Improvement of Irrigation Water Management in Lebanon & Jordan	**MEDA WATER PROGRAMME** ***Euro-Mediterranean Regional Programme for Local Water Management*** **IRWA** Improvement of Irrigation Water Management in Lebanon and Jordan ***ME8/AIDCO/2001/0515/59776-P 007***	APREL

Fertilization practices assessment and recommendation for adapted Extension Services

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4. National Center for Agricultural Research and Technology Transfer – NCARTT (Jordan)

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List of acronyms

- INRA – Institut National the recherché Agronomique - national center of agronomic research
- Ctifl – Centre technique Interprofessionel de fruits et legumes– National organism of the fruit and vegetable inter-profession.
- DRAFT – Direction régionale des Eaux et Forets - Regional direction of agriculture and forest; it is the office of the ministry of agriculture in each area.
- CETA – Centre d' Etudes Techniques Agricoles– extension services associations managed by farmers;
- AE – Agricultural Expert
- GTZ – Deutsche Gesellschat fur Technische Zusammenarbeit
- MREA – Mission Régionale Eau Agriculture
- SCP – Société du Canal de Provence

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Executive summary

This report is related to the first mission of Mr Jean-Michel CERSTIN in Jordan in the framework of IrWa project of integrated fertilization and irrigation practices dissemination. The overall objectives were:

- to classify the current fertilization practices encountered in the project area depending on their management intensity,
- to provide recommendations on fertilization optimization and
- to settle the first basement of an adapted vulgarization strategy through NCARTT extension agents using.

The fertilization assessment was based on data collected in the "Mémento fertilisation des cultures légumières" published by the French research station Ctifl (Centre technique interprofessionnel des fruits et légumes). Fertilization management was considered satisfying to low. Most farmers do not use any soil analysis to design their fertigation planning and depend only on their own experience. Usually, the amount of fertilizer is fixed per area and per crop and does not evolve during the cropping season. Fertilizers injection is done through the main pump, in a very short period of time and without any control of the fertigation solution quality (EC and pH) suggesting an important efficiency lost.

All the soil samplings were found with very high quantity of available P and K. Analysis using NITRACHEK displayed an excessive amount of NO_3 in the soil and in the crop (tomato and eggplant were tested). Fertilization application may be reduced and save some inputs cost and reduce environmental burdens. Soil organic matter content is generally good. Soil pH is above 7.2 and should be reduce to improve element uptakes by the plant. Farmers mainly use organic matter (chicken manure or mixed chicken sheep, sheep cow) to ameliorate soil structure without taking into account the element mineralization capacity (N specially). Soil and water excessive EC are the main constrain in Karamah region compared to the north of the Jordan Valley.

According to the previous observation fertilization practices can be optimized by:

- Planning fertilization using soil analysis and regular monitoring of NO_3 available in the soil and up took by the plant.
- Adapting fertilization practices depending on crop stage and weather.
- Using acidifying fertilizers (MAP, Ammonium sulphate, ammonium nitrate, urea, nitric or phosphoric acids).
- Promoting adapted injection material (fertigation tanks and Dosatron) to control injection rate and fertigation solution quality.

Currently, the public extension service is under the responsibility of MoA and NCARTT. The NCARTT is internationally recognized for its academic studies but provide only limited applied research activities that have permitted to answer

production constrain met by local farmers. In fact, both national entities are subjected to the same bottle necks that limit the Extension Agents services reliability. Indeed, low skills of Extension Staff, insufficient logistic facilities, lack of working methodologies for on-farm assessment and low motivation of extension agents result in the promotion of a top-down approach where farmers are expected to contact extension agents rather than vice versa.

To gain farmers lost confidence, and promote and adapted extension service, NCARTT should:

1. Specialized its extension service in major farming domains (fertilization, irrigation, plant protection…) with skilful staff, well trained and equipped with the adapted tools and methodologies to answer farmers need directly on the field.

2. Reinforce the role of farmers in decision taking in the planning and implementation of experimentations.

3. Develop applied research strategy base on farmers needs.

4. Strengthen exchanges between extension services and farmers through regular technical meeting and field visits

5. Increase actions visibility through redaction of technical sheets, reports and field visits. During the cropping season, visits of experimentation should be organized to show the first results.

A clear border should differentiate fundamental and applied research and both services should work together to find applied solution to farmers' problem.

