The Khanasser Valley Integrated Research Site - Progress Report 2006

R. Thomas, F. Turkelboom, A, Bruggeman, H. Dessougi, E. Luijendijk, & S. Wahiba, ICARDA, Aleppo, Syria

I. Introduction

Activities in 2006 focused on a Participatory Learning and Action Research (PLAR) approach, continued analyses of the groundwater resources via a modelling approach and dialogue with national policy makers. Details of these and the biophysical and socio-economic context of the research site are reported elsewhere (Thomas et al., 2004, 2006).

II. Description of activities

National workshop on marginal drylands in Syria

Following the series of national workshops held in previous years sponsored by the SUMAMAD project, a meeting was organized on January 22, 2006, with the Head of the State Planning Commission of Syria to discuss the results of the KVIRS study and its implications for similar marginal zones in Syria and elsewhere. Around 40 participants drawn from the research organizations and relevant government ministries such as agriculture, water and irrigation, rural development, reviewed the results of the project. It was emphasized that the KVIRS represents the marginal dryland or Zone 4 of the Syrian classification system, i.e., marginal land for cropping. This zone covers around 11% of Syria's land area and houses 2 million people or 14% of the population, most of whom are poor. Rather than dwell on the limitations of the zone, the positive aspects were highlighted as indicated in Table 1:

Biophysical: • Relatively unpolluted environment. • Lower risk for crop and animal diseases • Low input of pesticides. • Specific biodiversity. • Ecological hotspots (e.g. Jabbul • salt lake).	**Socio-economic:** • Indigenous knowledge and local innovations. • Relative cheap land and labour. • Some investments from off-farm income into productive resources. • Improved access to education. • Presence of social networks. • Culture heritage.
Market: • Improved market knowledge via mobile phones and other media. • Reasonable mobility. • Accessible markets (somewhat • remote, but not too far from • urban markets).	**Institutional:** • Improved basic services (electricity, roads, mobile phone network). Increased government attention for poverty alleviation and environment.

Table 1. *The comparative advantages of Zone 4.*

The following range of options were presented and discussed based on on-going research.
Options that strengthen the traditional farming system:
- Extensive sheep production and technologies to improve animal productivity.
- New barley varieties selected through a farmer-participatory approach.
- Wheat production with supplemental sprinkler and surface irrigation to improve water productivity.
- Dairy production from sheep for household consumption and sale of surplus.

Diversification options:

- Drought-tolerant vetch varieties to expand cultivation and minimize production risks.
- Improved management of rainfed cumin (a new cash crop) to increase production and price.
- Olive orchards cultivated on hill foot slopes, with water harvesting, to increase production and reduce need for groundwater irrigation.
- Barley intercrop with Atriplex shrubs to stabilize forage production and enhance protein content in sheep diets
- Application of phosphogypsum to improve soil fertility, increase and stabilize barley production in dry years.

Intensifaction options:

- fattening with lower-cost feeds.

These options were discussed in terms of the possible future livelihood trends and anticipated development pathways that include the intensification and diversification of agricultural enterprises, the temporary out-migration of workers for income generation, permanent migration or exit from agriculture. The meeting concluded that the zone is worthy of increased attention because of the large population numbers with high densities of poverty and that scenarios should be built that include economic, environmental, social, institutional and policy options based on a long-term vision.
Any development strategy for this zone and similar areas in the drylands should consider the multi-functionality of such zones that include agricultural production, social dimensions, environmental services and the need to combat land degradation.
A positive output of the meeting was the recognition by the government ministries of the potential of these areas and a commitment to replicate the study in 3–4 areas with different socio-economic contexts.

Progress on Objective 2. Identification of practices for sustainable soil and water conservation with local communities

Participatory Learning and Action Research approach (PLAR) for monitoring nutrient flows and the development of integrated soil-fertility management practices at the household level.

