ANNUAL RESEARCH REPORT 2010

VOLUME XVI

CAMS RESEARCH 2010

FACTS & FIGURES

- **RO 1,968,582 Total Budget**
- **61 Research Projects in Total**
  - **36 Internal Grant Projects (13 awarded in 2010)**
  - **9 Strategic Projects (2 awarded in 2010)**
  - **16 Externally-Funded Projects (7 awarded in 2010)**
- **287 Scientific Publications**
  - **71 Refereed Journals**
  - **139 Conference Publications**
  - **1 Book**
  - **19 Chapter in Books**
  - **4 Book Evaluations**
  - **18 Technical Reports**
  - **1 PhD Dissertation**
  - **34 Articles in Newspapers and other SQU Publications**

Annual Research Report
2010

Volume XVI

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Foreword

Research carried out by faculty and graduate students at CAMS is a response to the global mission the College has sets for itself: (1) develop human resources to meet challenges in producing food while conserving the natural environment and biodiversity, processing food to add value and trading food to ensure food security in Oman; (2) Find solutions to issues of strategic importance through basic and applied research and disseminate knowledge to the Omani and international communities which will result in continuous improvements to the quality of life; and (3) coordinate career guidance for students at CAMS, provide continuous education for professionals in CAMS and the wider community and consult private and public sector agencies to facilitate progress of a knowledge-based society.

In 2010, the total research budget at CAMS nearly reached 2 million Omani Rials (1,968,582 OR). Our research funding in 2010 includes two new strategic research grants from His Majesty Sultan Qaboos' Research Funds. CAMS was also successful in attracting research funds from external sources with nearly 340,000 OR worth of externally funded projects: a new high for our College.

As the Masters programs in the College stabilize with approximately 20 students graduating every year (19 in 2010), the PhD program maintains a regular growth with 6 new students registered in 2010. There were 62 students registered in the various graduate programs at CAMS in 2010.

The year 2010 was a good year in terms of scientific production with 287 publications of which 71 were in peer-reviewed journals and 139 in conference publications. This success reflects the individual effort of our faculty to attract funding, to supervise graduate students and to publish their findings but rests also on the commitment of both the Research Committee and the Postgraduate Committee to improve the research organization and the quality of our postgraduate programs. I would like also to thank the Deanship of Research, the Deanship of Postgraduate Studies, and the Deputy Vice Chancellor for Postgraduate Studies and Research for their continuous support to improve the research culture at CAMS.

Michel R. Claereboudt
Assistant Dean
Postgraduate Studies and Research

Research Committee (2010)

Dr. Michel Claereboudt, *Chair*

Dr. Malik Al-Wardy

Prof. Osman Gaafar

Dr. Abdullah Al-Sa'di

Prof. Md. Shafiur Rahman

Dr. Sergey Dobretsov

Dr. Slim Zekri

Dr. Mushtaque Ahmed

The Year in Review

Introduction

Research in the College of Agricultural and Marine Sciences (CAMS) is an important part of its academic life and involves not only faculty and graduate students but also an increasing number of undergraduate students who carry out "special problem studies" as part of their degree plan. CAMS pursues fundamental and applied research in a very broad range of disciplines in agriculture, horticulture, water management, marine production, ecological modelling, food system, oceanography, plant diseases, etc. through a wide range of funding sources from internal grant (12%), strategic grants (28%) and external research grants (56%). This growing proportion of external research funding is important as it expresses the committment of the faculty at CAMS to engage in research strategically significant to the Sultanate.

Research Projects and Budgets

For the year 2010, the CAMS total research budget was RO 1,968,582 (Table 1).

Thirteen internal grant projects were awarded in 2010 (Table 2) (abstracts of internal grant research projects awarded in 2010 can be found on pages 44 to 56), while 13 also were still ongoing (Table 3) and 10 internal grant projects were completed (Table 4).

Table 5 shows the 2 Strategic Research projects awarded in 2010 (abstract of these projects are on pages 57 to 59), while 5 other strategic projects were ongoing (Table 6) and 2 completed (Table 7).

In addition to the 5 externally-funded research awarded in 2010 (Table 8), another 2 were also awarded and completed in the same year (Table 9), while 7 were ongoing (Table 10). Two externally-funded research and development projects awarded from previous years were completed in 2010 (Table 11).

Table 1. Summary of research and development projects held by the College over 2005-2010.

Source of Fund	Number of Projects	Budget (RO)	Total Budget (RO)
Internally-funded (SQU) projects			**265,025**
Awarded in 2010	13	70,000.000	
Ongoing	13	119,795.000	
Completed in 2010	10	75,230.000	
His Majesty's strategic research fund			**841,050**
Awarded in 2010	2	180,000.000	
Ongoing	5	484,100.000	
Completed in 2010	2	176,950.000	
Externally-funded projects			**862,507**
Awarded in 2010	5	339,012.000	
Awarded in 2010 and completed in the same year	2	4,610.000	
Ongoing	7	491,485.000	
Awarded from previous years and completed in 2010	2	27,400.000	
		Total	**1,968,582**

Internal Grant Research and Development Projects

Table 2. Internally-funded research and development projects awarded in 2010.

No.	Title of Research	Principal Investigator	Amount (RO)
1	Study on Theileriosis of indigenous sheep in the Sultanate of Oman	*M. Tageldin*	8,400
2	*Escherishia coli* 0157:H7 and other Shiga toxin-producing *E. coli* in the faeces of healthy sheep, goats and cattle in the Sultanate of Oman	*D. Al Ajmi*	4,000
3	Integrated management of the Dubas bug: Fundamental investigation in biological, cultural, and chemical control	*A.K. Al Wahaibi*	6,000
4	A study of the nutritional and metabolic factors contributing to the occurrence of autistic spectrum disorders among children in the Sultanate of Oman	*M.Waly*	8,000
5	Extraction and structural characterization of gelatin from fish skin	*M.S. Rahman*	8,000

Table 2 . . . .

No.	Title of Research	Principal Investigator	Amount (RO)
6	Diabetes education in primary health care in Oman: Factors predicting diabetes control, effect on knowledge and metabolic control	*L. Al-Subhi*	6,400
7	Assessing the impact of global food crisis on food security in Oman	*H. Boughanmi*	4,000
8	A supply chain management approach to promoting competitive advantage of small-scale fishery sector in Oman	*O. Al-Jabri*	4,000
9	Optimal control of micro irrigation systems	*H. AbdelRahman*	6,000
10	Effects of siltation behind Al-Khod Dam on the soil properties and recharge efficiency	*A.K. Al-Maktoumi*	6,000
11	Agronomic and economic feasibility of salt tolerant plants for saline lands and water of Batinah	*A. Al-Busaidi*	5,000
12	Performance evaluation of a solar tunnel dryer for drying of lemons in Oman	*M.A. Basunia*	4,000
13	Roof-mounted irrigation by capillary siphoning	*A. Kacimov*	200
		Total	**70,000**

Table 3. Ongoing internally-funded research and development projects.

No.	Title of Research	Year Granted	Principal Investigator	Amount (RO)
1	Effect of manure amendment with varying C:N ratios on N mineralization in soil	2006	*S. Ismaily*	4,400
2	Application of water saving technologies in domestic water conservation in Oman	2007	*M. Ahmed*	4,900
3	Reduction of post-harvest losses and improvement of fish handling systems in Oman	2007	*S. Al-Jufaili*	4,995

Table 3 . . . .

4	Effect of thermal processing and enzyme supplementation on the nutritive value of local agricultural by-products as feed ingredients in chicken diets	2008	*W. Al Marzooqi*	11,500
5	Evaluation of Omani camel performance under intensive management for meat production and quality	2008	*O.M. Gaafar*	12,000
6	Investigation on *Brucella melitensis* immunogenic domains	2008	*Y. ElTahir*	12,000
7	Characterization of gummosis and foot/root rot diseases of citrus in Oman	2009	*A. Al-Sa'di*	11,600
8	Causal agents of melon sudden decline in Oman	2009	*M. Deadman*	10,000
9	Molecular characterization of Begomovirus associated with tomato and other crops and screening of tomato cultivars tolerant to tomato yellow leaf curl virus	2009	*A.J. Khan*	10,000
10	The role of zooplankton in controlling the bloom-formation in Oman water bodies	2009	*A. Al-Azri*	10,500
11	A database on the Arabian sea ecosystem	2009	*S. Piontkovski*	11,000
12	Non-toxic antifouling compounds from marine bacteria	2009	*S. Dobretsov*	12,000
13	Design and construction of greenhouses for arid regions: Phase 2	2009	*Y. Al-Mulla*	4,900
			Total	**119,795**

Table 4. Internally-funded research and development projects completed in 2010.

No.	Title of Research	Year Granted	Principal Investigator	Amount (RO)
1	Economic and institutional aspects of Kingfish management	2005	*H. Kotagama*	5,000
2	Investigation of the prevalence of tick infestation and tick-borne haemo-parasites of goats in the Sultanate of Oman	2007	*P. Bobade*	12,000
3	The effect of Omanization policy on the efficiency of dairy and date farms in Oman	2007	*M. Mbaga*	11,350
4	Molecular characterization of phytoplasma associated with Witches' Broom, phyllody/ virescence diseases of Sesame (*Sesamum indicum* L.) in Oman	2007	*A.J. Khan*	12,000
5	Damage cost in dry aflaj and live aflaj value for recreation	2008	*S. Zekri*	8,900
6	The taxonomy and ecology of *Benthic elasmobranchs* in the Gulf of Oman	2008	*A. Henderson*	4,980
7	Antiatherogenic characteristics of consumption of fruit and vegetables grown in Oman	2008	*M. Al-Ani*	11,000
8	Chemical and physical characterization of date pectin and its effect on Date syrup quality	2008	*A.A. Al-Alawi*	6,000
9	Production and quality assessment of a smoked tuna (*Thunus albacares*) product	2008	*N. Guizani*	3,800
10	Roof-mounted irrigation by capillary siphoning	2010	*A. Kacimov*	200
			Total	**75,230**

His Majesty's Strategic Research Projects

Table 5. Projects funded through His Majesty's Strategic Research Fund and awarded in 2010.