Introduction

This report is related to the first mission of Mr Jean-Michel CERSTIN in Jordan in the framework of IrWa project of integrated fertilization and irrigation practices dissemination. The overall objectives were:

- to classify the current fertilization practices encountered in the project area depending on their management intensity,
- to provide recommendations on fertilization optimization and
- to settle the first basement of an adapted vulgarization strategy through NCARTT extension agents.

The mission took place from May 14th to the 18th, 2007 and included:

- Field visits (9 pilot farms) to assess the current fertigation practices, evaluate soil analysis, and conduct several field tests (EC, soil and sap NO3 content).
- Meetings with NCARTT fertigation specialists to understand current research program and vulgarization strategies,
- Presentation of the main mission conclusion to farmers (workshop on Fertilization Assessment and Recommendations for Adapted Technological Transfer Service).

Part 1: Evaluation of current fertilisation practices

Data collection and indicators to be followed during cropping season

This assessment has been done through 9 farm visits that included field measurements on one side, qualitative and quantitative interviews on the other side. Open & close questions on current fertigation practices for major crops of the area (tomato, cucumber, eggplant) has allowed understanding the current situation of fertigation techniques, farmer knowledge, quantity and quality of fertilizers used per crop.

1.1 Indicators

Current fertilization practices were be assessed through:

- Soil and water laboratory analysis interpretation performed before planting
- On farm soil EC measurement
- Sap and soil NO_3 measurements (PILazo®).
- Plants observation on the field

Soil tests have been collected in each interviewed farms at the beginning of cropping season. Soil texture, electro conductivity, organic matter content and cation exchange capacity are basic information to assess fertilizers practices and soil quality. The analyses have been done through NCARTT and JVA soil analysis laboratories in Jordan. A classification of the management will be done taking into account most important field practices.

1.1.1 Soil texture

Soil texture has been use to classify the soil according to 3 main sizes: fine and very fine (Clay, Silt clay, Sandy clay, Silt clay loam, Clay loam), medium (Silt loam, Sandy loam), large (Loamy sand, Sand).

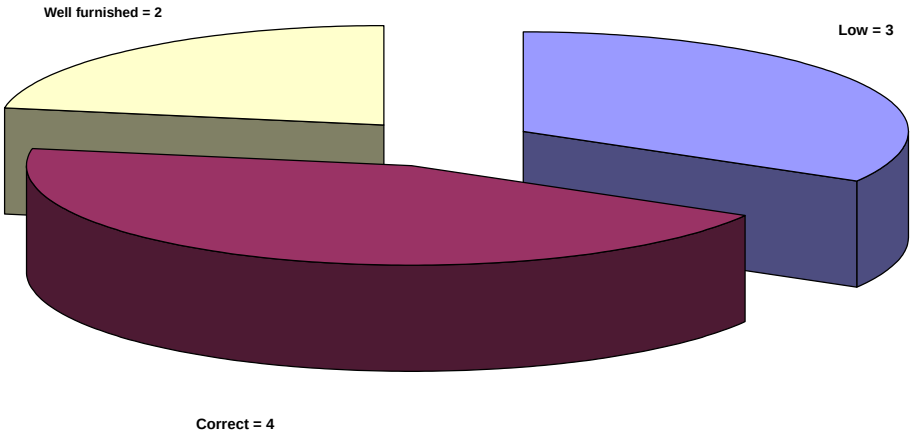
Two zones are defined in the Jordan Valley: the area mainly constituted by loam with more clay in the north (near Deir Alla) and the area with more sand in the south (near Karamah). In our samples, the soil textures were fine to medium. Two soils were Silty clay, three sandy clay loam and 4 sandy loam.

1.1.2 Organic matter content

Organic matter is the vast array of carbon compounds in soil. Originally created by plants, microbes, and other organisms, these compounds play a variety of roles in nutrient, water, and biological cycles. It plays a key role in soil electro conductivity appreciation as low OMC will increase the effects of EC. Organic matter content will be appreciated depending on the soil structure as presented bellow (Table 1).

Appreciation	Organic matter content in g/kg (to have the result in % should divided by 10)	
	Medium soil texture	Fine and very fine soil texture
Low	< 20	< 25
Average	20 to 25	25 to 30
Well furnished	> 25	> 30

Table 1: Organic matter appreciation depending on the soil structure.