Before the beginning of the cropping season 05/06, the PLAR team visited the farmers of the selected village and the new season's planning maps were discussed. Different strategies for improving their soil fertility, which had been tested during the 2004/05 cropping season, were reviewed (Thomas, et al., 2005). Farmers expressed their interest in improved rotations using vetch (*Vicia sativa.* L.), and the planting of a food legume e.g. lentil. In addition the farmers opted to continue experimenting with the improved cereal varieties. This resulted in the following agreed activities for the 2005/06 season:

- Rotation experiments of vetch and lentil with barley *(Hordeum vulgare* L.).
- Experiments to select new improved cereal and legume cultivars: farmers tested different barley varieties in comparison to the local variety and 2 improved lentil varieties.

As in the previous planting season 04/05 (Thomas et. al., 2005), all experiments were conducted by farmers using their own management strategies under the supervision of the PLAR team.

Results and Discussion

Rotational experiments

The average yield of barley after vetch was comparable or slightly higher to that obtained before incorporating the vetch (1.1 and 0.9 t/ha grain and straw and 1.05 and 0.9 t/ha, respectively) under medium and good fertility management conditions. The average yield of barley after vetch plus added animal manure (20 m^3) was only 50% (1.8 and 0.4 t/h grain and straw, respectively) that of barley with animal manure only, which yielded 2.8 and 1.0 t/ha of grain and straw. This indicates that further research is needed on the effects of animal manure and vetch on cereal yields in the rotation. Soil analysis showed no differences in nitrogen concentrations in the soil before and after vetch as would be expected after one growing season. In general, the participating farmers, as well as over 50% of the households in the community, who have adopted the planting of vetch in rotation with barley and/or wheat, expressed their satisfaction with this strategy because it restores or builds the soil fertility (which is a slow process) and at the same time provides the farmers with additional income by selling the vetch seed, i.e. it combines long term soil fertility maintenance and build up and provides short term increases in income.
Improved barley and lentil varieties

The average grain yield of the local barley variety was 1.05 ton/ha and average straw yield of 0.9 t/ha under medium soil fertility management classes and 2.8 t/ha grain and 1 t/ha straw under good fertility management as compared to the introduced varieties Zanbaka and Tadmour with an average grain yield of 0.9 t/ha and straw yield of 1 t/ha and 0.62 t/ha grain and 0.8 t/ha straw, under good and medium fertility management. The farmers again opted for the local barley variety indicating that it is superior in terms of adaptability to their conditions, needs less inputs and the fact that the local variety yields more grain than the improved ones. However, one of the farmers expressed his interest to continue testing with other new cultivars and comparing to the local barley variety.
The yields of both improved and local lentil varieties were severely affected by a phase of hot temperatures during the flowering stage. However, the improved lentil variety (Idlib 3) had a higher grain and straw yield of 0.4 and 1.3 t/ha, respectively, as compared to the local variety with 0.1 and 1 t/ha of grain and straw, respectively, under good fertility management conditions and 0.04 and 0.6 t/ha of grain and straw, respectively, under medium fertility management. The farmers were enthusiastic for the new improved variety but suggested planting it again in the new cropping season in order to assess its full potential under their conditions.
However seed production is a problem. The PLAR test farmers kept the seeds from the harvest for the new season 2006/07 and agreed to consider the possibility of providing other interested farmers with some of the improved lentil variety seeds, under the condition that the same amount of the improved seed should be given back to them at harvest time.

Nutrient flow analysis

To be able to analyse the nutrient status at community level as affected by the land use systems, fertility management level and environmental conditions, a large scale study needs to be conducted. The PLAR nutrient flow questionnaire was modified and data is being collected from 140 farmers from 10 different villages representing all land use systems and all rainfall zones. The analysis of this data is pending and will give an idea about the nutrient status and the factors affecting it under dryland conditions.

