LRBMS Program aiming at (i) showing benefits to farmers by adopting drip irrigation on potato and other vegetables that allows savings in terms of water consumption and (ii) increase yield and improve quality. It also has the objective of demonstrating to farmers how drip irrigation is worthwhile investment in agriculture.

This report presents the results of the drip irrigation program implemented by Robinson Agri

1) Delivering to 14 Bekaa Valley farmers drip irrigation systems to be installed on either potato or tomato fields along with a new mini sprinkler for potato**;**

2) Follow-up and assist these farmers to optimize their use of the equipment; and

3) Document their progress, performance and achievements.

EXECUTIVE SUMMARY

The results of a study on the effects of drip irrigation system on the production of potato in Southern Bekaa Valley are presented here. These results would be more encouraging if farmers were more responsive.

Accordingly, it would be useful to repeat this study the next growing year (summer 2012), but with a maximum of 2-3 farmers and a larger production scale for each farmer, among whose Mr. Nassif El Bach was shown to be very cooperative and responsive.

I suggest also to expand the geographical area of the study and to expand the cooperation with key potatoes farmers and growers in Central and Northern Bekaa Valley. The scope is to spread the observed techniques to a wider agricultural spectrum. In addition, it would be better to include in this study farmers that are using private wells for irrigation purposes in order to account for the savings not only of water but also of fuel consumption.

The topic presented in this study may constitute a scope of work for a research project for a student of Saint Joseph University – Faculty of Agricultural Engineering (Taanayel) in order to carry out accurate point experiments and publish the obtained data and results.

Water saving is one of the main advantages of using drip irrigation on potato and tomato. Drip irrigation helps increasing efficiency of soluble fertilizers, while increasing yield and saving fuel are the ultimate advantages of drip irrigation for both potato and summer vegetables, mainly tomatoes.

The feedbacks of farmers were positive and can be summarized as follow:

- The behavior of potato under drip irrigation is great and the plant does not sound to suffer from any water stress.
- Both vegetative and tuber growth are homogeneous.
- The system is easy to handle and provides an easy solution to dissolve fertilizers in water, increasing thus the efficiency of nutrient uptake by the plant.
- Yield increase by 20-25 %.
- Water saving of as much 30 % as the applied water.
- When private wells are used for irrigation, drip irrigation results in 85 % of fuel saving.

- Reducing the labor cost while shifting from sprinkler to drip and in the latter case the soil is less compacted.
- Irrigation can be started at any time of the day, not considering the problems that may rise due to high wind speed.

The consultant wishes to reveal that some of farmers were not responsive, and did not follow closely the trials, especially those on potato. As a result some farmers did not install the system; others install it on tomato instead of potato, while others combined both sprinkler and drip irrigation.

Concerning the trials on potato, four farmers can be considered as supportive and they achieved the trials till the end; three out of them, Mr. Nassif El Bach, Mr. Ahmad Joumaa and Mr. Mahmoud Khalife, applied the drip irrigation system, Mr. Mansour Estefan applied the LC sprinkler. It is worth to note that Mr. Nassif was very accurate and responsive.

الملخص التنفيذي

يتضمن هذا الملخص نتائج دراسة تأثير نظام الري بالتنقيط على إنتاج محصول البطاطا في منطقة البقاع الجنوبي. وكان بالإمكان إعتبار نتائج هذه الدراسة مشجعة أكثر لو كان المزارعون قد ابدوا تجاوباً وتعاوناً أكبر.

