

**FACULTY OF AGRICULTURAL
AND FOOD SCIENCES**



**ANNUAL REPORT OF SPONSORED RESEARCH
PROJECTS AND SERVICE CONTRACTS**

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PREPARED BY

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Chairman of Research Committee

EXECUTIVE SUMMARY

Research funds and income from service contracts amounted to 3,885,726 US\$. Research funds from the Lebanese National Council for Scientific Research (LNCSR), University Research Board (URB)/Initiative for Biodiversity Studies in Arid Regions (IBSAR) at AUB, Service Contracts and International Agencies accounted for 1, 4.8, 20 and 74.2 %, respectively.

During the academic year 2003-2004, the Faculty of Agricultural and Food Sciences hosted 14 international-, 7 LNCSR-, and 16 URB/IBSAR-funded projects and 8 service contracts. Research areas funded by International Agencies included biotechnology, biodiversity, animal nutrition, poultry science, crop production, plant pathology, sustainable agriculture, and integrated pest management. Research domains funded by the LNCSR and URB/IBSAR were more varied and included agronomy, crop production and protection, animal and plant diseases, genetically modified organisms, fertigation, human nutrition and obesity, community nutrition, animal and poultry nutrition, trace minerals, cereal science and wild life. Service contracts involved agricultural extension, crop production, dairy stock improvement, and vegetable seed trials.

The number of research projects was 37. Of these, 18 were in the Department of Plant Science, 7 in the Department of Animal Science, 6 in the Department of Land and Water Resources, 5 in the Department of Nutrition and Food Science and 1 in the Agricultural Research and Education Center.

The number of service contracts was 8. Of these, 3 were coordinated by the Department of Land and Water Resources, 3 by the Department of Animal Science and 2 by the Agricultural Research and Education Center.

INTRODUCTION

The Faculty of Agricultural and Food Sciences at the American University of Beirut is at the forefront of internationally-recognized basic and applied research geared towards serving the needs of Lebanon and the region and is actively involved in providing extension/training services to the community.

In addition to addressing a broad spectrum of research needs in the agricultural, food, landscape and nutritional sciences, the Faculty is particularly active in community service and development. Since 1997, the Faculty has assumed the leading role in the Dairy Stock Improvement Project, aimed at upgrading the productivity of Lebanese dairy farms, through supervising import of genetically-improved heifers from the US and providing training to recipient farmers on management practices. The Sustainable Forage Development Program provided effective training for enhancing the capabilities of dairy farmers, who received cows through the US Dairy Stock Improvement Program, to produce forage crops. The Technology Transfer and Extension projects outlined the profiles of farming systems in the country and provided training to farmers to upgrade agricultural productivity and profitability.

The Faculty has been participating in collaborative efforts to establish standardized virus detection methods for the Middle East. The project, Development of a Regional Viral Indexing and Certification Program for Plant Propagation Materials in The Middle East, aims at developing detection methods for major viruses infecting selected crops and establishing a plant pathogen detection laboratory in Lebanon through collaborative research among countries in the Middle East under the leadership of the University of Wisconsin, Madison, in the US. The Faculty has been leading in efforts on management of Cedar Forests in the Mediterranean. The project, Integrated Management of Cedar Forests in Lebanon in Cooperation with other Mediterranean Countries, aims at developing an action plan for integrated management of forests including assessment of insect infestation in cedar forests in the Mediterranean region, determining the causes of *Cephalcia tannourinensis* insect infestation outbreak in Tannourine and assessing the possible threats of similar outbreaks in cedar forests in the region. The project Bioprospecting in the Middle East aims at identifying medicinal plants that are indigenous to Lebanon and investigating their biological activities through multidisciplinary approaches.

The Faculty operates an Environmental and Sustainable Development Unit that aims to promote collaboration on sustainable development initiatives among departments at AUB and other institutions and organizations undertaking related activities. The Unit draws on the vast experience of the Faculty in natural resource management and environmental issues of relevance to the region. The Unit focuses on research and development activities linked to community development and operates in close cooperation with the Interfaculty Graduate Environmental Science program.