Use of animal manure in home gardens

With regard to the study investigating the use of animal manure in home gardens (Thomas et. al., 2005), the MSc. student has finished with the first pot experiment in the glasshouse at ICARDA to study the effect of different rates of manure on tomato growth and yield of irrigated tomato. Soil from the participating farmer's field was analysed and collected for pot experiments under controlled conditions. The soil was sieved and put in the pots and then mixed with sheep manure at rates equivalent to 0; 10; 20; 40; 60; 80; and 100 t/ha (treatments M0; M1; M2; M3; M4; M5; M6, respectively). In addition, there was a fertilizer treatment of added NPK. The seeds were germinated and 1 month old seedlings were transplanted to the pots with each treatment being replicated 4 times. The experiment was harvested after 4 months and soil and plant nutrient contents were analysed.
To determine the most appropriate rates for using sheep manure on tomato plants in home gardens in rural societies under field conditions, the same experiment was conducted in the field. The experiment was harvested after 6 months.

Chemical analysis of soil and plant samples is pending

Results

Generally, the results have shown that at low levels of manure application from treatments M1 to M4 there were no differences in dry weights of the shoot, roots or nutrient contents of the plants as compared to the control at 0 t/ha (Figs. 1; 2a and 2b; 3a and 3b). The results showed that with about 80 t/ha (M5) the plants had their highest yields both above and below the ground and had highest uptake nutrient content (Figs. 1, 2, 3). MP4 and MP6 shoot and root dry weights were comparable to the optimum NPK dose but, with regard to nutrient concentration the MP6 treatment produced highest nutrient concentrations. Thus it can be concluded that the optimum amount of sheep manure for growing tomato is 80 to 100 t/ha. On completition of chemical analysis, the data from the field experiment will also be analysed and the results compared to those from the pot experiment, and a final conclusion can be draw

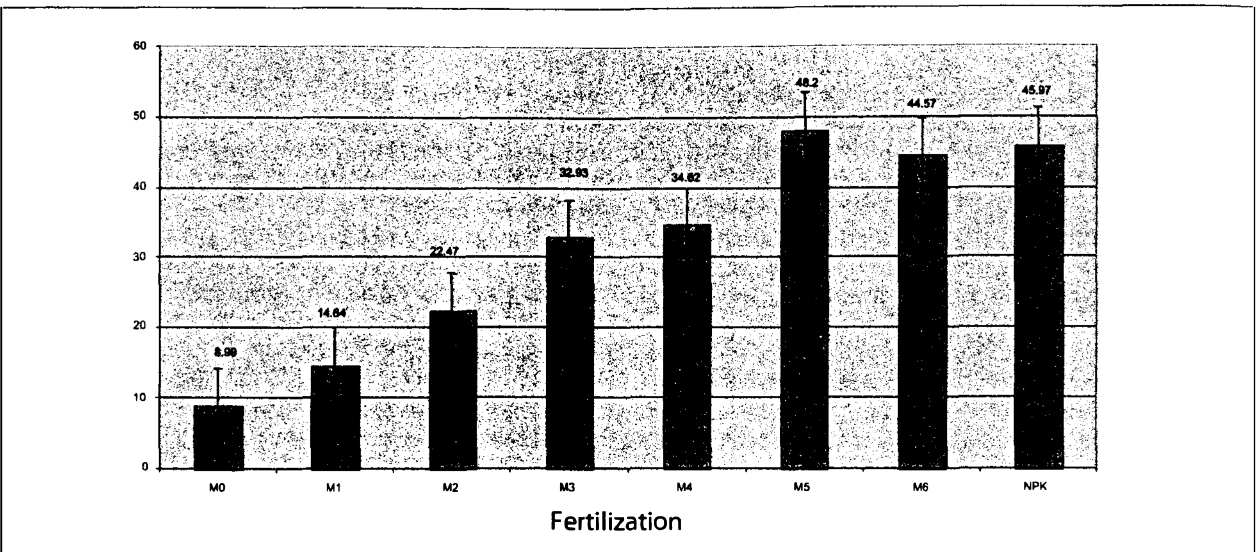

Figure 1. *Shoot dry weight of tomato plants as affected by different levels of sheep manure and inorganic fertilization*

The project activities have mainly helped the farming communities that are part of the Participatory and Learning Action Research and made researchers realize that farmers can undertake experimentation when motivated other than through financial incentives. The gains in productivity and income generation remain a main driving force for farmer participation but along side this is an increasing awareness that soil fertility can be built up and land degradation can be reversed.