وبناءً على ما تقدم، سوف يكون من الأفضل إجراء هذه الدراسة مجدداً خلال الفصل الزراعي القادم ٢٠١٢, باعتماد مزارعين أو ثلاث من الذين شاركوا في برنامج العام ٢٠١١ على أن تكون المساحات المزروعة المعتمدة لكل مزارع أوسع مما كانت عليه خلال هذه ألسنة. بين هؤلاء المزارعين هناك السيد نصيف الباش الذي أبدى تجاوباً مميزاً وإستعداداً للتعاون. كما اننا نقترح توسيع الإطار الجغرافي لهذه الدراسة ليشمل بعض مزارعي البطاطا في البقاعين الأوسط والشمالي. والهدف من ذلك هو نشر ونقل المعلومات الفنية على محصول البطاطا التي حصلنا عليها خلال هذه الدراسة إلى أكبر عدد من مزارعي هذا المحصول. بالإضافة إلى ذلك، سوف يكون من المستحسن أن تقوم هذه الدراسة مستقبلاً بضم مزارعي البطاطا الذين يعتمدون على الأبار لري هذا المحصول، مما يتيح الفرصة لإجراء مقارنة على صعيد الإقتصاد المائي بين مزارعي شبكة قناة ال ٩٠٠وهؤلاء الذين يعتمدون على الأبار الجوفية لأغراض الري، عدا عن الأخذ بعين الإعتبار الكلفة التي يتكبدها هؤلاء جراء الضخ

(صيانة موتورات، زيت موتور، وقود)

كما أنه يمكن إعتماد موضوع هذه الدراسة في إطار بحث علمي يمكن لطالب من كلية العلوم الزراعية في جامعة القديس يوسف في تعنايل أن يقوم به من خلال إجراء تجارب يمكن من من خلالها الحصول على نتائج قابلة للنشر.

يعتبر الإقتصاد المائي من أهم فوائد تطبيق نظام الري بالتنقيط على محصول البطاطا والبندورة. فهو يساهم في زيادة كفاءة إستعمال الأسمدة الزراعية الذوابة، فيما تعتبر زيادة الإنتاج والتوفير في كلفة الطاقة، الهدفين الأساسيين اللذين يدفعان المزارعون إلى إعتماد هذا النظام في الري على محصول البطاطا وبعض اصناف الخضار الصيفية، لا سيما البندورة منها.

إن الملاحظات والأراء التي ابداها المزارعون نتيجة هذه الدراسة كانت إيجابية ويمكن تلخيصها كما يلي:

١) أبدا محصول البطاطا تجاوباً كبيراً في ظل إستخدام نظام الري بالتنقيط، سواءً من ناحية النمو أو من ناحية عدم التأثر بالنقص المائي الذي عادةً تتعرض له الزراعات نتيجة الأحوال المناخية التي تسود في فصل الصيف

٢) تميز النمو الخضري للنبات بالتجانس مع نمو مماثل للدرنات

٣) يتميز نظام الري بالتنقيط بسهولة التركيب وهو يتيح فرصة كبيرة للاسمدة الذوابة بزيادة كفاءة استعمالاتها من قبل النبات

٤) زيادة في الإنتاج تتراوح بين ٢٠ و-٢٥٪ مقارنةً مع أنظمة الري التقليدية، كالري بواسطة الرش

٥)يساهم نظام الري بالتنقيط بزيادة الإقتصاد المائي على نحو يشمل ٣٠٪ من إجمالي كميات مياه الري

٦) يساهم نظام الري بالتنقيط بتخفيض كلفة الطاقة بحوالي ٨٥٪ في حال إستعمال الأبار الجوفية

٧) يشكل نظام الري بالتنقيط عاملاً أساسياً في تخفيض كلفة اليد العاملة الحقلية مقارنةً مع نظام الري بالرش الذي يتسبب بزيادة درجات رص التربة

٨) يمكن البدء بعمليات الري بنظام التنقيط في أي وقت من النهار كونه لا يتأثر إطلاقاً بسرعة الهوأ كما هو الحال مع نظام الري بالرش.

1. INSTALLATION OF THE SYSTEMS

Table 1 presents a summary on the status of the installation of the drip irrigation system in the farmers' plots. In addition, Photo 1 illustrates views from the plots of the installation process.