No.	Title of Research	Principal Investigator	Amount (RO)
1	Potential sources of soil-borne plant pathogenic fungi and bacteria into farms in Oman	*A. Al-Sa'di*	87,500
2	Economical, social and environmental impacts of marine biofouling in the Sultanate of Oman	*S. Dobretsov*	92,500
		Total	**180,000**

Table 6. Ongoing projects funded through HM's Strategic Research Fund from 2007-2010.

No.	Title of Research	Year Granted	Principal Investigator	Amount (RO)
1	Conservation and utilization of plant genetic resources in Oman	2007	*N. Al-Saady*	139,300
2	Rejuvenating lime and mango production in Oman: Resolving current challenges	2008	*R. Al-Yahyai*	100,000
3	Characterization, evaluation and conservation of indigenous animal genetic resources in the Sultanate of Oman	2008	*O. M. Gaafar*	80,000
4	Stock assessment of Kingfish	2008	*A. Govender*	79,800
5	Feasibility of managed aquifer recharge using excess treated wastewater in Oman	2009	*M. Ahmed*	85,000
			Total	**484,100**

Table 7. Projects funded through His Majesty's Strategic Research Fund and completed in 2010.

No.	Title of Research	Year Granted	Principal Investigator	Amount (RO)
1	Management of salt-affected soils and water for sustainable agriculture	2006	*S. Al-Rawahy*	95,000
2	Development of management strategies for pesticide resistance and pesticide residue problems in Omani agriculture	2007	*F. Talukder*	81,950
			Total	**176,950**

Externally-Funded Research Projects

The externally-funded research involved collaborations with Ministry of Agriculture, (MoA), Ministry of Fisheries Wealth (MFW), United Arab Emirates University (UAEU), International Islamic University, Malaysia (IIUM), The Research Council in Oman (TRC), International Center for Biosaline Agriculture (ICBA) and other private institutions.

Table 8. Externally-funded research and development projects awarded in 2010.

No.	Title	Principal Investigator	Agency	Amount (RO)
1	Molecular characterization of Begomovirus associated with tomato and other crops and screening of tomato cultivars tolerant to leaf curl virus	*A.J. Khan*	TRC	132,000
2	Oceanographic regime shift in the Sea of Oman	*S. Piontkovski*	TRC	146,000
3	Baseline study on distribution and the reproductive biology of the brown mussel in the Sultanate of Oman	*S. Al Barwani*	MFW	57,400
4	Comprehensive master plan for Al Batinah	*S. Zekri*	HMR Consul-tants [Contract Research (CR)]	798
5	National strategy to combat salinity and protect water resources from pollution	*S. Zekri*	ICBA (CR)	2,814
			Total	**339,012**

Table 9. Other externally-funded research and development projects awarded in 2010 and completed in the same year.

No.	Title	Principal Investigator	Agency	Amount (RO)
1	The application of planning and management principles and techniques to the design of the Duqm port project	*A.Palfreman*	MFW [Additional Services (AS)]	2,450
2	Fatty acid analysis in fish samples	*M. Claereboudt*	MFW (AS)	2,160
			Total	**4,610**

Table 10. Ongoing externally-funded research and development projects awarded from previous years.

No.	Title	Principal Investigator	Year Granted	Agency	Amount (RO)
1	Characterization of camel milk protein isolates as nuraceutical and functional ingredients	*A. Alawi*	2008	UAEU [Collaborative (CL)]	40,000
2	Jabal Akhdar rose water production projects	*M. Mbaga*	2008	MoA (CR)	12,385
3	Assessment of shark population movements, delineations and breeding grounds in the Sultanate of Oman	*A. Henderson*	2008	MFW (CR)	100,000
4	Diversity, stocks and feasibility of sea-cucumber aquaculture in Oman	*K. Al-Rashdi* *M. Claereboudt*	2008	MFW (CL)	94,300
5	Assessments of mesoscale physical-biological interactions along the coast of Oman as the basis for understanding the periodic fisheries losses	*A.Al-Azri*	2009	MFW (CL)	222,900
6	Heavy metal contamination of fish and shellfish	*S. Goddard* *S. Al-Barwani*	2009	IIUM (CL)	14,400
7	Detection of citrus exocortis viroid, citrus cachexia viroid and citrus greening bacteria by PCR assays in citrus trees from Royal Gardens and Farms	*A.J. Khan*	2009	Royal Court Affairs [Additional Services (AS)]	7,500
				Total	**491,485**

Table 11. Other externally-funded research and development projects awarded from previous years and completed in 2010.

No.	Title	Principal Investigator	Year Granted	Agency	Amount (RO)
1	Pesticide resistance and residue problems in Omani and UAE vegetable production. Phase II: Solution through rapid and molecular detection techniques and farmers awareness	*F. Talukder*	2006	UAEU (CL)	24,750
2	Histology training and consultation	*A. Ambu Ali*	2009	MFW (CL)	2,650
				Total	**27,400**

Other Significant Activities

University Research Day 2010

Some of the College's research projects were presented through oral and poster presentations. Abstracts of the projects presented can be found on pages 14 to 29.

ABSTRACTS

Oral & Poster Presentations

University Research Day
May 2, 2010

Oral Presentations

Thermal Characteristics of Gelatin Extracted from Shaari: Effects of Extraction Conditions

(SQU Project Code: IG/AGR/FOOD/10/02 –
Extraction and structural characterization of gelatin from fish skin)

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Gelatin extraction yield increased with the increase of acetic acid concentration and temperature. Gelatin extracted from shaari skin using 0.1 N acid solutions and temperatures of 60 and 80^{o}C gave highest protein content comparable to that of commercial bovine and porcine gelatins. Shaari gelatin contained higher amount of the amino acids alanine, glycine, and threonine; and lower contents of hydroxyproline, isoleucine and proline than bovine and porcine gelatins. The L values of bovine and porcine gelatins were significantly higher ($p<0.05$) (i.e. less dark) than those of shaari gelatins extracted under experimental conditions used in this study. In general, gelatin extracted from shaari gelatin showed lower onset of glass transition temperature than mammalian gelatins. For shaari skin gelatin, the onset of glass transition temperature decreased with the increase of extraction temperature up to 50^{o}C and then remained nearly constant. The decrease in glass transition was more pronounced for gelatin extracted at 1 N compared to the 0.1 and 0.01 N samples. Unfolding temperature decreased exponentially with the increase of extraction temperature. Similar to glass transition, the curves of unfolding temperature shifted to lower temperature, whereas the decrease was more pronounced in the case of higher (1.0 N) concentrated samples. The extraction concentration and temperature did not show significant effect on the onset solids-melting temperature.

The Influence of the Sea Surface Temperature on Tropical Cyclone Track – A Case Study

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College of Agricultural and Marine Sciences
Sultan Qaboos University

Three cases of tropical cyclone paths in the northern Indian Ocean from 2003 to 2008 have been investigated. The tropical cyclones, T01B (2003) and Nargis (2008) in Bay of Bengal and Gonu (2007) contravened the predictions of their landfall points by standard models. In this study, we have carried out an analysis of available *in situ*, satellite observations and model results during the periods of the above tropical cyclones. The anomalously warm (>32°C) sea surface temperature (SST) over large part of south-central Bay of Bengal apparently held the cyclone "T10B" stationary for 4 days between 12 and 16 May, 2003 and rapidly veered eastwards to strike Myanmar on 19 May 2003. In 2007, the tropical cyclone "Gonu" developed in the SE Arabian Sea, moved northwestwards over anomalous SST corridor to strike the northern tip of Oman failing all the predictions of a landfall along central east coast of Oman. Similarly in 2008, the movement of the tropical cyclone "Nargis" also appeared to have been controlled by the SST distribution in the Bay of Bengal. This cyclone was initially predicted to strike east coast of India but it deflected eastwards to strike the Myanmar coast. In all the above cases, anomalously warm sea surface temperatures developed and persisted before and during the cyclone passage. The cyclones appeared to have been towed along the high SST corridor. The anomalous SST pools have even retarded their movement for as many as 4 days and changed their paths. Since the damages due to the tropical cyclones are high in terms of life and property, monitoring and forecasting of anomalous SST development may improve the accuracy of track prediction.

Effect of Low Voltage Electrical Stimulation and Splitting Carcasses on Meat Quality of Omani Camel

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Two experiments were conducted to study the effect of low voltage electrical stimulation (LVES) and splitting carcasses on histochemical, structural and meat quality characteristics of Omani camel carcasses. The first experiment was carried out to evaluate the effects of LVES on meat quality of four age groups of 72 camels (1-3, 4-6, 7-9 and 10-12 years old). The second experiment aimed to evaluate the effect of splitting 30 carcasses and LVES on meat quality of two camel age groups (1-2 vs. 8-10 year old). Warner-Bratzler shear force, pH, sarcomere length, myofibrillar fragmentation index (MFI), expressed juice, cooking loss and *L*, a*, b** colour were measured. LVES resulted in a significantly (P<0.05) more rapid muscle pH fall during the first 12 hr after slaughter. Muscles from electrically-stimulated carcasses had significantly (P<0.05) lower pH values, longer sarcomeres, lower shear force values and higher expressed juice than those from non-stimulated ones. Electrically-stimulated meat was significantly (P<0.05) lighter in colour than non-stimulated based on *L** value. Muscles of 1-3 year old camels had a significantly (P<0.05) lower shear force value, and pH, but longer sarcomere, and higher MFI, expressed juice, and lightness color (*L**) than those of the 10-12 year old camels. The proportions of Type I, Type IIA and Type IIB in camel muscle were 25.0, 41.1 and 33.6%, respectively. Muscle samples from 1-3 year old camels had significantly (P<0.05) higher Type I and lower Type IIB fibres compared to those from 10-12 year old camel samples. There were no differences in muscle quality between split and unsplit carcasses. Muscles of 8-10 year old camels had significantly lower expressed juice, cooking loss were darker (L*) more red (a*), more yellow (b*) and higher pH and MFI than those from 1-2 year old animals. These results indicated that age and electrical stimulation had a significant effect on camel meat quality. They should be considered in camel meat production for better quality.