Schema 1 **:** Organic matter content

Organic matter content was not perceived as a limiting factor. Only 3 farms were found with a low content of organic matter mainly due to their soil texture (sandy) and low applications habits.

1.1.3 Cation Exchange Capacity

The cation exchange capacity determines the soil fixation ability of the main cation (H+, Ca2+, Mg2+, K+, Na+ and NH4+). It does not evolve much with the time and is a fundamental soil characteristic to take into account. CEC should be appreciated depending on the soil structure as presented bellow (Table 2).

Appreciation	Coarse soil texture	Medium soil texture	Fine and very fine soil texture
Low	< 50	50 to 100	100 to 150
Average	50 to 100	100 to 150	150 to 200
High	100 to 150	150 to 250	250 to 300
Very high	> 150	>250	> 300

Table 2: CEC appreciation depending on soil texture (me/kg)1

Most of the soils from sampled field were find with an average CEC. Only 2 soils were under 100 and only 1 above 150.
To ameliorate this configuration it would be recommended to increase the organic matter content focussing on composted manure and humus.

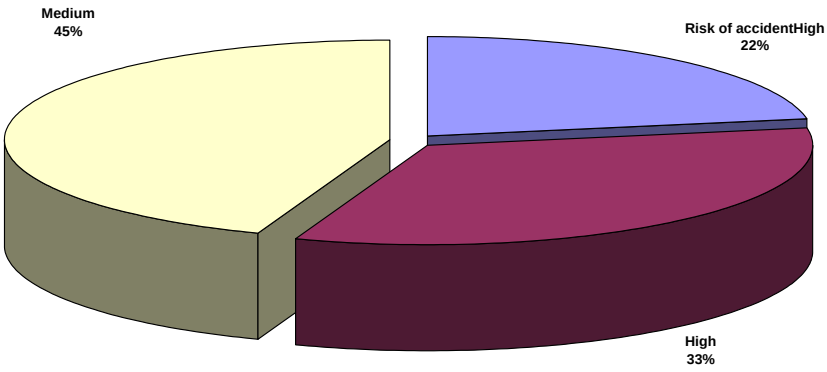
1.1.4 Soil EC interpretation (1/5)

The EC measurement in a sample diluted 5 times gives you the total amount of salt dissolved in your sample. Its appreciation must be done according to the soil organic matter content. More organic mater you have in your soil, less soil salinity will affect the crop. As an example, a soil that contain less than 4% of organic matter is considered salty when the reading is above 0,5. Commonly, the appreciation can be done as following:

Conductivity (mS/cm)	**Salt content (g/kg)**	**Appreciation**
0 to 0.4	0 to 1.6	Low
0.4 to 0.7	1.6 to 2.8	Medium
0.7 to 2	2.8 to 4	High
2 to 5	4 to 20	Risk of accident

Table 3 : EC interpretation

[1] ODET and Al. – 1989. Memento fertilization des cultures legumieres. Edition CTIFL



schema 2 : Soil Conductivity

As we can see on the graph above the soils have a high EC is a residual problem in the farm visited.

Several factors can explain the EC variation within the two regions (south and north):

- The reclaimed water used in Karamah region may induce, with time, an increase of soil salinity,
- Not adapted fertilization practices using reclaimed water involve a higher risk of soil depletion,
- The soils can be naturally salty due to shallow water table or other geologic or pedologic factors.

1.1.5 pH data interpretation

pH mainly impacts on nutrients availability and plant uptake. pH is also an indicator to determined fertilizer nature to be used as fertilizers chemical compositions, affect soil pH. This property is measured in kg of CaCO3 for 100 kg of fertilizers. Normal soil pH range between 6 to 9 even though crops tolerance differs.

Common name	Optimum range of soil pH values
Squash, zucchini	6.0 to 7.0
Tomato	5.5 to 7.5
Eggplant	5,5 to 6,8
Cucumber	5,7 to 7,5
Sweet pepper	5.5 to 7.0

Table 4: Optimum soil pH values

Lower pH values could influence positively plant growth, since most of soils are alkaline (above 7.5). One way to decrease the pH near the roots of the crops is to use acidifying fertilizer like ammonium nitrate, ammonium sulfate, MAP, Urea or to use acids in the irrigation water (nitric or phosphoric acids).