Table 1: A summary on the status of the installation of the drip irrigation system in the farmers' plots

Farmer Name	Area (ha) Tomato	Area (ha) Potato	Installation Status		Planting date	Harvest date
Abbas Abbas		1	Drip	Installation not done (we were unable to contact him)		
Mansour Estefan	1	1	Mini sprinkler	Installation of mini-sprinkler on potato (mid-August)	15 August	10/11/2011
				Installation mini-sprinkler on tomato (May 2011)	May 20	August
Abd Ghani Dasouki		1	Drip	Installation of drip system on tomatoes		
Ghantous hadad		1	Drip	Installation was not made (The field was highly infected by *Orobanchae ramose*) ramose		
Samir saleh		1	Drip	Installation was not made (The farmer was persuaded that the wind will take away the system – The consultant showed this farmer a sound installation case at Mahmoud Khalifeh plot)		

Table 1 (continued)

Ghassan Saber	1	1	Mini sprk	Potato sowing did not occur in the late growing season (August-November) as being agreed previously and this is because the farmer lost the money that he invested in the potato early growing season (March-July) for unknown reasons		
Nassif El bach		1	Drip	Installation was made (Positive results were obtained with this farmer)	15/3/2011	19/7/2011
Ahmad Joumaa	1	1	Drip	Installation of the drip was made on tomatoes in mid-June	1/9/2011	11/11/2011
				Installation of the drip system was made on potato in September	5/9/2011	End of November
Mahmoud Khalifeh		1	Drip	Installation of the drip system on potato in March (positive results were obtained with this farmer)	1/4/2011	2/9/2011
Fahim Chedid	1			Installation of the drip system was made in May	15/5/2011	Starting 25/7/2011
Safa Issa	1			Installation of the system was made in June	20/6/2011	Starting 1/9/2011
Antoine Saber	1			Installation of the system was made in May	3/5/2011	Starting 18/7/2011
Khaled El Kordi	1			Installation of the system was made in May	20/5/2011	Starting 29/7/2011
Emtissal El Saghir	1			Installation of the system was made in August	15/8/2011	Starting 15/10/2011

Photo 1: Views of the installation process of the drip system in the farmers' plot (top: manifold installation, middle: laterals' installation, bottom: Fertigation tank installation)

Due to the observed low prices of potato fresh tubers of this year, a couple of farmers switched their cropping from potato to tomato. Only 4 hectares (1 hectare by farmer) were not planted as planned earlier at the beginning of the season. The reasons are:

- One farmer showed an untruthfulness behavior and it was not to ensure a contact with him after that we delivered to him the irrigation equipment.
- One farmer did not grow potato on the late season because of the low prices he got after harvesting the fresh tubers during the early growing season (March-July).
- One farmer decided to use not the drip irrigation system because he was not convinced of the efficiency of the system.
- There was one field belonging to one farmer that was affected by *Orobanchae ramose* (a parasite weed that hassles *Solonacae* family and other summer vegetables).

Therefore, 13 out of the 17 hectares were cropped, as it can be seen in Figure 1.