The Effect of Omanization Policy on the Efficiency of Dairy Farms in Oman

(SQU Project Code: IG/AGR/ECON/07/01)

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By 2020 it is expected that the Oman economy will have diversified into non-oil sectors. The non-oil sector's contribution is expected to increase to 29 percent in 2020 from the 7.5 percent registered in 1996. Agriculture is one of the non-oil sectors of the Oman economy. The Oman government vision for the agricultural sector, aims at achieving among other things, an annual growth rate of approximately 4.5 percent and a contribution to the GDP of 3.1 percent by 2020. Agricultural commodities produced in Oman include crops (dates, fruits, and vegetables) and livestock (dairy and beef cows, sheep, goats, and camels). The performance of the agricultural sector in the recent past development periods—the fifth five-year development period (1996-2000) and the sixth five year development period (2001 – 2005) has not been as expected. During the fifth five year plan period, for example, the relative contribution of the sector to the GDP decreased from 1.8 percent in 1995 to about 1.3 percent in 2000.

In an effort to guarantee increased employment of Omanis in all sectors of the Omani economy, the Sultanate government instituted the Omanization policy[1]. The policy has been in place for sometime now. Studies assessing the effect of the Omanization policy on job prospects for agriculture and fisheries specialists, as well as, on agricultural human resources development, have been conducted conclusions from these studies on key indicators have been largely positive. However, there is no study we know of that evaluate the effects of the Omanization Policy on agricultural production efficiency. This study therefore seeks to address that shortfall by assessing the effect of Omanization Policy on the efficiency of dairy farms. The assessment would generate information that would help stakeholders to create an enabling environment necessary to bolster the performance of the sector.

Efficiency analysis preliminary result shows that on average milk production per cow is very low. One of the reasons behind low milk production is that most of the dairy farmers in Oman keep only indigenous cows. These indigenous cows yield very low amount of milk per day. Furthermore, there are serious problems of market outlets for milk especially in the mountain areas of Salalah. Results also show that dairy producers are about 65 percent efficient. This means that it is possible to increase milk production by up to 35 percent with the current levels of inputs use if farmers improve their dairy husbandry practices.

[1]Omanization is a policy enacted by the government of Oman in 1988 aimed at replacing expatriate workers with trained Omani Personnel. The government of Oman sets quotas for various industries to reach in terms of the percentage of Omani to foreign workers.

Rejuvenating Lime Production in Oman: Resolving Current Challenges

(SQU Project Code: SR/AGR/CROP/08/01)

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Production of lime (*Citrus aurantifolia*) and other related citrus species in Oman have been significantly reduced in recent years. The reduction in yield has been attributed to a combination of abiotic and biotic factors that adversely affected tree growth and productivity. Loss of area cultivated with lime trees was 50% of that in 1990, mainly due to Witches' Broom Disease of Lime (WBDL). The disease that may have originated in the Sultanate has the potential to devastate lime production throughout the entire regions of western Asia and North Africa thus affecting fruit imports to Oman as well. In Oman, these problems have been worsened by increasingly stressful abiotic conditions caused by prolonged drought and salinity which ultimately led to the decline of fruit production in the country. The compound adverse effects of biotic and abiotic stresses on tree fruit yield have resulted loss of tree fruit acreage and profitability and reduced income from largely traditional farming systems. While the causal agent of WBDL (i.e. *candidatus* Phytoplasma aurantifolia) has long been identified, practical solutions to the disease have not been tested and these challenges remain many years later. This research project tackles several aspects of WBDL lime disease in Oman. The researchers aim to provide practical solutions to tree fruit growers, thus enabling them to continue production from diseased trees while new, long-term solutions through resistant cultivars are being gradually evaluated and introduced. The proposed project addresses the phytoplasma-caused WBDL through molecularly identifying native citrus species for tolerance or resistance; characterizing the interaction of WBDL with other citrus diseases; continued breeding and hybridization of new *Citrus* resistant clones; establishment of field trials for evaluating hybridized and exotic cultivars of *Citrus*, particularly lime; study the alternative vectors and hosts; and optimizing fruit production through management of diseased trees.

Management of Salt-Affected Soil and Water for Sustainable Agriculture

(SQU Project Code: SR/AGR/SWAE/06/01)

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Strategic research project sponsored by His Majesty's research fund entitled "Management of Salt-Affected Soil and Water for Sustainable Agriculture" was conducted jointly by Sultan Qaboos University as represented by College of Agricultural and Marine Sciences (CAMS), and Ministry of Agriculture as represented by Directorate General of Agriculture and Livestock Research.

The collaborative efforts of the two organizations working together produced excellent results in diversified areas in the management of soil and water salinity for sustainable agriculture. The Ministry of Regional Municipality and Water Resources and International Center for Biosaline Agriculture also collaborated in this project. The project concentrated on soil-water-plant interactions as related to salinity, use of remote sensing and GIS techniques to determine the degree and extent of salinity in the al-Batinah Region, effect of feeding salt-tolerant sorghum to on Omani sheep and integrating aquaculture. Socio-economic study, which reflect the very existence of the rural society, was one of the main objectives of the project.

This involved holding workshops with farmers in eight "wilayats" of the Al-Batinah Region. A total of one hundred and twenty farmers participated in these workshops, their salt-affected farms visited and detailed information gathered for the study. At the end of the project, the results were conveyed to the120 farmers on 20th and 28th March 2010 in Sohar and Barka. Multidisciplinary approach nature of this project has widened the scope of problem solving and opportunities for five graduate students to conduct their research (MS thesis) within the main theme of the project. God Willing, the results obtained from the project will benefit the farmers and the country in adapting to live with salinity and contributing towards food security and combating desertification.

Poster Presentations

Chemical and Physical Characterization of Date Pectin and its Effect on Date Syrup Quality

(SQU Project Code: IG/AGR/FOOD/08/01)

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Date is rich with many compounds that can be utilized to produce value added products. One of these compounds is pectin. Pectin is produced commercially as a by product of other products mainly because it exists in small quantities. The same principle is applied to dates. Although the percentage is very low, pectin has big influence on quality of date syrup which is considered as one of the most products of dates. This influence comes preliminarily from the fact that pectin can exist in many forms and sizes depending on the maturation stages. Therefore, good understanding of the changes and their time will effectively provide dates processors with good knowledge to control the quality of the date syrup between batches. Preliminary results showed changes in the nature of pectin with maturation.

Economic Impact of Salinization

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Water and soil salinity problems are widespread in the agricultural sector of many countries, in particular those of arid and semi-arid climates. Soil salinity has emerged as a main worldwide crop production problem. Rising salinity in the sultanate of Oman is a serious threat as salt affected soils represents 4.97% of cropped area. The accelerated use of groundwater through over pumping in coastal areas resulted in seawater intrusion and high temperature and low rainfall are conducive conditions for salt accumulation in the surface and sub-surface of the soil. The objectives of this paper are to evaluate the economic damages due to groundwater quality degradation at the farm level, and to analyze and evaluate the adoption of management practices of salt-tolerant crops tested by researchers at experimental level. Linear programming was used as methodology for three types of farms according to salinity levels, low salinity “LS”, medium salinity “MS” and high salinity “HS”. One hundred twelve farmers were randomly selected and contacted in seven Willayat of the Batinah. Water samples from each farm were collected. Information about income, cropping patterns, livestock activity, labor characteristics and water sources and uses were collected. For the “LS” farms, the gross margin equals US$ 5,712/ha then reaches US$ 4,108/ha in case of “MS” farms and finally drops to US$ 1,360/ha for the “HS” farms. The damages caused by salinity are evaluated to US$ 1,604/ha (28%) when salinity increases from "LS" to "MS" level, and US$ 2,748/ha (67%) when salinity increases from "MS" to "HS".

Research impact on salt-tolerant crops tested in the Rumais Research Center during 2007-2009 represented by a salt tolerant tomato variety and three forage crops which are sorghum, pearl-millet and barley are incorporated into the LP models to test for their possible adoption by farmers. Results showed that tomato is retained in the crop mix in the “MS” farms. Pear-millet forage replaces the existing forages. Consequently, the farm gross margin is improved by 20%. In the “HS” farms, results showed that the salt-tolerant tomato with mixed fertilizers is retained in the crop mix too. Pear-millet forage is also retained. However, the improvement of the total farm gross margin is only 6% compared to the basic “HS” scenario. This shows the incapacity of mitigating the salinity effect after a threshold level by adopting higher salt tolerant crops. Thus the future of the “HS” farms is gloomy. Consequently, more research is needed to address the problem of ways to stop seawater intrusion in a proactive fashion. The adoption of salt-tolerant crops can help mitigate the problem in the medium run but it is far from being a solution as long as seawater intrusion is not completely stopped.