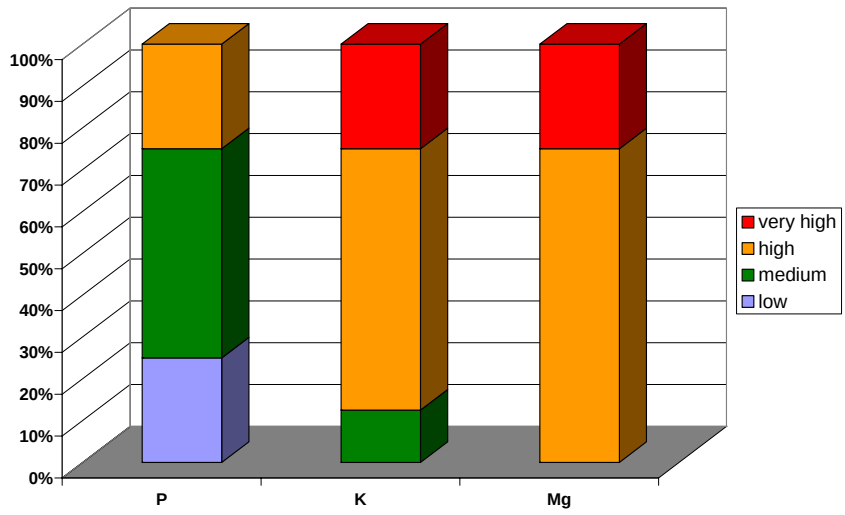
Generally speaking the soil pH was found alkaline (7.2 to 7.9). This particularity is well known by the farmers who are used to apply nitric, phosphoric, citric acid or humic acid. Nevertheless, the application methodology (quantity applied, injection techniques) presented was not satisfying and further measurements could be envisaged to check the real impact of these acids on soil pH.

1.1.6 Nutrients analyze in the soil

Phosphor, potassium and magnesium contents interpretation are presented bellow.

	P Olsen (g/kg)	K (mg/kg)	Mg (mg/kg)
Low	< 50	< 20	< 10
Medium	50 to 80	20 to 80	10 to 50
High	> 80	80 to 500	50 to 500
Very High		> 500	> 500

Table 5: Interpretation of P, K and Mg contents



Schema 3: Appreciation of the quantity of nutrients in farm visited

The soils is quite well furnished in phosphor. Only 2 farms show minor deficiency. Potassium and magnesium amounts are excessive but their balance is good (K/Mg = ½ should be between 0,3 to 0,7).
These high contents may result from fertilizers application. The problem could be solved by a reduction of amendments.

1.2 Measures and observations done during the assessment

Soil and the sap Nitrogen measurements are good indicators of the current situation in the soil and can traduce the plant up take quality at the time of the measurement. As we were at the end of the season, a high amount of nitrates indicate an excess of fertilization. On the contrary, a low level shows that the end of the cropping stage was well managed.

5 farms on 9 were found with high amounts of nitrates in the soil (more than 100 kg NO_3/ha). The NO3 content in the 4 remaining farms was considered as medium (above 30 kg NO_3/ha). This trend was confirmed by the high amount of NO3 found in the sap (PILzao®). Only one farm was found with a low amount of nitrates in the saps.

These high contents of nitrates can be explained by 2 main factors:

- the amendments done with chicken manure and the good organic matter rate increase the mineralization in the soil
- the fertilization during the crop which is higher than the needs of the plants because of soil mineralization.

During the field visit some problems of blossom, due to a deficiency in the calcium absorption and climate changes were observed. Even so the general situation was good with few diseases or pest (except some mites).

1.3 Classification of fertilization management

Farmer management level was first graded according to their practices reliability concerning:

- Fertigation techniques
- Crop rotation
- Type of organic manure used
- Manure application
- Fertilizers solution preparation
- Fertilizer solution injection

and secondly ranked as following:

- <6 low
- Between 6 and 12 medium
- > 12 advanced (cf. appendix 1)

The management level was satisfying as 8 farmers within the 9 were classified with a medium management level. Only 1 has low skills of management.

Most of the farmers base their fertilisation planning on their own experience. They apply compound fertilizers taking into consideration crop stage to determine the fertilizer nature (Phosphorus at the beginning, Nitrogen and Phosphorus in the middle and Potassium at the end). **The main problem relies on the quantity applied**. No real methodology is used to determine the quantity needed and usually farmers apply a determined quantity per area. This practice is encouraged by private companies who provide regular technical assistance even if its reliability is often contested. Very few farmers rely on public extension service mainly due to its low skills quality.