RESEARCH FACILITIES

Research facilities available in the Faculty of Agricultural and Food Sciences include the following:

Department of Animal Sciences

- Animal Rooms
- Feed Analysis Laboratory
- In Vitro Digestibility Apparatus
- Culturing and Enumeration of Microorganisms
- Tissue Culture Compartment
- Serology and Molecular Biology Research
- Histology and Immunofluorescence
- Conventional and Environmentally Controlled Poultry Houses
- Small Ruminant Digestibility Units

Department of Land and Water Resources

- GIS Facilities
- Atomic Absorption Spectrophotometer (Micro and Macro Nutrient Analysis)
- Flame Photometer (K, Na & Ca measurement)
- Digestion Block and Microwave Digestion System
- Measurement of Soil Physical Properties
- Water Quality Measurement (Salinity, pH, Cations, Anions & Turbidity)
- Computer Facilities to Perform Required Analyses

Department of Nutrition and Food Science

- Caloric Value Determination of Foods
- Dietary Fiber Determination Unit
- High Pressure Liquid Chromatography Apparatus
- Gas Chromatography Apparatus
- Human Metabolic Unit
- Dual Energy X-Ray Absorptiometry Unit
- Body Composition Analyzer Apparatus
- Indirect Calorimetry
- Mixograph
- Sensory Evaluation Laboratory
- UV-VIS Spectrophotometer
- Food Processing Pilot Plant with Facilities for Canning, Evaporation, Dehydration, Bread Making, and Chilled and Frozen Storage, of Foods

Department of Plant Sciences

- Greenhouses for Plant Propagation and Pot Experiment

- Growth Chambers and Incubators for Microorganisms, Insects and Plants
- Extraction Equipment
- DNA and Protein Analysis (Electrophoresis and PCR)
- Tissue Culture Setup and Equipment
- Plant Tissue Analysis and Composition Equipment
- Light Microscopy Equipment for Research and Teaching
- Gas-chromatography and Mass Spectrometry

Agricultural Research and Education Center (AREC)

The Agricultural Research and Education Center, located in the Beqaa, has 600 dunums that can be subdivided into 5 dunums plots, and allocated for research on rain-fed and irrigated agronomic and horticultural crops including medicinal plants using several types of up-to-date agricultural machinery and implements in the fields of mechanization, irrigation, and soil fertility. A plot of 110 dunums has recently been allocated for organic crop production. In addition, phytothrone, three greenhouses, and an orchard of several fruit species are available. Facilities in the poultry sector allow for conducting nutritional trials on broilers in floor pens, battery brooders and cages. Moreover, a Seed Bank has been recently established to preserve genetic materials for short and longtime periods. Trials on laying hens can be conducted in groups using floor pens, or individually in cages placed in environmentally controlled rooms. A new environmentally controlled layer house, equipped with colony cages, has been established for research trials on laying hens and parent breeders. Moreover, a conventional poultry house has been converted to conduct free-range poultry research trials. A dairy herd and flocks of Awassi sheep and Shami goats with milking parlors are available for research activities. Research trials on small ruminants can be conducted in individual and collective pens. Crates for conducting digestibility trials on small ruminants are also available. A creamery has been recently renovated and equipped to conduct research on dairy products.

RESEARCH INTERESTS

Research themes/interests that are being pursued by faculty members include the following:

Department of Animal Sciences

- Identification and Control of Animal Diseases
- Identification of Major Contaminants of Milk
- Utilization of Food By-products in Animal Nutrition
- Restricted Feeding and Fat/Fat-Soluble Vitamin Supplemented Diets in Animal Nutrition
- Pasture Utilization and Grazing Intensity
- Livestock-Environment Interactions
- Bioeconomic Sustainability of Small Ruminant Systems

- Optimization Strategies for Small Ruminant Production
- Barley and Low-Protein Diets in Poultry Nutrition
- Molting of Laying Hens
- Nutrient Requirements of Poultry at High Temperatures
- Utilization of Prebiotics and other Feed Additives in Poultry Diets