Farmers have agreed to continue the experimentation in future growing seasons but will need to be supported by the PLAR team. In this respect it is too early to determine if there will be 'sustainability'.

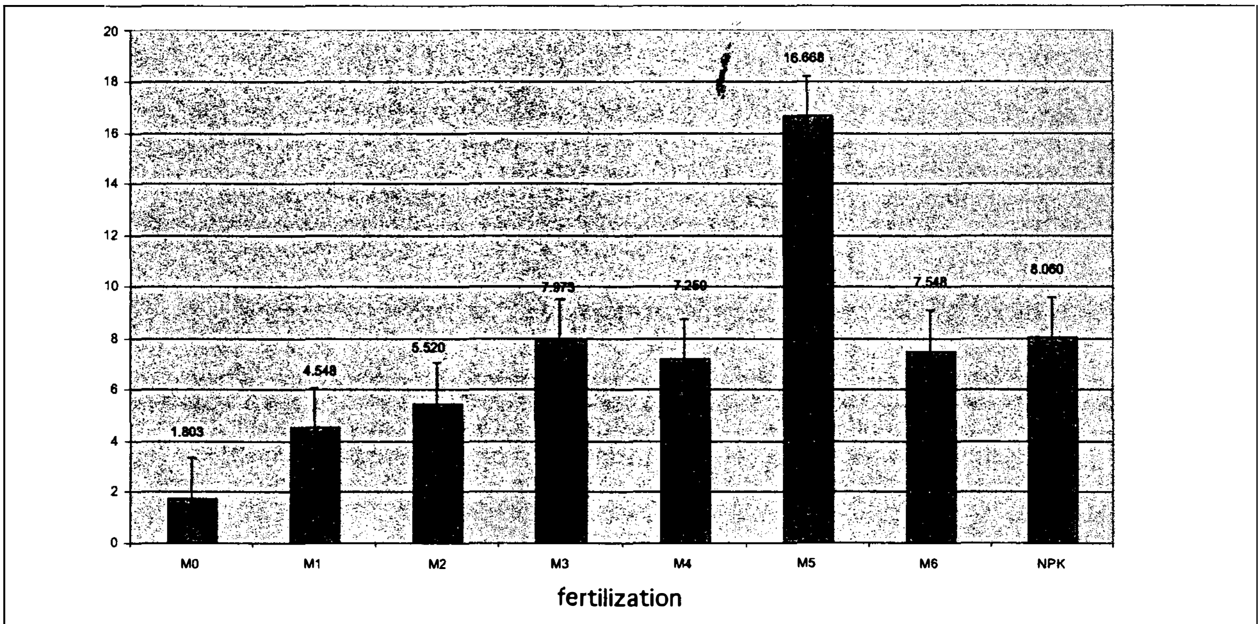

Figure 2a. *Root dry weight of tomato plants as affected by different levels of sheep manure and inorganic fertilization*