All the farms were equipped by IrWa project with Dosatron and fertigation tanks. Unfortunately only 2 farmers were able to use properly the Dosatron. The fertigation tank was adopted by a large majority of farmers but still, the use of the main pump to inject important amount of fertilizer in a short period (during winter as e.g) is a common practice within the group.

The use of single or mixed organic matter (cow, sheep, chicken) is widely spread in the farming community. The use of fresh chicken manure is not taken in count in the fertilization schedule and there is a risk of excess of nutrient due to its high power of mineralization. Usually farmers concentrate the amendment in the row which may affect positively the final quantity in the roots zone. The application is generally made before solarization to generate bio fumigation. This practice is highly recommended as it ensures good soil disinfection and prevents too high mineralization during the cropping season (element are leached during the solarization). The crop residues are generally not used as organic matter mainly to prevent the spread of pest and disease. Nevertheless one farmer was successfully reusing his crop residue by ploughing them before solarization. **Such practice should be encouraged as it improves soil structure with a low cost of investment, but a particular attention must be paid to prevent the spread of soil disease and some controls of the risk must be done in the farm**.

1.4 Recommendations

According to the management level and taking into consideration the main current practices a room of improvement could be forseen in optimising the fertigation planning and scheduling taking into account crops needs, soil content and water quality by:

- using soil analysis before planting, to schedule the fertilization and the choice of fertilizer. The soils are very high in K, P and Mg in most of case.

- before and during the cropping season, using fast soil and sap analysis (PILazo, nitrachek) to determine the amendment depending on plant uptake

- using acidifying fertilizer like urea, ammonium sulphate, or nitric or phosphoric acid to decrease the pH and to accurate the assimilation. NB: N fertilizer should be avoided when the soil is already well furnished

- promoting the use of composted manure avoiding fresh chicken manure, to increase the buffer effect of organic matter in the saline soil.

Also, to help farmers in adopting integrated practices and to assist extension agents in improving their skills the following experimentations could be studied:

- Role of citric and Humic acid in soil pH reduction

- On farm comparison of fertilization planning between PILazo® management and traditional fertilization practices

- Compare different kind of manure in mineralization power and role in buffer effect

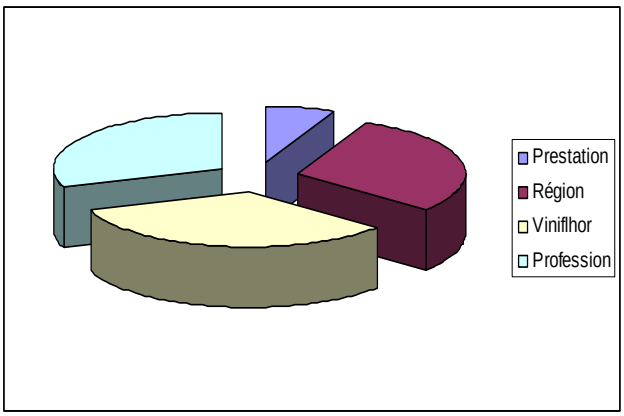
- On farm experimentation to promote manure composting

- Control of the soil disease when crop residues are ploughed.

Part 2: Recommendations for an adapted Extension service

2.1 Presentation of APREL

APREL is a non profit organization created in 1984 to answer the need of decentralized experimentations in the farms, to cross check research center conclusions and to build up strategies of research and development. The board of APREL is constituted by 24 presidents of agriculture organisation (CETA[2]) and of agriculture's chambers extension services (cf. appendix X). These persons are directly related to field problematic as most of them are farmers which ensure the strategy applicability adopted. In more than 20 years, APREL developed a pole of competences concerning variety screening, plant health protection, integrated production techniques.