Department of Land and Water Resources

- Environmental/Rural and Dry land Hydrologic Modeling
- Water Harvesting/Storing
- Nutrient Management in Agricultural Systems
- Agrochemical Toxicity and Residual Effects in Soils
- Development of Suitable Fertilization Programs for Major Crops in Lebanon
- Fertigation
- Design and Analysis of Agricultural Machinery
- Pesticide Application Technology and Drift Reduction Techniques
- Modeling the Dynamics and Transport of Pesticide Sprays
- Water Requirements of Crops and Deficit Irrigation
- Water Resources Management
- Agricultural and Environmental Sustainability
- Application of GIS Methodologies in Desertification Monitoring
- Phytoremediation and Pollutant Dynamics in Soil-plant Systems
- Economics of Water and Natural Resources
- Wastewater Utilization
- Economics of Biodiversity
- Selenium Status in Lebanese soils, Plants and local Foodstuffs

Department of Nutrition and Food Science

- Diet Composition in Obesity and Hyperinsulinemia
- Dietary Fats and Plasma Lipids
- Nutritional Status of Populations
- Vitamins in Health and Disease
- Macronutrient Metabolism
- Assessment of Bone Density and Percent Body Fat
- Nutrition and physical performance
- Nutrition and Renal Disease
- Metabolic Aspects of Appetite Control
- Processing, Nutritional Value and Sensory Properties of Traditional Foods
- Bread and Cereal Technology
- Nutritive Value of Foods
- Functional Foods
- Shelf-Life Determination of Foods
- Food Microbiology
- Sensory Evaluation of Foods

Department of Plant Sciences

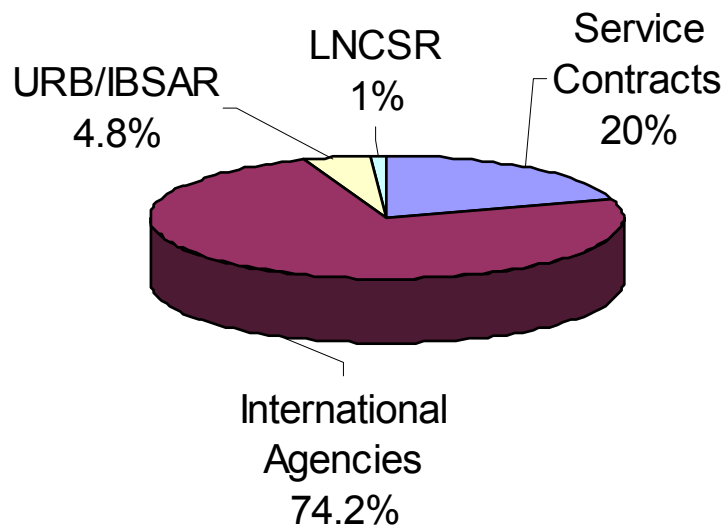
- Etiology and Epidemiology of Plant Diseases
- Integrated Pest Management
- Validation of Models for Disease Prediction and Forecasting
- Survey and Identification of the Wild Mushrooms of Lebanon
- Pesticides Residues, Metabolism and Fate in the Environment
- Biorational Pesticides
- Alternative Use of Herbicides, Fungicides and Insecticides
- Characterization of Plant Genetic Resources
- Plant Breeding
- Medicinal Properties of Wild and Cultivated Plants
- Phytoremediation

Faculty Research Funds and Service Contracts

2003 – 2004

Faculty Research Funds and Service Contracts (2003-2004)

Source	Amount (\$)
Service Contracts	776,212
International Agencies	2,882,651
University Research Board (URB)/ Initiative for Biodiversity Studies in Arid Regions (IBSAR)	185,603
Lebanese National Council for Scientific Research (LNCSR)	41,260
Total	3,885,726