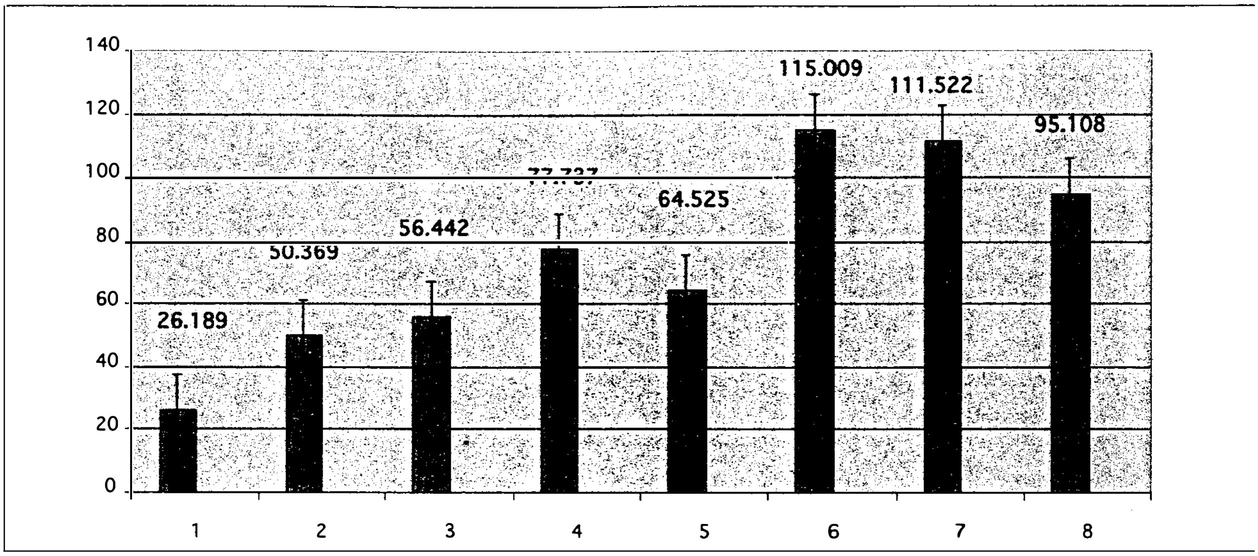

Figure 2b. *Root length of tomato plants as affected by different levels of sheep manure and inorganic fertilization*

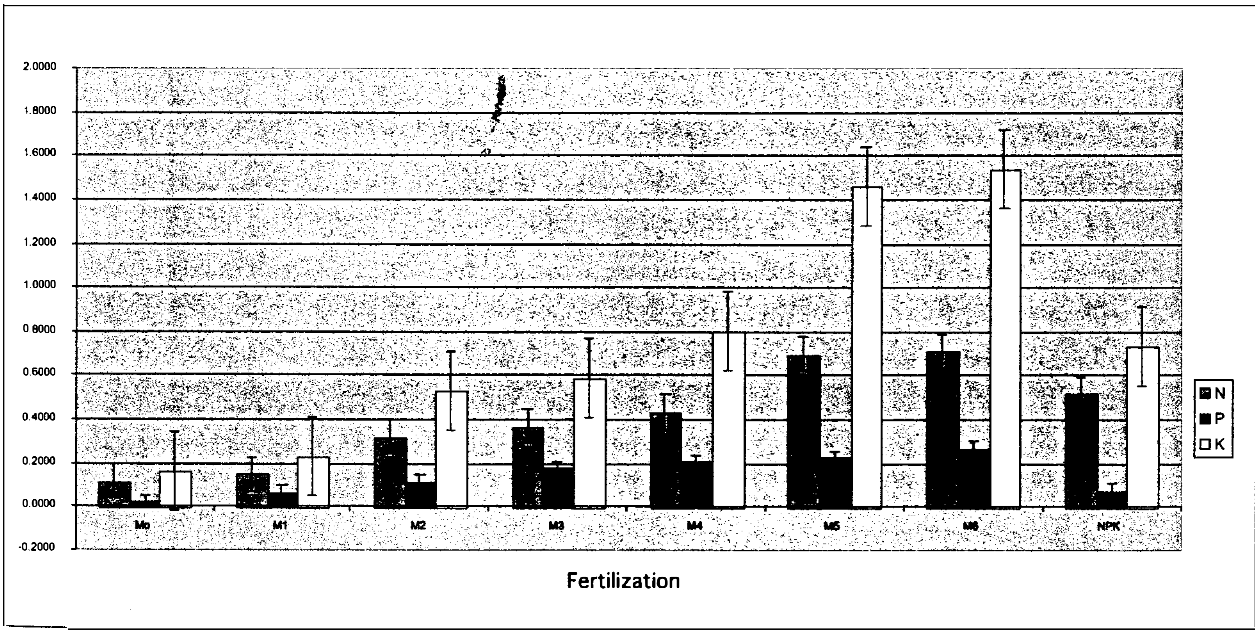

Figure 3a. *N, P and K uptake of tomato plants as affected by different levels of sheep manure and inorganic fertilization*