Schema 4 : APREL source of financing

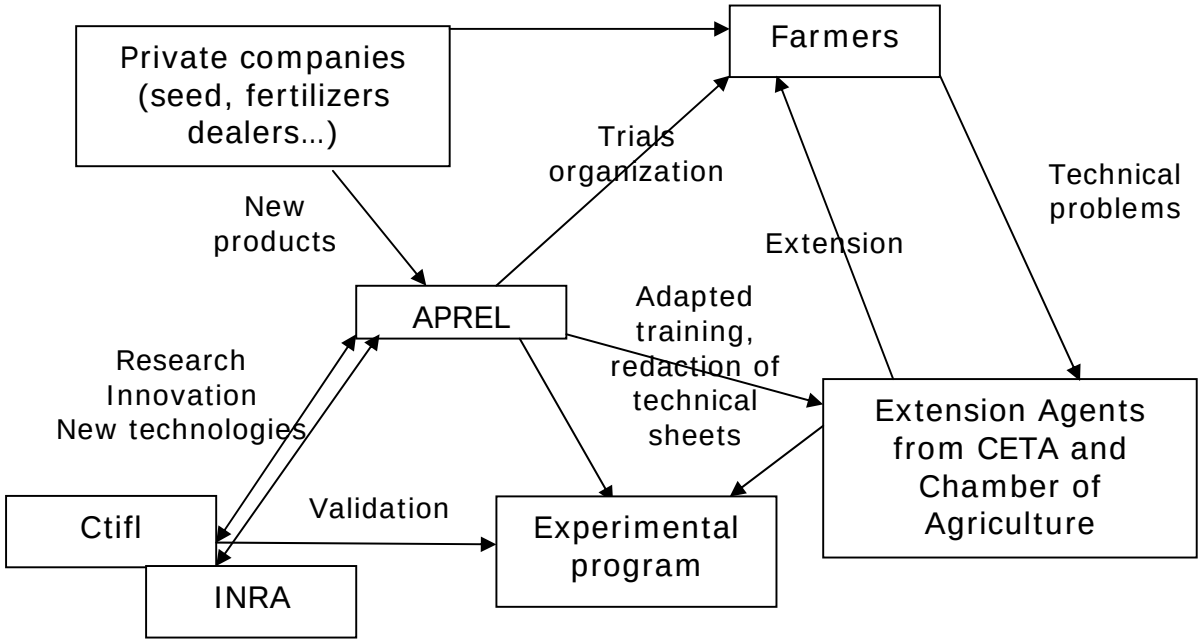
APREL financial sustainability is guarantee by its ability of auto financing through its members contributions. It is also financed on a smaller share by the public establishment in charge of wine, fruits and vegetable (VINIFLHOR), the region Provence Alpes Côte d'Azur, the Committee on Economic and Agricultural Affairs of the Rhone Mediterranean area, agricultural chambers and market gardening CETA.

2.2 Over view of the current organization of technology transfer in Provence.

Under the impulse of agricultural organizations and with the support of other institution (DRAFT and Ctifl), APREL is developing experimentation gathering the technical information from partners working on the regional level (Chamber of Agriculture[3], CETA, private sector). The center benefits form the technical support form the French Institute for Agricultural research INRA and the Ctifl Inter professional Technical Center of fruits and vegetable) to answers its technical constrains and cooperate in the realisation of some experimentation. Both organisms coordinate the experimental strategy at a national level. The following diagrams present how extension strategy is organize.

[2] CETA group of farmers created to engage a common extension agent.

[3] Chambers of agriculture are public establishments managed by representative farmers elected in the working area.



Schema 5 : Functioning of technology transfer and extension in Provence

APREL board is in charge of the experiment program validation defined by extension agents or proposed by private companies. When approved, the experiments are organized on farms and the extension agents from CETA and Chamber of Agriculture drive them in collaboration with APREL. At the end of the season, feed back meeting are organised to restore the conclusions of each demo plots. Finally the transfer of technology is done by producing technical sheet, technical reports and organising field days where producer, extension agent and private companies are invited. In addition regular meetings per species are organized with all the producers to expose the major evolutions.

2.3 How can the APREL organization be used in Jordan?

NCARE is engaging researches on several fields: fertilization, irrigation, variety screening but little information reaches the farmers mainly. To improve its extension service, it is important to professionalize its extension agents and enhance the collaboration between public and private sectors in the design of experimentation strategy. **A clear border should differentiate fundamental and applied research and both services should work together to find applied solution to farmers' problem.**

In addition, the following measures are important to be foreseen:

1. Specialized its extension service in major farming domains (fertilization, irrigation, plant protection…) with skilful staff, well trained and equipped with the adapted tools and methodologies to answer farmers need directly on the field.