Service Contracts*

Coordinator	Department ^a	Title	Funding Agency ^b	Area	Amount in \$
R. Zurayk	LWRS	Provision of technology transfer and extension to complement the irrigation rehabilitation project –Yammouneh	CDR	Agricultural Extension	89,570
R. Zurayk	LWRS	Provision of technology transfer and extension for major irrigation schemes (Akkar El Bared, Dannyieh, Qasmieh, South Bekaa)	CDR	Agricultural Extension	475,895
R. Zurayk	LWRS	Asset building of small Lebanese farmers	SEAL	Agricultural Extension	9,000
N. Dagher	ANSC	Dairy stock improvement in Lebanon	US AID	Animal Science	93,837
S. Hamadeh	ANSC	Establishing a national training unit in Lebanon	IFAD	Agricultural Extension	77,761
S. Hamadeh	ANSC	Technical training support & monitoring to field extension agents & the M&E team of C/MADP	IFAD	Agricultural Extension	20,857
M. Farran	AREC	Vegetables seeds trial at AREC	Unifert	Crop Production	3,500
M. Farran	AREC	Expansion of the existing pilot apple nursery	INDEVCO	Crop Production	5,792

*. Processed by Regional External Programs (REP) office.

a. ANSC: Animal Science; AREC: Agricultural Research and Extension Center; LWRS: Land and Water Resources.

b. CDR: Lebanese Council for Development & Reconstruction; IFAD: International Fund for Agricultural Development; SEAL: Social and Economic Action for Lebanon; US AID: United States Agency for International Development.

International Agencies

Investigators	Dept. ^a	Title	Funding Agency ^b	Research Area	Amount in \$
Y. Abou-Jawdah	PLSC	Development of a regional viral indexing & certification program for plant propagation materials in the Middle East.	University of Wisconsin	Integrated Pest Management	69,000
Y. Abou-Jawdah	PLSC	Selection of cucumbers for resistance to cucurbit yellow stunting disorder virus	USDA	Plant Pathology	7,051
N. Kawar	PLSC	Integrated management of cedars forests in Lebanon in cooperation with other Mediterranean countries	UNEP/GEF	Integrated Pest Management	530,500
S. Talhouk	PLSC	Collaborative molecular biotechnology integrating network	MAICH	Biotechnology	400
S. Talhouk	PLSC	Bioprospecting in the Middle East	Hightech FZE	Biotechnology	1,198,680
S. Talhouk	PLSC	Biotechnology II Program: Escort fund	Mercy Corps	Biotechnology	10,996
S. Talhouk	PLSC	Biotechnology III Project	Mercy Corps	Biotechnology	138,164
S. Talhouk	PLSC	Development of the national biodiversity framework for Lebanon and top up biodiversity enabling activity	UNDP	Biodiversity	99,950
R. Zurayk	LWRS	Sustainable livelihoods in drylands community of practice	World Bank /UNDP	Sustainable Agriculture	7,661
R. Zurayk	LWRS	Enhancing livelihoods of poor farmers in south Lebanon: Community supported agriculture.	Mercy Corps International	Sustainable Agriculture	218,020
M. Sidani	AREC	Sustainable forage development program	Mercy Corps International	Crop Production	589,000
M. Farran	ANSC	MEA dehulled meal feeding trials	ASA	Animal Nutrition	229
M. Farran	ANSC	Evaluation of graded levels of organic manure on yield and quality of vegetable crops grown in the Bekaa valley	Green Line Association	Crop Production	8,000
M. Farran	ANSC	Free range table bird production	Green Line Association	Poultry Science	5,000

a ANSC: Animal Science; AREC: Agricultural Research and Extension Center; LWRS: Land and Water Resources; PLSC: Plant Science.

b. ASA: American Soybean Association; MAICH: Mediterranean Agronomic Institute of Chania; UNDP: United Nations Development Program; UNEP/GEF: United Nations Environment Programme/Global Environment Facility; USDA: United States Department of Agriculture.