Eddies of the Western Arabian Sea: Physical-biological Coupling

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An important hydrophysical feature of the western Arabian Sea is a powerful field of mesoscale eddies which have a size of ~ 200km and the life time from one to four weeks. The analysis of data available from the archives of International expeditions (USA, UK, Ukraine, and Germany), ongoing field sampling, and remote sensing enables one to estimate the impact of eddies on spatial distribution of oxygen concentration, plankton species diversity, phyto- and zooplankton biomass. In the oceanic regions, maxima of chlorophyll *a,* zooplankton biomass, and depletion of the oxygen concentration were associated with the location of eddies. The cyclonic eddies generate patchy distributed zones of the oxygen-poor waters (approaching the coast) which could result in fish kills. Margalef's diversity index for copepod species (which contributed about 40% of zooplankton biomass) has exhibited maximal values in the frontal zones between cyclonic and anticyclonic eddies. In the Sea of Oman, the variation of chlorophyll within the annual cycle has increased over the past 12 years. Similar tendency was evaluated for the kinetic energy of eddies. The median level of kinetic energy and the coefficient of variation within the annual cycle-both increased, from 1997 through 2009. In turn, these two trends might be complemented by and associated with the reported tendencies of the nitrate concentration in the mixed layer and the mixed layer depth- both to decrease, over the same time period (Piontkovski *et al.,* 2010).

Dietary Manipulation of the Polyunsaturated Fatty Acid Content of Red Hybrid Tilapia (*Oreochromis* sp.).

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Red hybrid tilapia were fed isonitrogenous and isoenergetic practical diets containing 0, 4, 8, and 12% cod liver oil, substituted against corn oil, giving n-3/n-6 ratios of 0.1, 0.2, 0.6 and 1.0 respectively. After feeding triplicate groups, each of 20 fish, for 10 weeks no significant difference were seen in weight gain, specific growth rate, feed conversion ratio, whole body or fillet proximate composition. Significant differences were seen in the fatty acid content of dorsal muscle. There was evidence of selective retention of docosohexaenoic acid (DHA) in the dorsal muscle since DHA levels significantly exceeded dietary levels. The retention of eicosopentaenoic (EPA) was low in all dietary groups, providing further evidence of its role in fish as a substrate for □-oxidative processes. There was no evidence from this study of accumulation of arachidonic acid (ARA) in the dorsal muscle of fish fed any of the experimental diets, including those rich in n-6. The results demonstrate the potential to modify favorably n-3/n-6 ratios of fatty acids in consumable fillets by increasing dietary fish oil. The n-3/n-6 ratio of tilapia fillets increased from 0.1 (fish fed 0% cod liver oil) to 1.44 (fish fed 12% cod liver oil).

The present study, carried out with juvenile tilapia, showed that a relatively short period of feeding (10 weeks), with a fish oil-based diet, is sufficient to modify significantly the fatty acid profile of tilapia fillets. Further research, using 'finishing diets' containing fish oil on market- sized tilapia, is necessary to examine the potential to culture tilapia, as an n-3 enriched functional food. It may be possible in the future to offset the additional feeding costs, associated with the use of fish oil, by sales of n-3 enriched tilapia fillets into specialized markets, where promotion strategies are based on the health-promoting value of long chain, n-3 fatty acids.

Binding of Collagen Type 1 to bp26 *Brucella* Protein – Identification of Specific Binding Sites

(SQU Project Code: IG/AGR/ANVS/08/03 – Investigation on *Brucella melitensis* immunogenic domains)

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Brucella species are a group of facultative gram-negative intracellular bacteria, which parasitize humans as well as several other animal species. Interaction of *Brucella* species with the host epithelial tissues is largely unknown. In this report, we studied binding of bp26 a *brucella*-periplasmic protein to collagen type 1. In western blotting, collagen type 1 bound to Bp26 in a concentration dependent manner. Moreover, synthetic peptide biotinylated to their N-terminus and mimicking the entire bp26 sequences were used to determine collagen type 1 binding sites. We identified five bp 26 protein linear epitopes for collagen type 1. The collagen binding sites are in the N-terminal amino acids number 1-20, 51-64, 97-110, 121-135, and the C-terminal amino acids number 230-250. This is the first report of collagen binding sites on Bp 26 protein which could shed some lights on the *brucella*-host binding mechanism.

The Effect of Low Levels of Dietary Cobalt on Select Parameters of the Specific and Non-specific Immune System of Omani Goats

(SQU Project Code: IG/AGR/ANVS/06/01)

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Cobalt is synthesized by rumen bacteria to vitamin B_{12} which has two distinct but interdependent c-enzymatic functions. Low levels of dieatary cobalt leads to vitamin B_{12} deficiency. At the field level we have observed that goats with low levels of serum vitamin B_{12} had higher levels of specific parasite loads and often appeared to be more susceptible to infections. It was hypothesized that low levels of dietary Co might have an effect on the immune system. This served as the catapulting framework upon which the present study was undertaken.

Twenty ten-week-old newly weaned male Batinah goats were randomly assigned to a control (n=10) and a treated (n=10) group and were fed a diet containing 0.1 mg/kg DM cobalt (Co). Goats in the treated group received bi-monthly subcutaneous injections of 2000 µg of hydroxycobalamin. Lymphocyte function was studied using WST-8 blastogenesis assays while an antigen specific antibody response was done examining the immunological response of goats to keyhole limpet haemocyanin. The phagocytic function of the polymorphonuclear leukocytes (PMN) were tested using a luminol-dependent chemilumines-cence assay with opsonized zymosan as the phagocytic target. At no time points was there a measurable difference in mitogenic response to either the T cell mitogen PHA or the mixed T and B cell mitogen PWM. One month after the onset of the experiment however, PMN from the control group exhibited a significantly ($p<0.05$) lower CL response, which continued for the second month. The results of the present study demonstrated that low levels of dietary cobalt leads to an early impairment of phagocytic function and may at least in part, be an explanation as to why at the field level in Oman young goats fed diets containing low levels of Co appear to be more susceptible to infections. Indeed the impaired immune response demonstrated in the present study could be considered as a more powerful diagnostic indicator of Co deficiency than the more commonly employed diagnostic indicators such as vitamin B_{12} concentrations in plasma or the liver.

Antioxidative Effect of Light Muscle Press Juice from Hamour

(SQU Project Code: SR/AGR/FOOD/05/01 -
Value-added marine raw materials and health)

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Reactive Oxygen Species (ROS) can cause oxidative stress which is in turn linked to various diseases. Studies have shown that antioxidant rich food can reduce the generation of ROS and hence reduce the risk of diseases associated with oxidative stress. Increasing intake of dietary antioxidants may help to maintain an adequate antioxidant status. We have recently developed a cellular model using human monocytes, to assess the effect of Press Juice from Herring and known antioxidants. Hamour (*Epinephalus chlorostigma*) light muscle press juice (PJ) is used here for antioxidant capacity on the generation of ROS from the monocyte system along with in vitro analysis.

The light muscle of fresh Hamour was manually dissected from the whole fish, minced and extracted. After ultra filtration using 1000 Da membrane for the LMW (Light Molecular Weight) fraction, and 3500 Da for the HMW (High Molecular Weight) fraction, Oxygen Radical Absorbance Capacity (ORAC) assay at 600 nm was used for the determination of Total Antioxidants Capacity.

Both ORAC and CL data show an antioxidant profile of the PJ from Hamour. This effect was, however, more pronounced in the HMW fractions.
It is concluded that the PJ from Hamour reduces the generation of ROS in the human monocyte model owing to its antioxidant capacity. The mechanisms of action remain to be elucidated.

Characterization of Pathogens Associated with Root/Foot Rot and Gummosis Diseases of Citrus in Oman

(SQU Project Code: IG/AGR/CROP/09/01)

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A study was conducted to characterize the most common pathogens associated with root/foot rot and gummosis diseases of citrus in Oman. The survey covered six different regions (Batinah, Musandam, Buraimi, Dhahira, Interior and Sharqiya). Isolations were established from roots, shoot bases and stems of healthy and diseased citrus trees which included acid lime, sweet lime, mandarin, grapefruit, sour orange and others. Identification of fungal pathogens was based on morphology and sequences of the internal transcribed spacer region of the ribosomal DNA (ITS rDNA). Root rot, gummosis, stem girdling and slow and rapid decline were found to be the most common disease symptoms associated with citrus trees in Oman. Different species of *Fusarium*, *Pythium*, *Phytophthora*, *Lasidiplodia*, *Phoma* and *Rhizoctonia* were isolated from diseased citrus trees. *Fusarium* species (mainly *F. solani*) were found to be the most common species associated with declining trees, followed by *Lasiodiplodia theobromae*.

Drying of Dates in Oman Using a Solar Tunnel Dryer

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Taking into consideration the dates harvesting and land–holding capacities of the marginalized rural farmers in Oman, a 12 meter long and 2 meter width tunnel was designed and constructed to dry about 180-200 kg of freshly harvested dates per batch. The half of the tunnel base was used as the flat plate air heating solar collector and the remaining half as a dryer. The drying air was forced from the collector region (south side) to the drying region (north side) of the half circled tunnel where the product is to be dried. The drying temperature could be easily raised by some 5-30^{0}C above the ambient temperature inside the tunnel at an air velocity of approximately 0.3-0.4 m/sec. The test was conducted with 190.2 kg freshly harvested dates with initial moisture content of 32.8% (wet-basis) to analyze the performance of the dryer. The dates were dried to a final average moisture content of 18.6% (wet-basis) within two days (20 hours). The results indicated that the drying was faster in solar tunnel dryer than the natural open air sun drying. It was possible to reach the moisture content level for safe storage within less than two days (20 hrs) with solar tunnel dryer and 5-7 days in open air natural sun drying. The improvement in the quality of dates in terms of color, brightness, flavor, and taste and food value was distinctly recognized.

Significant Research Outcomes

Significant Research Outcomes

Department of Animal and Veterinary Sciences

The aim of AVS research is to improve animal production and health in the Sultanate.