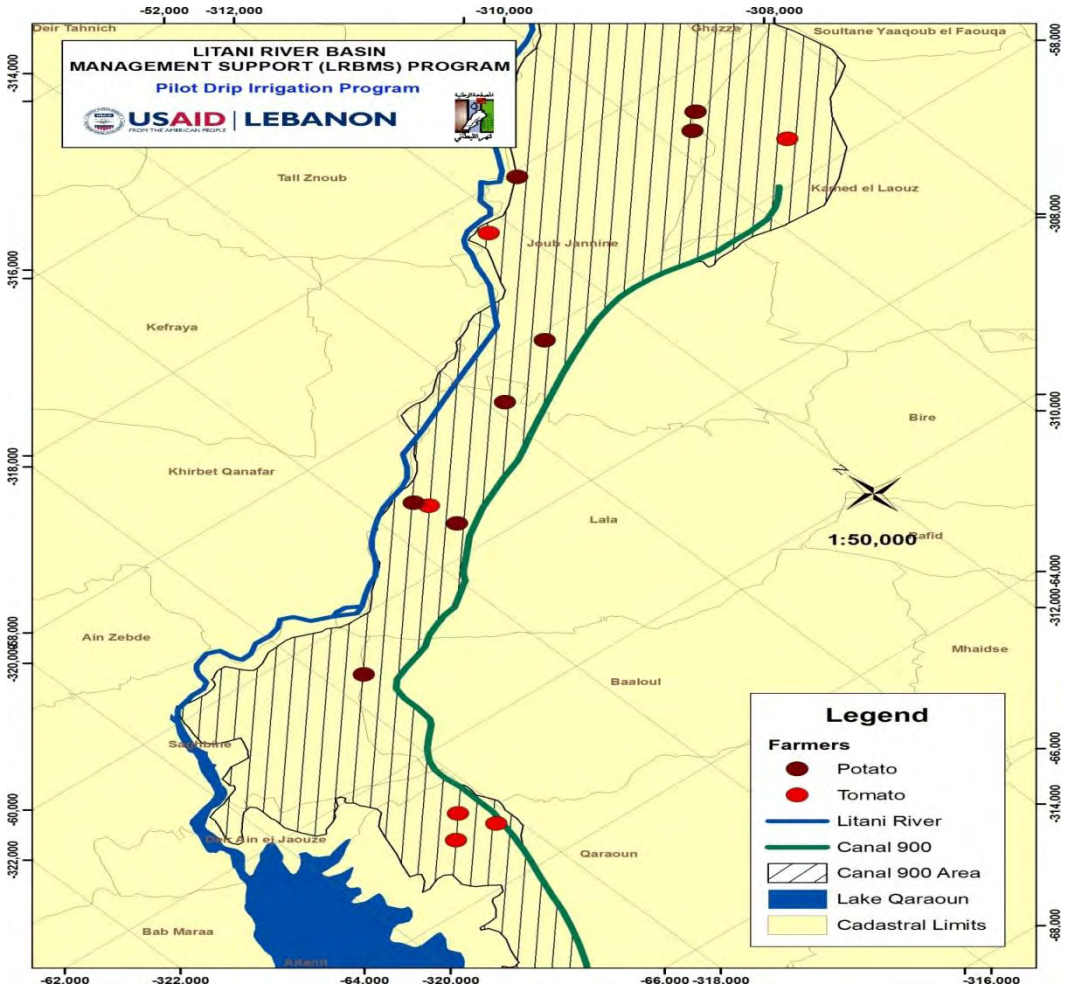

Figure 1: Geographic distribution of the cropped plots within the project area

2. FIELD VISITS AND TECHNICAL SUPPORT

Regular field visits were conducted during the consultancy term every 7 to 10 days. The field visits had three purposes:

1) Encourage, assist and monitor the installation of the irrigation equipment in the farmers' plots;
2) Get farmers started with the initial irrigations; and
3) Provide technical assistance and support to farmers during the growing season.

Photo 2 elucidates a view of a field monitoring visit of one Robinson Agri resource engineer.

Photo 2: A view of a field monitoring visit to the project area

Table 2 shows a chronicle of the various field visits undertaken by Robinson Agri during the consultancy term.

Table 2: A chronicle of the visits to the farmers' fields

Farmer	Date																			
	2/6/2011	6/5/2011	6/7/2011	17-6	20-6	23-6	16-7	19-7	23-7	30-7	3-8	6-8	19-8	27-8	2-9	7-9	17-9	24-9	8-10	Number
Abbas Abbas																				
Mansour Estefan											1		1		1		1		1	
Abd Ghani Dasouki									1											
Ghantous hadad									1											
Samir saleh										1										
Fahim Chedid		1			1		1			1	1			1		1		1		
Safa Issa	1			1			1		1	1	1		1		1	1		1		1
Ghassan Saber	1			1			1		1		1		1							
Nassif El bach								1												
Antoine Saber																				
Ahmad Joumaa												1		1					1	
Mahmoud Khalifeh			1			1	1		1			1	1		1					
Khaled El Kordy	1					1	1													
Emtissal El Saghir										1		1		1		1	1			
visits/day	3	1	1	2	1	2	5	1	5	4	4	3	4	3	3	3	2	2	2	

Note that from August onwards the team had a series of field visits to farmers Ahmad Jomaa and Mansour Stephan till potato harvesting time.