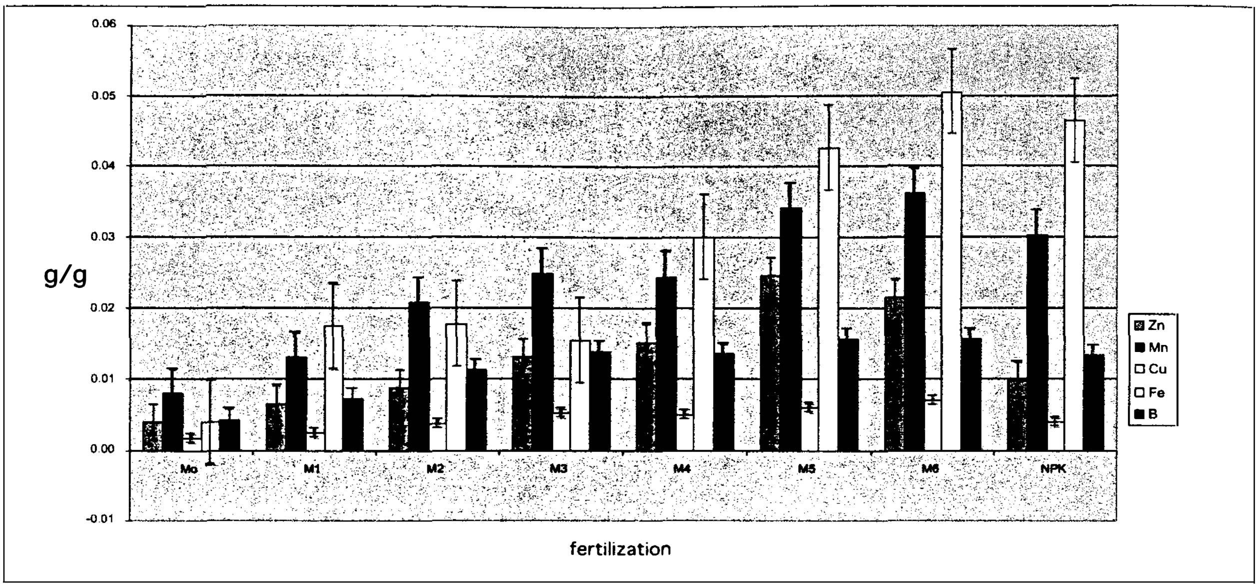

Figure 3b. *Zn, Mn, Cu, Fe and B uptake of tomato plants as affected by different levels of sheep manure and inorg*

Numerical modeling to estimate sustainable groundwater use rates for the Khanasser Valley

In dryland areas such as Khanasser Valley access to groundwater can help stabilize rainfed crop production. But groundwater is often also the only drinking water source for rural families and their livestock. With the rural population in the valley doubling in size during the last three decades, the stress on this resource has been enormous. On the other hand, due to the low rainfall and high evaporation rates in this environment, little water replenishes the aquifers. Isotope analysis in Khanasser Valley indicated that some of the water being pumped today was recharged more than 3,000 years ago. Current day recharge mainly takes place in the basalt covered plateaus of the Jabal Al-Hass and Jabal Shbayth hill ranges that border the valley. Remains of four ancient qanats, slightly sloping underground tunnels that have been dug into the hillsides to let the groundwater flow out in to the valley, have been found in the Khanasser Valley area. Two of these qanats dried up in the 1970s when motorized pumping started, whereas two others had collapsed much earlier. A fifth qanat located in the undisturbed valley of Shallalah Saghirah is still in use today.

To improve our understanding of the dynamics of the groundwater system in the Khanasser Valley and the reaction of this system to external influences, such as pumping, a numerical flow model (MODFLOW-2000) was used. The model was calibrated to match groundwater levels and flow observations taken in the 1970s, prior to the development of the groundwater resources in the valley, supplemented by a number of recent observations from locations where groundwater levels were not likely to have been substantially affected by pumping. Parameter uncertainty was taken into account by calibration of the model for a range of recharge values. The optimum calibrated parameters gave an average recharge over the study area of 1.0% of the long term average annual precipitation, with an uncertainty range of 0.24% to 2.4%.