Dr. Isam Kadim

Meat Quality and Production Research: The aim of this research is to identify factors that have potential to improve meat production from Omani livestock. Local breeds are potentially valuable food source because of their ability to produce high quality and low-cost meat. The demand for camel meat has increased over the past few years due to its low fat content, but its meat quality characteristics have received little attention. Effect of age and postmortem electric stimulation on the quality, composition and histochemistry of meat from the camel was thoroughly studied. Sultan Qaboos University (SQU) is now recognized as an international leader in research on camel meat as a result of this research. Improvement of the understanding of factors affecting the quality and marketability of camel meat has resulted in SQU being selected to host the 3rd Conference of the International Society of Camelid Research and Development in 2012.

The findings of the effects of heat stress on carcass and meat quality of local animals has important implications for livestock production in Oman due to high ambient temperatures, which is one of the main constraints on animal production.

The relationship between the nutritive value of local feeds and animal health led to identify several low cost feed alternatives which could reduce the cost of local animal production.

Dr. Patrick Akin Bobade

A large survey resulted in the identification of 10 species of ticks, two of which had not been reported in Oman. Also two tick-borne haemoparasites of goats which had not been reported in Oman were detected by means of molecular diagnostic procedures.

Prof. Eugene H. Johnson

A multi-year project culminated in discovering that cobalt deficiency is a serious clinical and subclinical disorder of Omani goats that has widespread effects on the health, growth and production of Omani goats. Goats are generally considered to be fairly resistant to low levels of

dietary cobalt. However, studies from our laboratory have shown that this is not a valid assumption for Omani goats. Our laboratory made the discovery that a pathological condition long observed in the Sultanate of Oman, which we named hepatic lipidosis is actually the result of goats eating diets containing levels of cobalt previously considered to be adequate even for sheep. Hepatic lipidosis was experimentally reproduced in goats and the hypothesis was validated that this condition was the result of insufficient amounts of cobalt in the diet of the experimental animals. Goats with Co deficiency showed poorer growth, lower nutrient digestibility, poorer meat quality and increase levels of porositosis. We have provided the first evidence that cobalt deficiency does indeed affect the non-specific immune response of goats, a possible avenue to diagnostic of Co deficiency.

Polymorphonuclear leukoctyes (PMN) serve on the first line of the immunological defense of ruminants. The first definitive study was undertaken by our laboratory to ascertain whether there might be functional differences in PMN from neonatal lambs when compared to those from adult sheep. PMN isolated from lambs exhibited significantly lower levels of CL up until two months of age. At three months of age the PMN produced levels of CL equal to that of their dams. As CL mirrors the ability of PMN to efficiently phagocytize and kill pathogens the present findings provided the first evidence that PMN of neonatal lambs during the first two months are likely less capable of defending them from pathogenic organisms. This novel finding has serious potential implications as it raises the possibility that PMN from neonatal lambs might potentially be activated to support their ability to kill pathogenic organisms at that time when they are most susceptible to infectious diseases.

Department of Crop Sciences

The Department continued its very active research on the identification and management of various diseases.

Dr. Michael Deadman

On mango, a strategy has been put in place to effectively counter the threat of mango wilt disease. Exotic varieties have been imported and are currently being screened for resistance to disease at SQU and elsewhere.

On cucurbit disease management, commercial collaborations have been established to provide disease resistant seed material for field trials in Oman. The mechanism of resistance has been investigated and is related

to plant vigour. Grafting has been successfully evaluated as a method of disease management under controlled and on-farm trials.

Dr. Akhtar Jamal Khan

The destructive pathogen of sesame phyllody has been identified as wall-less bacteria commonly known as phytoplasma. Genetic analysis of 16S rRNA gene of the phytoplasma revealed that causal agent belongs to 16SRII group similar as previously reported on alfalfa. The same phytoplasma has been recorded on chickpea, eggplant and some weeds indicating the spread of pathogen on various host plants.

Two viral species belonging to the family *Geminiviridae* has been identified by molecular techniques as PCR, Rolling circle amplification, viral full-length genome sequencing. Sixteen (16) tomato breeding lines from AVRDC has been challenged to tomato yellow leaf curl virus using viruliferous whiteflies. At least three tomato breeding lines exhibited field resistance against the virus, however, all breeding lines tested positive for virus by PCR test. Trials are underway to exploit the field tolerant breeding lines against yield reduction due to virus.

Dr. Nadiya Al-Saady

Legume seeds have been collected from different parts of Oman for genetic characterization. DNA fingerprinting has been completed on some legume accessions and others are under progress. The genetic data obtained from DNA fingerprinting of various collected accessions would help to recognize the overlap among accessions, characterize local Omani accessions from exotic ones. The Omani accessions will be conserved in gene bank.

Dr. Rashid Al Yahyai

Extensive survey in all regions of Oman has been conducted to record the presence of witches' broom phytoplasma associated with lethal disease of lime. Molecular studies such as PCR, RFLP and sequencing of 16S rDNA revealed the possible presence of variants of the lime witches broom phytoplasma. In certain orchards mainly in southern Oman, some fully-grown lime trees were symptomless indicating natural tolerance of the witches' broom disease. These plants can be exploited in propagation as tolerant rootstock.

Dr. Ali Al Wahaibi

Integrated Management of the Dubas Bug: Fundamental Investigations in Biological, Cultural and Chemical Control - A survey in different regions and governorates of Oman revealed the presence of three major natural enemies: an internal egg parasitoid, an egg predator, and a

nymphal-adult parasitoid. In addition, numerous potential predators and porositoids were documented. A geographic analysis revealed strong similarities between the distribution of the 3 main porosities and predators and that of the dubas bug.

Rejuvenating Citrus Production in Oman: Resolving Current Challenges - Thirty hopper morphospecies have been sorted out since April 2009. Six of these were abundant relative to other species. These were collected from citrus and some other host plants. Two of the six species (*Hishimonus phycitis, Diaphorina citri*) were found mostly on citrus. The other four species were more common on non-citrus hosts, and two of these were collected from weedy plants.

A total of 56 and 29 putative hopper morphospecies were recorded respectively from Jabal AlAkhdar and SQU-AES sites since March 2009. The total number of specimens was higher at the Jabal AlAkhdar site than the SQU-AES site. In Jabal AlAkhdar there were two periods in which abundance of hoppers was highest, in the spring (April-May), and in the fall (September and October). Hopper activity was the lowest during winter months.

Leafhoppers/planthoppers were collected from lime and from adjacent non-citrus trees and weeds in the Ministry of Agricultural Research Station and from Razat Farm in Salalah. The suspected vector of the phytoplasma causing WBDL (*Hishimonus phycitis*) was observed on lime in both locations. However, no WBDL symptoms were observed on lime in any of the seven sites visited. The closely related alfalfa witches broom disease was observed in one farm in Nejd. It seems that lack of a suitable secondary plant host for the phytoplasma could be the reason for the absence of WBDL in Dhofar.

Dr. Abdullah Al-Sadi

We discovered the existence of over 40 new fungal species to Oman which will update our existing knowledge about diversity of fungi associated with the major crops in the country.

We observed for the first time contamination of some organic manures and potting media with serious fungal pathogens. Findings will be sent to Ministry of Agriculture to take the necessary actions in order to protect farms from new or serious plant pathogens.

A new method of screening for detection of fungi in potting media and organic manures - This will be of great help to quarantine officers in Oman and elsewhere to facilitate the inspection procedures for such samples.

Department of Food Science and Nutrition

The Department conducts research in food science, nutrition, and related areas, using available resources to study topics of significance to these disciplines. In all of its efforts, the Department aims to contribute to health and well-being of the Omani society and to contribute to the global knowledge.

Food science

The research in the area of food science is focused on improving the quality and safety of fresh and processed products in Oman and in developing new food products and ingredients from indigenous raw materials and waste products and to study their properties. In addition it develops new analytical techniques and generates data on food properties such as glass transition, freezing curve, and maximal-freeze-concentration conditions in order to develop state diagram of dates and gelatin, which could be used for dates and gelatin processing and in determining its structural characteristics. The results of these studies can be used by the food industry to diversify their production and to generate more wealth.

The impact of environmental storage conditions on some vegetables produced locally was also determined and this information will be used by Agricultural Experimental Station (AES) and local farmers to ensure that their produce arrives in the market in the best possible condition.

Tests were also evaluated for developing a system to rapidly identify adulteration of honey on sale in the local market. Honey is an expensive commodity and the practice of adulteration is of economic value to the unscrupulous. Samples that had potentially been adulterated in the local market were identified. It is hoped that this information can be used to control this practice. These techniques can be extended to study the adulteration of other products of strategic importance to Oman.

Human nutrition

The nutrition research focuses on the evaluation of the associations between dietary and lifestyle factors and the occurrence of certain chronic diseases. Results showed so far that diseases such as non-Hodgkin's lymphoma (NHL) can be managed by choosing the right foods.

The effect of Omani fruits against *in vitro* fibrillation of a beta protein was also analyzed. Results showed that fruits and vegetables grown in Oman such as whole dates, figs, carrot, papaya, tomatoes and pomegranate inhibited Aß fibril formation in a concentration and time-dependent manner. The outcome of this study will give the lead to increase the economic value of the fruits and vegetables grown locally.

Department of Marine Science and Fisheries

The marine resources of the Sultanate of Oman are a vital and sustainable part of the national economy. From fisheries to coastal zone management developments are moving rapidly within carefully designed frameworks to protect and conserve the national marine heritage. The research carried out in the Department documents the diversity and complexity of the marine ecosystems and develops ways of managing marine resource wealth efficiently for the prosperity of generations to come. The Department of Marine Science and Fisheries is the main national research center for studies in the areas of fish and fisheries biology, coral reef ecology and oceanography. It is also a significant contributor to research in aquaculture and marine biotechnology.