During the field visits, the following assistance and guidance were provided to farmers:

- Fertilization scheduling
- Irrigation scheduling for most of the farmers though few of them were convinced, notably Nassif El Bach and Georges Estefan.

- Training on 'Pest Control and Management' was organized by the team to improve the farmers' skills on this subject and give them advices on pesticides and their active substances and the ideal time to use them.

At the same time, field visits were achieved to collect the soil tensiometric data using the soil tensiometers (watermarks) that are installed in the plots of some farmers. The collected data served to monitor the variation of the soil water potential and schedule irrigation application, in terms of quantity and timing, by the farmers. The collected soil water potential data are found in Table 3.

Table 3: Soil water potential data as collected from the watermarks at different stages of the crop growing cycle.

Date	2/6/2011		9/6/2011		15/6/2011		23/6/2011		28/6/2011		7/7/2011		18/7/2011		21/7/2011	
Farmers	**Sensor 20**	**Sensor 40**	**Sensor 20**	**Sensor 40**	**Sensor 20**	**Sensor 40**	**Sensor 20**	**Sensor 40**	**Sensor 20**	**Sensor 40**	**Sensor 20**	**Sensor 40**	**Sensor 20**	**Sensor 40**	**Sensor 20**	**Sensor 40**
Antoine Saber	3	0	12	10	11	3	12	2	7	4	3	4			11	12
Nassif el Bach	0	0	0	2	28	29	31	37	15	15	6	6	53	53		
Mahmoud khalife	0	0	2	0	11	2	12	7	18	11	20	50	80	43		
Khaled al korde	0	0	0	0	0	0	12	0	4	2	8	17	4	3		
Mansour Estefan					0	0	0	0	0	0	0	0				
Ghassan saber					4	0	2	0	0	1	3	0	10	0		
Fahim					2	0	2	2					3	3		
Safa Issa									0	0	0	0				
Ahmad Joumaa									0		0				0	

It was obvious that farmers are using too much water to irrigate their crops. This was revealed by the Watermarks the ones readings indicate that the soil is near to saturation. It was not easy however to convince farmers to decrease the amount of the applied water, but it was beneficial to stress to them the

advantages of reducing water applications and schedule their irrigations upon the readings that are collected regularly from the tensiometers.

To note that readings less than 15 cbars means that there is no need to supply water to the field, when the readings become lower than 15 cbars, irrigation is needed.

It is worthwhile to note that farmers used to read and monitor themselves the data of the soil water tension during the crop growing cycle in August-September and after getting familiar with this technique.

3. RESULTS

The advantages of drip irrigation on potatoes compared to sprinkler irrigation have the following reasons:

- Water savings;
- Yield quantity increases and quality improves under drip irrigation. Saving in labor costs;
- Increased fertilizer efficiency;
- Saving in fuel consumption.

In the following sections we consolidate the above mentioned advantages of drip irrigation system on potato by showing some of the results that we obtained during the consultancy term.

3.1. WATER SAVING FACTS

We would like to mention that this project has presented a sound demonstration case on how reducing the amount of water application on potato. Table 4 reports some data on water saving by using drip irrigation system with comparison to the conventional sprinkler irrigation.

Table 4: A comparison of water application made for sprinkler irrigation, conventionally used by farmers in the project area, and the newly introduced drip irrigation

Irrigation Technique	Water amount (l/dunum/season)[a]	Saved amount (l/dunum)	% of saved amount
Sprinkler	540 m^3	165.6 m^3	30 %
Drip	374.4 m^3		

[a] one dunum equals 0.1 hectare

It is clear that farmers even following their own ways (i.e. without following the sensor readings) may have water saving of as much 30% of the applied water. This saving can be easily increased to 50% if farmers decide to apply a reasonable irrigation scheduling based on the readings of the tensiometers.