2. Reinforce the role of farmers in decision taking in the planning and implementation of experimentations.

3. Develop applied research strategy base on farmers needs.

4. Strengthen exchanges between extension services and farmers through regular technical meeting and field visits. The main point is to be present in the farms and to return the results to farmers to make them feel that the work is done in their interest.

5. Increase actions visibility through redaction of technical sheets, reports and field visits. During the cropping season, visits of experimentation should be organized to show the first results.

Yearly field visit and feed back meeting should present to farmers the main conclusions of the different trials done during the previous cropping season. All the results should be used to do new trial with the aim of validate and adapt them to the field practices.

Conclusion

This first mission in Jordan allowed underlining main farmers' technical problems in fertilisation and presenting recommendations to strengthen the existing extension service.

In the framework of its mission to strengthen NCARE extension services, 6 extension agents are currently working two days per week for IrWa project. Field work, coordination and training were organized by IrWa agricultural expert in collaboration with NCARTT national coordinator. The work implemented by the project is a good starting point as extension agents already follow some of the project pilot farms on irrigation and fertilization topics. This follow-up is important and should not be restrict to irrigation and fertilisation. Additional subjects as cultural techniques, varietals screening, observation of pest and disease must be included in the strategy.

The follow-up of farms initiate by IrWa and NCARE can be the basement of a pilot extension services and should be develop with groups of farmers on different themes or area. It is important to strengthen NCARE visibility and reliance by provided adapted training to its extension agent, encourages field work and regular contact with farmers and build a national strategy for extension services taking into consideration both public and private entities.

Appendix 1

A. Fertigation technique

1. How do you design your fertigation program?	Rank
Personal experience	1
National Extension agent advices	2
Private Extension agent advices	3

2. How do you choose the quantity and quality of fertilizers to use?	
Depending in soil test and/or water test	4
Quantity per area depending on crop stage	3
Quantity per area depending on each crop	2
Quantity written in the packaging	1

B. Crop rotation

No Crop Rotation	0
2 Crop Rotation	1
3 Crop Rotation	2

C. Type of manure used

One Source (chicken)	1
Two Source (cow + sheep)	2
Three Source (chicken + cow + sheep)	2
Humus	3

D. Manure application

Before Solarization	1
After Solarization	2

E. Fertilizers solution preperation

Taking into account the EC and pH of the injected solution	1
Not taking into account the EC and pH of the injected solution	0

F. Fertilizers solution injection

With main pump	1
With fertigation tank	2
With dosatron	3
Maximum grade	**18**

The management level was satisfying as 8 farmers within the 9 were classified with a medium management level. Only 1 has low skills of management.
Farmer management level was first graded according to their practice reliability and secondly ranked as following:

- <6 low
- Between 6 and 12 medium
- > 12 advanced

Appendix 2

Office

	President Gérard Roche (GDA cultures sous abris 84)	
Vice-president Michel Safin (Comité économique BRM)		**Vice president** Loïk de Feraudy (Syndicat des serristes 84)
Treasurer Jean-Luc Tron (CETA de Châteaurenard)	**Secrétaire adjoint** Marc Zavatonni (Chambre d'agriculture 13)	**Secretary** André Bernard (Chambre d'agriculture 84 et Chambre régionale d'agriculture PACA)

Managers directorate

Interprofession

- ✓ Ctifl

Economic commitee

- ✓ BRM

Chamber of agriculture

Departmental

- ✓ Chambre d'agriculture 04
- ✓ Chambre d'agriculture 06
- ✓ Chambre d'agriculture 13
- ✓ Chambre d'agriculture 84
- ✓ Chambre d'agriculture 05

Regional

- ✓ FRCA

Extension services association

- ✓ GRCETA de L'Etoile
- ✓ GDA du Comtat
- ✓ CETA d'Eyguières
- ✓ CETA Durance Alpilles
- ✓ GDA sous abris 84
- ✓ CETA de Saint Martin de Crau
- ✓ CETA des Serristes de Vaucluse
- ✓ CETA de Châteaurenard
- ✓ CETA d'Eyragues
- ✓ CETA du Soleil

Extension services associations are association of farmers to engage an agent to give them some extension services on their farms.

Each organism is represented by its president or a member of the office. The directorate elects the office manager.

The office meets in exceptional case, for example to negotiate new partnerships.

The directorate meets 2 or 3 times per year one time to validate the experimental program and one time to know the results before the general meeting.