The Department works in close collaboration with the Ministries of Fisheries Wealth and Environment and Climate Affairs. Research outcomes are shared, as scientific papers and project reports, with government decision makers. Research findings and issues are also shared through the media of workshops, seminars and joint committees. The value of these collaborations is recognized through substantial external grants from government sources.

Specific Research Outcomes

Fisheries and aquaculture

Within his HM project, **Dr. Govender** has developed a kingfish management plan and a model that estimates the optimal number of kingfish to be sampled annually, in order to obtain robust growth parameters and age data. The model predicts that annual sampling can be reduced from 900 to around 600 fish per year. This represents a significant saving, not only financially but in terms of human resources to process the biological data.

Shark research, led by **Dr. Henderson**, has confirmed the Daymaniyat Islands as a nursery ground for black-tip reef sharks, and the Gulf of Masirah as a nursery ground for the halavi guitarfish. The research has also led to the identification of a guitarfish species new to science and the recording of seven elasmobranch species new to Omani waters.

Dr. Goddard, working with Ahmed Al-Souti, demonstrated the potential to increase fillet levesl of the highly unsaturated fatty acids, docosohexaenoic acid (DHA) and eicosopentaenoic acid (EPA), through dietary manipulation in farmed red hybid tilapia. This has interesting implications for fish farmers, who may wish to produce omega-3 enhanced fish with added health benefits for consumers.

Dr. Claereboudt, working with Mr. Al-Rashdi from the Ministry of Fisheries Wealth, has been successful in the artificial fertilization of sea cucumber eggs

and culturing the larvae to the post-metamorphic stages (6-8 weeks). This research opens up the potential for aquaculture of sea cucumbers in Oman. Sea cucumbers are a valuable export commodity to the Far East.

Marine biotechnology

In the area of marine biotechnology **Dr. Dobretsov** has obtained extracts from several cyanobacterial species collected from different marine and estuarine locations in Florida (USA), Belize and Oman that were then screened for their ability to disrupt quorum sensing (QS) in the reporter strain *Chromobacterium violaceum* CV017. Inhibitory activities were detected in the ethyl acetate: methanol (1:1) extracts of several inhibitory activities were detected in the ethyl acetate: methanol (1:1) extracts of several *Lyngbya* spp., and extracts of *Lynbbya majuscule* contained the strongest QS inhibitory activities. Extracts of *L. majuscula* were further purified by bioassay-guided fractionation. The antibiotic malyngolide 9MAL) was identified as a QS inhibitor. Activity of MAL was investigated using *N-acyl* homoserine lactone (AHL) reporters based on the LAsR receptor of *Pseudomonas aeruginosa*. MAL at concentrations ranging from 3.57 mM to 57 mM (EC50 = 12.2 ± 16 mM) inhibited responses of the LasR reporters without affecting bacterial growth. MAL inhibited 9ECO = 10.6 ± 1.8 mM) Las QS-dependent production of elastase by *P. aeruginosa* PAO1. QS inhibitors such as MAL, can be used as new drugs to combat antibiotic resistant strains in Oman and worldwide.

Dr. Dobretsov has also demonstrated the presence of bacteria on the surface of the alga *Fucus vesiculosus* by construction of a cloning library. Light regime and presences of grazers shifted microbial communities were dominated by Gram negative bacteria. This investigation is ecologically significant as it describes interactions between algae and associated bacteria.

Marine ecology

Dr. Claereboudt has developed a model of coral larval dispersal, based on ocean currents, which suggests that most larvae do not travel very far from their birth reef. Larval connectivity values, quantified by the proportion of larvae successfully transported from their birth reef to another, varied significantly among reefs and years by several order of magnitudes in response to mesoscale variability. His studies have shown that there was practically zero exchange of larvae between the coral communities of the Arabian Sea snd those of the Sea of Oman and *vice-versa*. The general flow of larvae was from NW to SE in the Sea of Oman and from SW to NE in the Arabian Sea. A few larvae were successful in crossing the sea of Oman from Iran to Oman and *vice-versa*. The relative low connectivity amongst reefs suggests a low resilience of NW Arabian Sea reef community should any major disturbance occur and that any subsequent recovery would be very slow.

Oceanography

Dr. Al-Azri has conducted research designed to extend our knowledge and scientific understanding of the biogeochemical and ecological dynamics of harmful algal blooms in the Sea of Oman and Arabian Sea. He has also sought to identify the prominent gaps in our understanding especially as they pertain to the role of physical and ecological processes in regulating biogeochemical cycles and the carbon cycle in particular. He has also continued his studies of the physiological response to environmental conditions and spatial distribution of the alga *Noctiluca scintillans.*

Field sampling, remote sensing and modellling were employed by Dr. Piontkovski to understand the seasonal and interannual changes of plankton community in the Sea of Oman compared to the open sea regions. In these regions, maximal chlorophyll concentrations were reported during the summer monsoon (with peaks in June and August) while in the Gulf of Oman the chlorophyll maximum was observed during the winter monsoon (February-March). Satellite derived (SeaWiFS and MODIS Aqua) weekly and monthly products for sea surface temperature and chlorophyll concentration were analyzed, to assess the long-term trends in physical-biological coupling. In the variability of chlorophyll (from 1997 through 2009), no interannual trends were found, for the Sea of Oman. However, the variation of chlorophyll within the annual cycle has increased. Similar tendency was evaluated for the variability of the energy of mesoscale eddies. The median level of kinetic energy and the coefficient of variation of this energy within the annual cycle-both increased from 1997 through 2009.

Dr. Sarma conducted an analysis of chlorophyll- for a 7-years period from the ocean color images of SeaWiFS in the Arabian Sea and its marginal seas. This revealed a considerable inter-annual and geographical variability. The variability in chlorophyll- is essentially centered on the southwest and the northeast monsoon periods. The mean seasonal chlorophyll- in the western Arabian Sea showed increasing trend from 1998 to 2004. The period of elevated chlorophyll- levels in the Gulf of Mannar is apparently extended due to advection of chlorophyll- rich waters from the Bay of Bengal along the east coast of India. The coastally trapped, chlorophyll- rich front from the east coast of India enriches the Gulf of Mannar and continues its propagation northward along the west coast of India. As this front propagates northward along the coast, the southern coastal waters turn oligotrophic. The chlorophyll- concentration in the region is also influenced by the large-scale climatic events. The chlorophyll- data from selected locations were subjected to the spectral analysis to extract the periodic signals. The annual signal was found to be dominant in the areas affected by only one of the two monsoons such as in the Gulf of Mannar. The semiannual signal was predominant in the areas affected by both the monsoons such as western and northern Arabian Sea. He has built an empirical model incorporating the annual and seminaanual modes of chlorophyll- from the ocean color data. The ratio of

the standard deviations of SeaWiFS observed to the modeled chlorophyll-□, taken as a measure of model suitability, varied between 0.71 and 0.86. Thus the chlorophyll-□ variability in this region can reasonably be predicted using the empirical model developed in this study.

Department of Natural Resource Economics

Significance and impact

The project on **"**Damage Cost in Dry Aflaj and Live Aflaj Value for Recreation" highlighted the role of the agricultural sector as a provider of positive amenities for the tourism sector in a desert environment. The project has estimated the recreation value of the oasis "Misfat Al-Abryeen)" to be around R.O 85000 per year or R.O 47 per recreational trip to the oasis. These results represent important economic information that can be translated into policy formulation to set a recreational entry price to the oasis and therefore generate additional income for farmers that help sustain the oasis for future generation.

The preliminary findings of the project on "Integrated Urban Water Management in Great Muscat" showed that the protection of the agricultural land in the Batinah needs to be addressed in three parallel solutions, which requires major policy changes in water management : 1) monitoring of groundwater pumping through the introduction of high technology at well level; 2) retirement of salt affected soils above 6,000 uS/cm ; and 3) creation of new farms in the form of lease contract in areas with groundwater availability and good soil quality. The ever decreasing size of farms is a threat bigger than salinity itself.

The food security project currently underway aims at quantifying the likely impacts of the food crisis both at the national and household levels in Oman. Results of the project will generate the information needed for policy makers to design effective policy responses. A new method based on the "compensating variation" is developed to estimate the government money transfers that are required to compensate low-income households for the price increase and maintain their original standard of living. This will form the basis to design cash transfers policies that are proven to be more efficient and cost effective than other safety net policies, such as subsidies, to alleviate the effect of high food prices.

A consultancy study conducted by the Department was used as a basis to establish a new wholesale fish market in Oman. A decision was taken by the government to locate the proposed new wholesale fish market close to Barka.

The Department contributed to a consultancy study that identified a code of practice for financing investment in the small-scale fisheries sector. Key

findings were that credit was available for the sector, especially through the Oman Development Bank but also from commercial sources, however, it failed to take into account the specific characteristics of the sector, such as seasonality of supplies. The credit system was found to be weak in respect of new entrants to the sector with limited capital resources to act as collateral for investment in fishing vessels.

The Department contributed to a policy study under the responsibility of H.E Vice Chancellor SQU to look into the feasibility of wheat cultivation in Oman. The study is now under review by the concerned government institutions. The most important contribution of the department is to estimate the economic cost of wheat production in order to achieve a reasonable proportion of self sufficiency and enhance food security in Oman. Recommendations were also made on the commercial policies needed to ensure the economic feasibility of wheat production in Oman.

Research on "The Effects of Omanization Policy on the Efficiency of Dairy and Date Farms in Oman," indicated that dairy farmers in the project area have no reliable market outlets for their milk and also they lack Artificial Insemination services needed to upgrade the breeds of their dairy cows. Efforts are underway through the Ministry of Agriculture to find solutions to these problems.