**University Research Board (URB)/
Initiative for Biodiversity Studies in Arid Regions (IBSAR)**

Name	Dept*.	Title	Research Area	Budget \$
Abou-Jawdeh, Yusuf	PLSC	Diagnosis of Mollicutes infecting fruit trees in Lebanon	Crop protection	10,000
Baalbaki, Riad	PLSC	Heat-shock proteins as biochemical markers for monitoring aging of cultivated and wild wheat	Agronomy	10,000
Bashour, Isam	LWRS	Concentrations of Selenium in selected Lebanese soils, grains, vegetables, grains and fruits	Trace minerals	10,000
Batal, Malek	NFSC	Determinants of infant feeding practices across Lebanon: Multi-site Trial	Community nutrition	8,000
Farajalla, Nadim	LWRS	Temperature and precipitation trends in Beirut and central Beka'a	Water resources	6,000
Haidar, Mustapha	PLSC	The role of inositol, 1,4,5-triphosphate in light signal transduction dodder (<i>Cucusta</i> spp) seedlings.	Weed science	8,300
Hwalla, Nahla	NFSC	Glycemic and insulinemic responses to hot versus cooled potato in healthy subjects w/ varied insulin sensitivity	Human nutrition	10,000
Lafta, Abbas	PLSC	Evaluation of yield and post harvest quality of potatoes exposed to water stress.	Crop production	5,000
Nimah, Musa	LWRS	Olive yield as affected by supplemental irrigation and split fertilization and pest management	Fertigation	7,200
Obeid, Omar	NFSC	The Effect of diet composition on hepatic glycogen synthesis and body weight of rats.	Nutrition	6,500
Saad, Adib	PLSC	Charac, host range, and control of fire blight disease of pome fruits in Lebanon	Crop protection	5,000
Sleiman, Fawwak	ANSC	The Potential use of food by-products as feed for ruminants.	Animal nutrition	6,900

Toufeili, Imad	NFSC	Determination of Sensory thresholds of selected calcium salts and formulation of calcium-fortified Arabic bread. Assessment of calcium bioavailability.	Cereal science	7,500
Yau, S.K.	PLSC	Agronomic studies on safflower. II. N fertilization and supplementary irrigation	Fertigation	7,000
Talhouk, S.	PLSC	Development of carbohydrate free bread**	Cereal science	4,999
Talhouk, S.	PLSC	A holistic approach to biodiversity use in Lebanon: Partnering with landowners	Biodiversity	73,204

* ANSC: Animal Science; LWRS: Land and Water Resources; NFSC: Nutrition and Food Science; PLSC: Plant Science.

** IBSAR.

Lebanese National Council for Scientific Research (LNCSR)

Investigator	Dept*	Title	Research Area	Budget \$
R. Baalbaki	PLSC	Detection of some genetically modified foods and crops in Lebanon	GMO	6,000
M. Farran	ANSC	Utilization of locally produced barley and oil seeds meals and feed additives in poultry	Poultry nutrition	6,630
A. Saad	PLSC	Disease forecasting for management of epidemic diseases on apple and potato in Lebanon	Crop protection	5,300
E. Barbour	ANSC	Relationship of water deprivation-stress to immunity in Awassi ewes of Lebanon	Animal science	5,330
N. Hwalla	NFSC	National nutritional micronutrient survey: Assessment of anemia and antioxidant micronutrient status of females in Lebanon	Human nutrition	6,000
M. Nimah	LWRS	Introduction of saffron to the Bekaa I. Selection and agronomic Studies	Crop production	5,840
S. Hamadeh	ANSC	Conservation of Striped Hyaena in Lebanon: A threatened and reviled scavenger in a human dominated landscape	Wild Life	6,160

*ANSC: Animal Science; LWRS: Land and Water Resources; NFSC: Nutrition and Food Science; PLSC: Plant Science.

PUBLICATIONS

During the academic year, 2003-2004, the Faculty generated 30 refereed articles, 27 abstracts, 6 proceedings, 23 reports, and 6 chapters in books. Details of publications are as follows:

Department of Animal Sciences

Barbour, E.K., Al Sharif, M., Sagherian, V.K., Habre, A.N., Talhouk, R.S., and Talhouk, S. (2004). Screening of selected indigenous plants of Lebanon for antimicrobial activity. *Journal of Ethnopharmacology*, **93**:1-7.

Barbour, E., Codsi, R. and Zurayk, R. (2004). Reproducibility of Bacterial and Copepod Density Assessment in Bathing and Artisanal Fishing Water of the Eastern Mediterranean. *International Journal of Environmental Health Research*, **14**: 315-321.