Simulation of the impact of present pumping rates (1.3 ×106 m3yr-1) indicated that these pumping rates would cause an inflow of water from the Jabbul Sabkhah (saline depression) after 15 to 62 years of pumping, and should, therefore, be considered unsustainable. An example of the change of flow volumes over time following the initiation of pumping is presented in Figure 4. Initially, pumping is mainly compensated by a decrease of the water stored in the aquifer. In a later stage the system stabilizes. The change in storage slows down, and evapotranspiration and outflow into Jabbul Sabkhah are both reduced, as compared to the initial steady-state situation. The slight decrease of pumping in the first 150 years is caused by the drying up of a number of wells.

Simulation of the current climate scenario indicated that the groundwater levels are much more vulnerable to changes in pumping rates than to droughts. The groundwater level changes in a 30 year simulation generally remained within a range of 0.4 m. Water level declines were mainly confined to the basalt plateaus. Testing of sustainable scenarios indicated that a uniform redistribution of the production wells, in which each village was assigned one well, resulted in higher sustainable pumping rates than could be obtained by the current production wells. Estimated sustainable pumping volumes per village were within the range of 800 to 29,740 m3 yr-1.

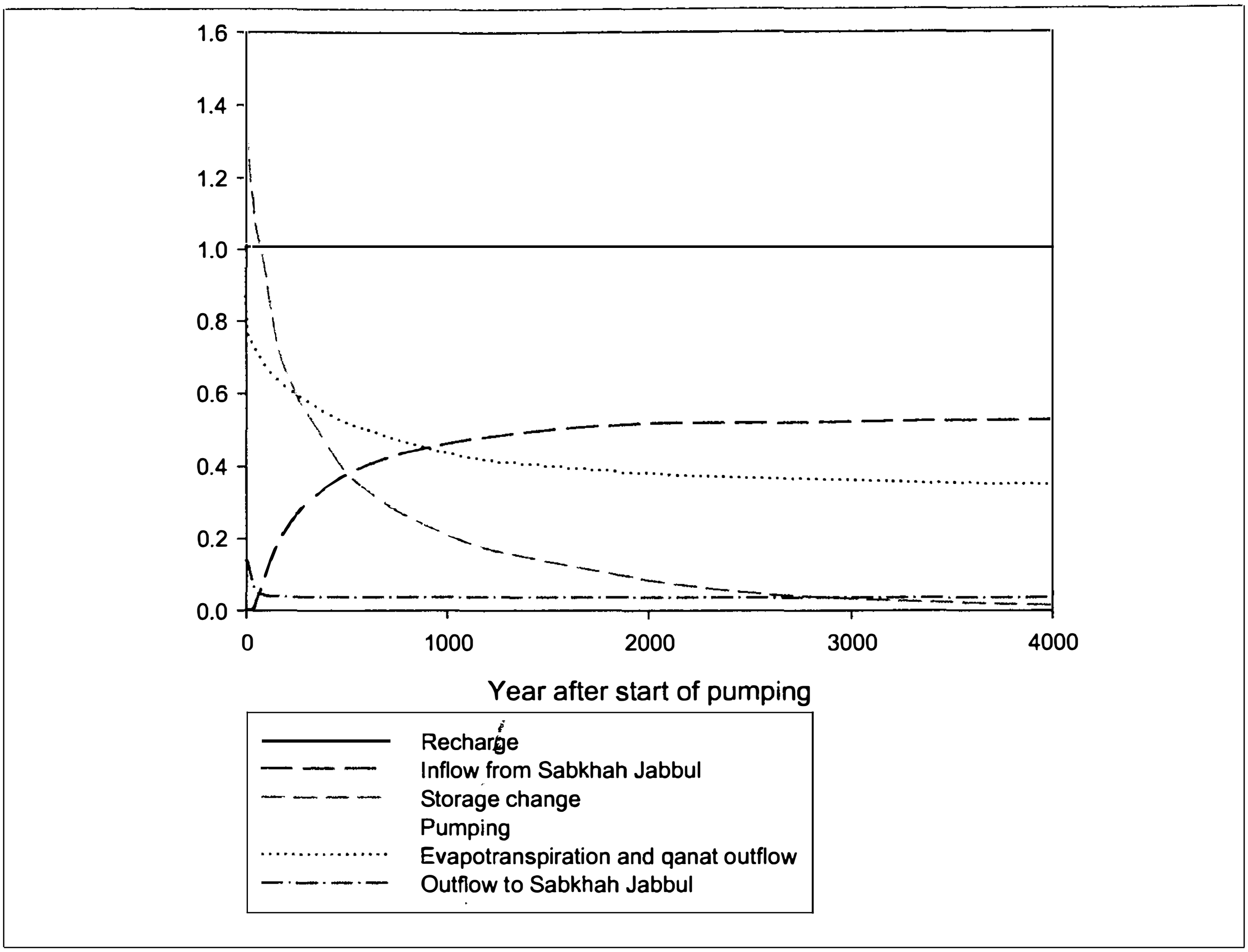

Figure 4. *Example of simulated changes in flow volumes over time as a response to current pumping rates.*

III. Conclusions

The national workshop was successfully used to present the overall project results and possibilities to high level policy makers within the Syrian government. The project team will work together with relevant ministry staff to develop a new development project for international funding.

The PLAR approach has proved to be very successful in understanding production constraints and farmers' concepts and ideas with regard to appropriate soil fertility management. The approach also has provided satisfactory strategies for soil fertility management which are being adopted by the PLAR farmers as well as other farmers not involved directly in the approach.