Work on the "Jabal Akhdar Rose Water Production," indicates that there is a potential for Oman to produce rose oil. Rose oil is much more valuable than rose water currently produced in Jabal Akhdah. The price of one kilogram of rose oil in the world market is around 7,000 EUROs. The Ministry of Agriculture through the Agricultural and Fisheries Development Fund (AFDF) has shown interest to fund a study to explore the possibility to expand rose production in order to produce rose oil.

Department of Soils, Water and Agricultural Engineering

Dr. Salim Al Rawahy, et al.

The outcomes of the HM project on salinity had a strategic impact on the policy of land water usage in the Sultanate.

Field trials confirmed that salt-tolerant varieties of tomatoes, sorghum, pearl millet and barley can be grown successfully in prevailing conditions. Two varieties of pearl millet were selected for their superiority in salinity tolerance in summer. The Ministry of Agriculture and Fisheries and the International Center for Biosaline Agriculture multiplied the selected seeds and distributed to farmers for planting during summer 2008. Mulching surface soil with a thin layer of shredded date palm residues resulted in lesser moisture evaporation from soil surface, more water for plants utilization and lesser

salt accumulation in the soil resulting in more crop yield than other methods. Results showed that feeding sorghum fodder grown on highly saline conditions to Omani sheep had neither adversely affected their health nor meat quality. The study also indicated the feasibility of integrating fish culture into more traditional agricultural production. A socio-economic study revealed that introduction of tomato, sorghum and pearl millet forage in the high salinity farms would allow an improvement of the gross margin by up to 40%, which will help mitigate the effects of salinity**.** Remote sensing and GIS techniques in assessing the degree and extent of salinity in the Al-Batinah Region have given good indication of its precision and effectiveness in terms of speed and low cost.

Sound management practices of saline soil and water identified in this study have shown great potential for sustainable agriculture in the Al-Batinah. This justifies the need to utilize land and water resources which are of marginal quality for growing salt-tolerant crops in the Al-Batinah where there is increasing demand on the limited water resources and contribute towards agricultural sustainability, food security and combating desertification**.**

Dr. Yaseen Al-Mulla

Design and Construction of Greenhouses for Arid Regions: Phase II - There is a need to increase the production efficiency of the currently used greenhouses through modification of their structures to fit our countries environmental and climatic conditions. Based on my findings of phase 1of the greenhouse project and for the purpose of achieving the main objective of the project, second phase of the project has started since January 2009 where the heat transfer modeling parameters inside greenhouses and screenhouses will be calibrated and then validated in addition to conducting more experiments after adding the required design modifications and work on preliminary benefit cost analysis on materials for modified PA structures and compare their performance with the currently used ones.

Prof. Anvar Kacimov

Study on Groundwater Flow in a Confined Homogeneous Aquifer Partially Intercepted by a Permeable Reactive Barrier (PRB) - Of fundamental importance are the degree of remediation inside PRB (residence time) and the portion of groundwater intercepted by a PRB (capture width). Based on a two-dimensional conformal mapping approach, the latter is analysed for drain-and-gate (DG) PRBs, which may possess a collector and a distributor drain ("full" configuration) or a collector drain only ("simple" configuration). Solutions for aquifer flow fields in terms of the complex potential are derived, illustrated, and analyzed for doubly symmetric DG configurations and arbitrary reactor hydraulic resistance as well as ambient groundwater flow direction. A series of practitioner-friendly charts for

capture width is given to assist in PRB design and optimization without requiring complex mathematics. DG PRBs are identified as more susceptible to flow divergence around the reactor than configurations using impermeable side structures (e.g., funnel-and-gate), and deployment of impermeable walls on drains is seen to mitigate this problem under certain circumstances. The shape of an arbitrary PRB without gates and funnels is optimized with the following hydraulic criteria: seepage flow rate through a PRB (equivalent to the width and frontal area of the intercepted part of the plume in 2-D and 3-D cases, correspondingly) and travel time of a marked particle through the PRB interior along streamlines. The wetted perimeter, cross-sectional area and volume of the reactive material are selected as isoperimetric constraints. Simple expressions for the longest travel time within the PRB and the discharge intercepted by it are obtained.

Summary of Internal Grant Projects Awarded in 2010

Study on Theileriosis of Indigenous Sheep in the Sultanate of Oman

Mohammed H. Tageldin, P.I.

Duration: 3 years **Budget:** 8,400

The government's livestock strategy is focused on increasing domestic meat consumption of small ruminants, containing meat imports and improving rural incomes. This strategy has not been met because of certain constraints that hamper production and productivity. Among the major ones are diseases of small ruminants. Sheep in the Sultanate are infected with as-yet-unidentified *Theileria* species. It affects the health and productivity causing high morbidity and mortality, consequently leading to great economic losses. In the Sultanate, records of theileriosis are very scanty. The vector responsible for the transmission of the disease is still hypothetical. Pathogenicity of the disease is poorly understood. Besides, there are numerous serious problems in the management of the disease related to drug resistance, poor availability of drugs in areas where problems exist. In addition, the indiscriminate use of acaricides for vector control might result in environmental pollution. In most cases, even if the animal survived, their productivity is severely impaired after recovery. In developing strategies against the disease it is essential initially to obtain base line data before the control programme is introduced. This study will therefore aim to determine the *Theileria* species involved the epidemiology, pathogenicity as well as the species and dynamics of tick infestation within indigenous sheep population in the Sultanate. Molecular techniques will be used to detect and identify the *Theileria* species.

Escherichia coli O157:H7 and Other Shiga Toxin-producing *E. coli* in the Faeces of Healthy Sheep, Goats and Cattle in the Sultanate of Oman

Dawood S. Al-Ajmi, P.I.

Duration: 3 years **Budget:** 4,000

Ruminant animals have been considered as a primary reservoir for Shiga toxin-producing *E. coli* (STEC) especially *E. coli* O157:H7, a bacterium responsible for the severe abdominal illness in human. This pathogen lives asymptomatically in the digestive tract of healthy ruminant animals such as cattle and sheep and is shed infrequently and intermittently in the faeces. Thus, it can contaminate carcasses upon slaughter and processing. Consequently, it enters the human food chain. To date, there were no studies conducted to test for the occurrence and prevalence of STEC in ruminant animals in Oman. Therefore, the aim of this experiment is to determine the prevalence of Shiga toxin-producing *E. coli* in slaughter animals such as cattle, sheep and goats in Muscat, Sultanate of Oman. This aim will be achieved through four stages. In stage 1 and 2 a total of 600 fecal samples from sheep (n=200), goats (n=200), and cattle (n=200) at slaughterhouse, will be collected and screened for the presence or absence of the shiga toxins genes (stx_1 and/or stx_2) using a published multiplex PCR method. They will also be tested for the presence of absence of the STEC O157:H7 using the conventional Immunomagnetic separation technique (IMS) and multiplex PCR for genes specific for O157/H7 (stage 3). In stage 4, all the stx^+ samples from stage 2 will be streaked on McConkey gar (SMAC, Oxoid) medium supplemented with cefixime (0.05 mg l^{-1}) to isolate the STEC colonies. Here all the selected isolates will be purified and characterized using the published Multiplex PCR method of Paton and Paton (1998). All the *E. coli* O157 as well as any colonies giving a positive result to any genes tested, using the multiplex PCR were re-grown again in BPW, purified by streaking on Sorbitol MacConkey agar supplemented with 0.05 mg ml^{-1} cefeximine and 2.5mg ml^{-1} tellurite and sent for serotyping. This will be a first report in the occurrence and prevalence of STEC O157 and non-O157 STEC in food animals in Oman. Data from this investigation will help to determine the possibility for the carcasses to be contaminated with these bacteria. The result of the present study will enable livestock producers to take more precaution when dealing with animal and its products. It will also help to compare the virulence properties of these STEC with the STEC isolated worldwide.

Integrated Management of the Dubas Bug: Fundamental Investigations in Biological, Cultural, and Chemical Control

Ali Khalfan Al-Wahaibi, P.I.

Duration: 3 years **Budget:** 6,000

Dubas Bug (*Ommatissus lybicus* Bergevin) is a very serious pest on date palm plantation in the Sultanate, Iraq, and an important pest in other countries of the Arabian Peninsula such as Saudi Arabia, UAE and Yemen. This pest has also been economically important on date palms grown in southern Iran. Both nymphs and adults suck the sap and excrete honeydew over leaf surfaces and fruits. This leads to dust accumulation and growth of sooty mold, which reduces the photosynthetic activity of the leaves. In the case of relatively high populations of dubas bug, a reduction in the yield of palms and a lowering of the grade of the crop have been observed. Such severe infestations could result in date fruits being unfit for human consumption. They could also negatively affect crops grown under date palms.

Since its establishment, the Ministry of Agriculture (MA) has been concerned annually with managing the Dubas bug by aerial and ground applications of selected insecticides (such as Nogos, Malathion, Sumithion, Decis, Elsan and others) in an area of about 12.6 thousand hectares. A "honeydew droplet" method was developed by MA to better time applications of insecticides and monitor their effectiveness against the dubas bug. The life cycle of the pest and its population dynamics are generally well known. Biological and ecological studies by MA and Sultan Qaboos University (SQU) discovered several potential biological control agents associated with dubas bug. However, the dubas bug is still a serious problem for the Sultanate and neighboring countries. In order to find sustainable solutions to the dubas bug problem, it is necessary to gather fundamental and detailed information regarding its economic damage and natural enemies. Moreover, novel methods of chemical (insecticide Confidor applied as soil drench) and cultural (pruning of old fronds) management as well as new and more effective biological control agents need to be tested before wider use in date plantations throughout the Sultanate. This proposal aims to gather this experimental and observational data, a necessary foundation for the building of an IPM program for the dubas bug in Oman.