Barbour, E.K., Farran, M., Elias, D., Banat, G. and Talhouk, R. (2004). A new animal welfare-molting approach maintaining immunity in commercial layers. *World Poultry Journal*, **20**: 36-38.

Barbour, E.K., Sagherian, V., Talhouk, R. and Talhouk, S. (2004). Cell-immunomodulation against Salmonella Enteritidis in herbal extracts-treated broilers. *Journal of Applied Research in Veterinary Medicine*, **2**: 1-9.

Jaber, L.S., Habre, A., Rawda, N., Abi Said, M., Barbour, E.K. and Hamadeh, S. (2004). The Effect of Water Restriction on some Physiological Indicators in Awassi Sheep. *Small Ruminants Research*, **54**: 115-120.

Abu Zanat, M., Amri, A., Hamadeh, S.K., Al-Laham, S. and Mawlawi, B. (2003). Promoting agrobiodiversity conservation in rangelands of dry areas. Seventh International Conference on development of dry lands: Sustainable Development and management of dry lands in the 21st century. Tehran, Iran. 14-17 September 2003.

Avedenian, L., Khauli, R., Sleiman, F.T. and Abdelnoor, A.M. (2004). Preparation of chicken anti-human lymphocyte globulin (IgY). *Clinical Investigative Medicine*, **4**:132D

Avedenian, L., Khauli, R., Sleiman, F.T. and Abdelnoor, A.M. (2004). Preparation of chicken anti-human lymphocyte globulin (IgY). *Immunology* (Supplement 1): 1-4.

Daghir, N.J. (2004). Higher Agricultural Education in the Middle East: The AUB Model. Proceedings of a Symposium on Higher Agricultural Education: Future Requirements, King Faisal Univ., Saudi Arabia, April 12-13, pp. 115-131.

Daghir, N.J. (2004). Nutritional strategies to reduce heat stress in laying hens. XXII World's Poultry Congress Book of Abstracts, p. 289.

Darwish A.H., Farran, M.T., Barbour, G.W., Usayran, N. and Ashkarian, V.M. (2004). Effect of Feeding Graded Levels of Three Barley Varieties on Performance and Carcass Yield of Broilers. XXII Worlds Poultry Congress, Istanbul, Turkey. P. 479.

Farran M.T., Haddad, D.E., Barbour, E.K. and Ashkarian, V.M. (2004). Ad libitum Feeding of Ervil (*Vicia ervilia*) Diet as an Alternative to Fasting Method for Induction of Molt in Laying Hens. XXII Worlds Poultry Congress, Istanbul, Turkey. P. 648.

Farran M.T., Usayran, N., Eid, R.Y., Barbour, E.K., Darwish, A.H. and Ashkarian, V.M. (2004). Effect of Prebiotic, Avilamycin, and Flavomycin on Broiler Performance and Cecal Flora. XXII Worlds Poultry Congress, Istanbul, Turkey. P. 525.

Hamadeh, S.K., Haidar, M., Zurayk, R., Obeid, M., and Dick, C. (2004). Goats, cherry trees and videotapes: PDC for natural resource management in semi-arid Lebanon. FAO-IDRC workshop on communication and natural resource management, Rome, Sept. 1-3.

Sleiman, F.T., Rebeiz, N.J., Uwayjan, M.G., Farran, M.T., Zurayk, R.A., Barbour, E.K. and Hamadeh, S.K. (2004). Use of Liquid Whey, Urea and Molasses as Additives to Ensiled Wheatstraw. *Journal of Animal Science*. **82**: supplement (1): 54.

Sleiman, F.T. Principles of raising dairy animals. MOA, 100 p.

Department of Land and Water Resources

Al-Hassan, R., Bashour, I. and Kawar, N. (2004). Degradation of α and β endosulfan in soil as influenced by different organic matter sources. *Journal of Environmental Science and Health, Part B*, **B39**: 757-763.

Bashour, I., Dagher, S., Chammas, G., Lteif, A. and Kawar, N. (2004). DDT residues in Lebanese soils. *Journal of Environmental Science and Health*, **B39**: 273-283.