Lessons learned from the approach shows farmer to farmer communication and demonstration is one of the most convenient methods for disseminating good technology and this has helped us in introducing the vetch to a large number of farmers who are now using the vetch without any interference from the PLAR team.

Modelling of groundwater use rates indicate that excess pumping from wells is more of a threat to supplies than unpredictable droughts and that it is possible to set targets for water extraction that will not jeopardise long-term sustainability.

The MSc. student will continue working with field experiments to study the effect of water shortage on tomato growth and yield when manure is applied; effect of manure on tomato plants at the different growth stages, and on the physical and chemical properties of the soil, and the trade-offs of manure uses.

IV. Draft workplan for 2007

- Continuation of glasshouse and field studies on the use of organic nutrient resources for tomatoes. (income generation)
- Completion of a M.Sc. thesis. (training)
- Continuation of farmer selected interventions in crop rotations. (soil and water conservation practices and income generation).
- National workshop or planning meeting (communication with policy makers).

References

Thomas, R., Turkelboom, F., La Rovere, R., Oweis, T., Bruggeman, A. and Aw-Hassan, A. 2004. Towards integrated natural resources management (INRM) in dry areas subject to land degradation: the example of the Khanasser valley in Syria. UNESCO-MAB Drylands Series No. 3. In: *Proceedings of the International Workshop on Sustainable Management of Marginal Drylands, Shiraz, Islamic Republic of Iran, 29 Nov–2 Dec., 2003.* pp. 80–93, UNESCO, Paris.

Thomas, R.J., Bruggeman, A., El Dessougi, H., Luijendijk, E., Turkelboom and LaRovere, R., 2005. Sustainable management of marginal drylands: the Khanasser valley integrated research site in Syria. In: *Proceedings of the Third Project Workshop, Djerba, Tunisia 11–15 December, 2004.* pp. 137–148, UNESCO, Paris.

Thomas, R. J., Bruggeman, A., El-Dessougi, H., Luijendijk, E., Turkelboom, F. 2006. Sustainable management of marginal drylands – the Khanasser Valley Integrated Research Site in Syria. In: *Proceedings of the Fourth Project Workshop held in Islamabad, Pakistan, 27–31 Jan., 2006.* pp. 121–134, UNESCO, Paris.