The calculated amount of water for sprinkler irrigation is an average for the entire growing season. While using sprinkler irrigation, farmers usually start with 6 hours/irrigation at the beginning of the growing season to reach 14 hours/irrigation during the hottest months (July-August). This may differ from a case to another depending on the soil and weather conditions.

The example listed above was used by two farmers, Nassif El Bach and Mahmoud Khalife.

To mention that Mr. El Bach was cooperating very well and he followed up the trial seriously.

Numbers listed on the table are calculated as following:

10 hours *1500 ltr/hour/ sprinkler * 3 sprinkler/dunum * 12 irrigation session = 540000 liters.

1300 meters of drip lines/ dunum * 4 liters/hour/meter *3 hours * 24 irrigation session = 374400 liters.

3.2. YIELD INCREASE

Table 5 gives an indication on yield increase hat was observed at selected farmers' plots that followed closely the instruction of the team. Moreover, drip irrigation seemed to homogenize the production of fresh tubers of the large caliber (> 200 g), which may be considered an asset for potato processing varieties (Photo 3).

Table 5: A comparison of potato fresh tuber yield obtained with sprinkler irrigation, conventionally used by farmers in the project area, and the newly introduced drip irrigation.

	Drip (kg/dunum)	Sprinklers (kg/dunum)	Yield difference (kg)	Yield increase (%)
Mahmoud Khalife	2300	1900	400	21
Nassif El Bach	2500	2000	500	25
Ahmad joumaa	2800	2300	500	21.7

Photo 3: A view of potato fresh tubers that were harvested in plots using drip irrigation system

3.3. LABOR COST SAVING

Farmers were not obliged to move sprinklers, so that they did not account for the labor cost due to this move In the case they use drip; they may save the amount of money that usually they pay for moving sprinkler system from a location to another within the field (Photo 4).

To note that each dunum costs 10000 L. P. / season for moving the sprinkler pipes in the field.

Photo 4: A view of sprinkler-irrigated potato field in the project area showing the movable sprinkler pipes

3.4. FERTILIZERS EFFICIENCY/ DRIP ON POTATO

Several farmers (notably Mr. El Bach and Mr. Khalife) agreed that delivering fertilizers through a drip irrigation system is more efficient than with a sprinkler system, because fertilizers will be delivered much placed with irrigation water close to the root system and it is one of the factors that affected positively growth and yield.

And we have to mention that soluble fertilizers are the same in both systems.

Table 6 gives an indication on the types of fertilizers used by the farmers in the project area, along with the estimated quantity involved and the application time.

Table 6: Types of fertilizers used by the farmers in the project area, and the estimated quantities involved and their application times.

Type of fertilizer	Quantity / dunum	Time of application,
DAP or 17-17-17	50 kg	Before sowing
Potassium sulfate granular	50 kg	Before sowing
Ammonium nitrate	50 kg	One month after emergency
Map	5 kg	flowering
Potassium nitrate soluble	10 kg	15 to 20 days prior to harvesting

Table 6 is considered as a common way of applying fertilizers followed by most of potato farmers in the project area, but it can have some adjustments by using soluble like 20-20-20 at seedling stage instead of NPK 17-17-17 that is broadcasted before sowing, or by using the soluble potassium nitrate (12-0-46) instead of the less soluble potassium sulfate (0-0-46).

On the other hand, a seminar was organized at Khorbet Kanafar Training Center of the LRA on 29/6/2011 by LBRMS and presented by Dr. Jihad Noun. The purpose of this lecture was to help and guide farmers on how to fertilize potato in a rationalized way. The fertilization recommendations instructed by Dr Noun are summarized in Table 7.