Kabengi, N.J., Zurayk, R.A., Baalbaki, R.Z. and Ryan, J. (2003). Phosphorous Dynamics and Characterization under a Long-term Rotation Trial. *Communications in Soil Science and Plant Analysis*, **34**:375-392.

Nimah, M.N., Bashour, I., Corbani, K. and Yanni, S. (2004). Water and Land Productivity Under Conventional Versus Vertical Cultivation. *Acta Horticulturae*, **664**: 437-443.

- Semerjian, L., El-Fadel, M., Zurayk, R. and Nuwayhid, I. (2004). An Interdisciplinary Approach to Environmental Education. *Journal of Professional Issues in Engineering, Education and Practice*, **130**:173-181.
- Sidahmed, M. M., Awadalla, H. H. and Haidar, M. A. (2004). Symmetrical multi-foil shields for reducing spray drift. *Biosystems Engineering*, **88**:305-312.
- Yanni, S., Nimah, M.N. and Bashour, I. (2004). Gravel Vertical Mulching for Improving Water Use Efficiency of Drip Irrigated Orchards. *Acta Horticulturae*, **664**: 673-681.
- Zurayk R. A. and Haidar, M. (2003). The Dryland Predicament: Natural Capital, Global Forces. *Development Outreach*, 35-39.
- Zurayk, R., Abdul Samad, L. and Talhouk, S. (2004). Environmental Analysis of Urban and Peri-Urban Coastal Agriculture in Lebanon. In: *L'interface Entre Agriculture et Urbanisation En Mediterranee Sud et Est*. Nasr, J. and Padilla, M. (eds.). Institut Francais du Moyen Orient, Editions Delta. 429 pp (Jounieh, Lebanon).
- Zurayk, R.A. (2003). Participatory GIS-based Natural Resource Management: Experiences from a Country of the South. *Arid Lands Newsletter*, No. 53, May/June 2003. <http://ag.arizona.edu/OALS/ALN/aln53/zurayk.html>
- Bashour, I., Hannoush, G. and Kwar, N. (2003). Trace metal content of commercial fertilizers marketed in Lebanon. In Hall, W. and W. Robarge (Editors). *Environmental Impact of Fertilizer on soil and Water* (Chapter 7, p. 90-99). Oxford University Press. American Chemical Society publication.
- Haddad, J. and Nimah, M.N. (2003). Water quality monitoring of a watershed. In *River Basin Management*. Brebbia, C.A. (Editor). Wessex Institute of Technology, U.K., pp 231-237.
- Nimah, M.N., Bsaibes, A., Alkal, F., Darwish, M.R. and Bashour, I. (2003). Optimizing cropping pattern to maximize water productivity. In *River Basin Management*. Brebbia, C.A. (Editor). Wessex Institute of Technology, U.K., pp 187-199.
- Bashour, I. and Nimah, M.N. (2004). Fertigation potentials in the Near East region. Submitted for Regional IPI Workshop on: Potassium and Fertigation Development in West Asia and North Africa Region, Rabat, Morocco. November 24-28, 2004.
- Bashour, I., Lteif, A., Nimah, M. and Darwish, R. (2003). Selenium content in soils and plants and its effect on animal and human nutrition (invited paper). Proceedings of Regional expert consultation on plant, animal and human nutrition. FAO regional meeting, September 7-13, 2003 in Damascus, Syria (CD publication).