Table 7: Recommendations on the types of fertilizers, quantities and application times for potato crop

Type of fertilizer	Quantity / dunum	Time of application
DAP	25 kg	Before sowing
Potassium sulfate granular	33 kg	Before sowing
Ammonium sulfate	50 kg	Before sowing
MAP	15 kg	Divided weekly between the third and the seventh week after sowing
Urea	15 kg	2 weeks after emergency
Magnesium sulfate	10 kg	between the third and the seventh week after sowing
Soluble potassium sulfate	12 kg	4 to 5 weeks before harvesting

Note: not all farmers followed the suggested schedule by Mr. Noun.

3.5. FUEL/ENERGY SAVING

Water savings also translate into fuel and energy savings, since water is pumped from groundwater in the case of private wells, or from Lake Qaraoun in the case of water coming from Conveyor 900. For the farmers subscribed to LRA, the difference is not perceived since they pay the cost of water as a flat rate per unit of irrigated area (dunum) and not per actual consumed water volume in the field. But For well-pumping farmers, data from a nearby farmer show that he has saved 26000 liters of diesel for 200 dunum (the area of the trial), so he saved an amount of 130 liters of diesel/dunum.

Considering the following:

- Price of 20 liter of diesel is 30000 L.L.
- Yield average for 1 dunum potato irrigated by sprinklers is 3 tones.
- Price of 1 kg of potato is 350 L.L.
- 1 dunum of potato irrigated with sprinklers needs 140 liters of diesel.
- 1 dunum of potato irrigated with drip needs 30 liters of diesel.

The results of the costs and profits of sprinkler and drip irrigation systems used on potato are presented in Table 8.

Table 8: A comparison of the costs and profits of sprinkler and drip irrigation systems on potato

	Sprinklers	**Drip**	
Diesel cost	210000 L.L.	45000 L.L.	+ 165000 L.L.
Dripper cost	0	150000 L.L.	_ 150000 L.L.
Moving sprinklers	10000 L.L.	0	+ 10000 L.L.
25 % yield increase	0	750 Kg	+ 262500 L.L.
Result			+ 287500 L.L.

Considering that the other costs for growing potato are the same between both systems, and the ones listed on the previous table are variable.

Than numbers on the previous table show that drip irrigation of potato will increase incomes around 287500 L.L. for each dunum, and we don't have to forget the quantity of water that will be saved and which is a very important and an initial matter.

NB: in our cases the increase was 400 to 500 kg because yield was between 2 and 2.5 tones and did not reach 3 tones (like usually) and the reason is because of seeds that they use it; they sow a local seeds and not the elite or class A.

3.6. RESULTS FOR TOMATOES

Using saddles to plug drip lines to laterals instead of conventional method has decreased water leakage and for sure we saved water. On the other hand, decreasing water leakage has increased the homogeneity of water distribution and the efficiency of fertilizers application.

3.7. RESULTS FOR LC SPRINKLERS ON POTATO

According to farmers how applied those sprinklers we can summarize the following advantages:

This sprinkler due to its low angle was not affected by wind.

It has a good distribution of water.

Once the system is installed, there will no need to shift sprinklers.

There was no difference on yield increasing but there was a good uniformity on potato tubers.

4. CONCLUDING REMARKS AND RECOMMENDATIONS

A range of technical options are available to seize the opportunity of managing the limited water resources supply in the project area and encouraging more use of drip system within the collective irrigation scheme. The following steps are suggested by the consultant for immediate action of the water utility and decisions-makers:

- Encourage the use of drip irrigation to a larger extent in the project area and help those farmers who would proceed with a shift to drip irrigation in their fields;
- Adaptation and evaluation of the newly introduced drip irrigation technology by the private sector and promotion of the irrigation system at competitive prices;
- Limit the use of sprinkler irrigation to those farmers who use private and/or common wells;
- Identification of target farmers and establishment of pilot plots using drip irrigation to serve demonstration plots to other farmers in the project area;

- Promote the role of water user's association and encourage farmers to deal commonly with water resources management;

- Raising awareness and interest of farmers in improved water resource management through training and field days.

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