- Habib, R.R., Nuwayhid, I.A., El-Fadel, M., Zurayk, R. and Kabakian, V. (2004). Water Quality in the Coastal Zone of Bebnine: A Case Study on Successful Community Participation. Coastal Zone Asia Pacific Conference, 5 – 9 September 2004, Brisbane, Australia.
- Nimah, M. N. (2003). Drought Planning and Water Conflicts: A Case Study of the Near East Region. Irrigation and Water Resources. FAO Regional Office for the Near East. Cairo Egypt, 24p.
- Zurayk, R. and Abdel Samad, L. (2004). Environmental problems of urban and peri-urban agriculture in Lebanon. Unesco/Scope workshop on peri-urban environmental change. Beirut, 18-19 March 2004.
- Zurayk, R., Haidar, M. and Hamadeh, S. (2003). Carting the Oxen. Putting research into development. Conference on Health Approach to Ecosystem. Montreal, Canada. May 2003.
- Bashour, I., Al-Hassan, R. and Kwar, N. (2004). Influence of organic matter amendments on the persistence of endosulfan in soils. 228th National Meeting, American Chemical Society, Division of Agrochemicals, August 22 – 26, 2004, Philadelphia, PA, USA.
- Farajalla, N. (2004). Characterization of Surface Water Pollutants through Riverbed Sediment Analysis: Assessment of Lebanese Coastal Rivers. American Society of Agricultural Engineers Specialty Meeting on Self-Sustaining Solutions for Streams, Wetlands, and Watershed, St. Paul, Minnesota, September 12-15, 2004.
- Farajalla, N. (2004). Institutional and Governmental Barriers to Implementing BMPs in Lebanon. American Water Resources Association Annual Meeting, Dundee, Scotland, August 29- September 1, 2004.
- Farajalla, N. (2004). Impact of Agrochemicals on Water Resources in Lebanon and Barriers to Implementing BMPs. Environment and Groundwater Institute's Annual Symposium, Salt Lake City, Utah, September 2004.
- Bashour, I. Guide for Fertilization of Fruit Trees and Vegetables. (2004). American University of Beirut and Lebanese Ministry of Agriculture. (In Arabic). Ministry of Agriculture Extension Bulletin, 6p.
- Darwish, R. (2004). Investigating Financial Appraisals for Developmental Projects, 60 pp. Environmental Sustainability Development Unit, Faculty of Agricultural and Food Sciences, American University of Beirut.
- Farajalla, N. (2004). Mitigating the Impacts of Agrochemicals on Water Resources in Lebanon. Report to Ministry of Environment, 104p.
- Moussa, Z. and Zurayk, R. (2003). Fertilization Techniques in Organic Farming.

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- Moussa, Z. and Zurayk, R. (2003). Forage Crops. American University of Beirut, USDA and Mercy Corps. (Arabic). 14 p.
- Moussa, Z. and Zurayk, R. (2003). Organic Farming. American University of Beirut, USDA and Mercy Corps. (Arabic). 14 p.
- Moussa, Z. and Zurayk, R. (2003). Rural Tourism. American University of Beirut, USDA and Mercy Corps. (Arabic). 14 p.
- Moussa, Z. and Zurayk, R. (2003). Sustainable Agriculture. American University of Beirut, USDA and Mercy Corps. (Arabic). 14 p.
- Moussa, Z. and Zurayk, R. (2003). Innovations in Agricultural Marketing. American University of Beirut, USDA and Mercy Corps. (Arabic). 14 p.
- Nimah, M.N. (2003). Irrigation Principles and Irrigation System Design. Workshop for Green Plan, Ministry of Agriculture, Lebanon. 130 p.
- Nimah, M.N. (2003). Irrigation Scheduling and Irrigation Systems Design and Evaluation. Provisions of Technology Transfer and Extension for Major Irrigation Schemes. American University of Beirut. 185 p.
- Sleiman, F., Abou Jawdeh, Y., Bashour, I. and Nimah, M. (2004). Production of Forage Corn. American University of Beirut and Ministry of Agriculture–Lebanon. (In Arabic). Ministry of Agriculture Extension Bulletin, 6 p.
- Zurayk, R. (2003). Community of Practice on sustainable Livelihoods in Drylands (COP) progress report covering Sep.-Dec., 3 p.
- Zurayk, R. (2003). Community of Practice on sustainable Livelihoods in Drylands (COP). Final Report. 36 p.
- Zurayk, R. (2004). Enhancing Livelihoods of Poor Farmers in South Lebanon: Community Supported Agriculture. First progress report covering period May 2004 – July 2004. 13 p.
- Zurayk, R. (2004) Opportunities for Socio-economic Growth and Environmental Protection. Final report. 35 p.
- Zurayk, R. (2003). Provisions of Technology Transfer and Extension for Major Irrigation Schemes. Progress report covering the period Apr. 2003- Dec. 2003, 46 p.
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