A Study of the Nutritional and Metabolic Factors Contributing to the Occurrence of Autistic Spectrum Disorders Among Children in the Sultanate of Oman

Mostafa Waly, P.I.

Duration: 3 years **Budget:** 8,000

Autism is a mysterious brain development disorder. It is poorly understood in terms of epidemiology, etiology, biochemical profile, management, and prognosis. Abnormalities involving the folate-dependent homocysteine methylation reactions, oxidative stress and genetic predisposition are implicated as potential causes of autism, but a specific metabolic target that is relevant to autism has not yet been identified. We hypothesize that exposure to certain environmental toxins may induce oxidative stress in human brain via inhibiting the folate-dependent homocysteine methylation and sulfuration reactions. These deficits may predispose particular individuals to the risk of Autism. Identification of a metabolic profile of Autism represents a tool for early diagnosis and treatment. Applying nutritional methylating and sulfuration intervention regimens may contribute to autism disorder therapy. Up to our knowledge, there are no published reports about autism in Oman. This study has therefore been planned to explore the prevalance in Oman as well as to investigate the role of important neurodevelopmental toxins and biochmeical parameters in the progression of Autism in Oman.

Extraction and Structural Characterization of Gelatin from Fish Skin

Mohd Shafiur Rahman, P.I.

Duration: 3 years **Budget:** 8,000

In recent years fish skin gelatin has gained importance as the demand for non-bovine and non-porcine gelatin increased due to the bovine spongiform encephalopathy (BSE) crisis and for religious and social reasons. In addition, fish skin is a major by-product of the fish processing industry, causing wastage and pollution. The waste could also be used to develop the value added by-products and it could contribute to solve the problem of waste disposal. The physico-chemical properties of fish skin gelatin are greatly influenced by the species or tissue from which it is extracted as well as the processing methods. The objective of this project is to study the extraction of the fish skin gelatin on acid hydrolysis reaction and to characterize its structural properties. Processing will be studied in the pretreatment modifying the structure of raw material, the acid concentration and the processing temperature. Different types of gelatin powders will be developed by varying processing conditions. Glass transition and water sorption characteristics will be measured by DSC, MDSC, isopiestic and DVS methods. Mechanical characteristics will be measured by DMTA and TPA methods for gelatin gels prepared from different types of gelatin. Graduate students and technical staffs will be trained up through this project. The results will be used to optimize the process. The scaling up of this process shall be studied in order to define a relevant industrial technology, valorized through adequate IPR and industrial policy. The main results will be communicated to the fish processing industry by organizing workshops. The developed scientific knowledge will be published in the refereed journals related to food science. A collaborative project will also be initiated with the IIUM related to the papaya skin extract.

Diabetes Education in Primary Health Care in Oman: Factors Predicting Diabetes Control, Effect on Knowledge and Metabolic Control

Lyutha Khalfan Al-Subhi, P.I.

Duration: 3 years **Budget:** 6,400

The evidence shows that the prevalence of diabetes and diabetes-related complications are on the rise in Oman which add in draining the health care system in addition to the indirect cost on the life of those affected with the disease. Lack of knowledge and misconceptions pertaining to diabetes symptoms and complications has been documented among Omani adults with Type 2 diabetes. Knowledge on diet and physical activity has yet to be explored. Diabetes management involves not only medication but also diet and physical activity components. Despite international recommendations to include life style management (diet and physical activity) as an essential component for diabetes health care, such education has not kept up with the alarming increase in the number of diabetes cases in Oman. There is a pressing need for diabetes education in life style management to equip patients with essential knowledge in adapting lifestyle changes. The primary objectives of this study are (a) to design, to implement and to investigate the effect of a comprehensive diet and physical activity education program for adults with Type 2 diabetes on knowledge and metabolic control parameters; and (b) to determine factors predicting diabetes management among patients based on Health Belief Model.

Assessing the Impact of Global Food Crisis on Food Security in Oman

Houcine Boughanmi, P.I.

Duration: 3 years **Budget:** 4,000

The sharp increase in global food prices over the recent years has raised concerns about the short term effects of high and volatile food prices on the welfare and nutritional status of people around the world, the effect on the food import bill for food deficit- countries, and the effect on the national food security now and in the long run. The GCC countries, including Oman, import most of their food and like the rest of the world are very much concerned about the recent global food price surge. Although the ability to import food for these countries is not affected in the short run, the continuous increase of world prices as well as their variability will drain public resources and impact negatively a large segment of the population. Because of their high dependence on food imports, the GCC countries have experienced the highest domestic food inflation rates in the Middle East during the last two years. To address these concerns, the GCC countries have typically responded by using a combination of trade and price policies, which include: reducing or eliminating tariffs on imported food, direct control of food prices, consumer subsidies, relaxing food import restrictions, and imposing restriction on food exports. The food crisis has however prompted public discussions and debates over its fiscal and household effects and the policies required to efficiently insure short term and long-term food security. The overall objective of this project is to quantify and measure the likely impacts of the food crisis both at the national and household levels in Oman in order to generate the information needed for policy makers to design effective policy responses. To achieve the overall objective, the project will (1) analyze the determinants of food inflation and the pass-through of global food prices to domestic prices; 2) develop food security indicators at the national level to gauge the vulnerability of the country to global food price shocks; 3) investigate policies options to insure food security including setting strategic reserve stocks at the country and possibly at the regional (GCC) level as a policy to manage the risk from global food price surge; and 4) Estimate the welfare impacts of the global food crisis on a number of "typical" categories of household in Oman by using information and data from the national household and income expenditure conducted by the Ministry of National Economy. Econometric techniques will be used to determine the global food price pass-through and the household welfare impacts by deriving the "compensating variations" and estimating a complete food demand system from the household survey data. The outcome of the project will provide policy makers with sufficient information to design and implement the appropriate policy actions in response to current and future food crises.

A Supply Chain Management Approach to Promoting Competitive Advantage of Small-scale Fishery Sector in Oman

Omar Al-Jabri, P.I.

Duration: 3 years **Budget:** 4,000

Small-scale fisheries in Oman are characterised by operational and performance inefficiencies, the undermanagement of marine resources and weak marketing linkage resulting in low competitiveness. Although the literature promotes supply chain management as a business model capable of improving low competitiveness no research has been carried out on supply chain management in this context in Oman or any other developing country. Supply chain management has been shown to enhance organisational productivity and profitability and improve the welfare of many groups and individuals, from the primary players in the chain to the secondary participants, such as credit providers, equipment manufacturers, and even research and development (R&D) institutions. This examines supply chain management as a strategy to improve the competitiveness of small-scale fisheries. In particular, it examines how supply chain management principles and practices contribute to the incomes of supply chain participants in the hope to identify strategies that might lead to better competitiveness in the sector.

The presence of marketing relationships and trust were used as an indicator to distinguish participants who have an orientation towards supply chain management practices. Contrasting their features and performance indicators with those of participants who do not have such an orientation might indicate the potential for supply chain management practices to improve fishing businesses and through them the wider industry.

A mixture of methods and techniques were used to collect data, based on the targeted groups, and how data are best obtained. Observations, interviews and surveys are the essential data gathering methods. Document analysis will provide information on the past, and current, conditions to help build a clearer picture of the situation.

Optimal Control of Micro Irrigation Systems

Hayder Abdel Rahman, P.I.

Duration: 3 years **Budget:** 6,000

This project aims at optimizing water supply in micro irrigation systems for achieving maximum yield through controlling the discharge (depending on the emitter type and pressure) and time of application, as a function of the actual evapo-transpiration, soil characteristics (including initial soil moisture) and plant root geometry. Optimizing water application parameters using reliable process models in order to generate a most favorable soil moisture profile under given soil and climatic characteristics - for different crops with their different root zone shapes at different stages of growth - is a complex nonlinear optimization problem. Common optimization techniques are computationally extremely demanding – and even more important – far too complicated for irrigation practice. Therefore, a new, alternative methodology is proposed which combines rigorous process modelling and an innovative type of Artificial Neural Network, a Self-Organizing Map with Input Output option (SOM-MIO) for solving the problem in two separate steps. The first step uses the subsurface flow model for generating a matrix of corresponding input/output values, used for training the SOM-MIO, which - after a unique training allows performing simulation tasks as well as solving inverse problems. The second step, the application of the fully trained SOM-MIO then provides the optimal irrigation parameters. The theoretical development will be accompanied by field experiments to validate the model using different emitters, pressures, crop types and stages of growth under given soil and climatic conditions. Combining highly reliable rigorous process models with the benefits of a task specific SOM-MIO, namely its performance in solving complex optimization problems, its high computational efficiency and its convenient and straightforward application, not requiring expertise in numerical methods, recommends such a new methodology as a very promising tool in irrigation practice.

Effects of Siltation Behind Al-Khod Dam on the Soil Properties and Recharge Efficiency

Ali Al-Maktoumi, P.I.

Duration: 3 years **Budget:** 6,000

Recharge dams in Oman represent one of the few practical tools available to augment water resources. Deposition of soil particles that are brought by runoff water is a common problem in recharge dams and it has been observed in Al-Khoud recharge dam. This adversely affects the storage capacity of the dam. Over time, layers of silt and/or other sedimented finer particles cover the bottom of the dam reservoir. As obvious, the infiltration rate decreases, water loss via evaporation increases, and groundwater recharge is reduced. This layer is commonly scraped. However, a part of the sedimented fine particles is carried downward by seeping water into the parent soil/rock. This gradually may changes the physiochemical properties of the original subsurface porous medium. The migration of particles in sub-soils of recharge dams with periodically applied hydraulic gradients typical for arid climates with sporadic flood events has not been studied. The primary objective of this research proposal is to investigate the effect of the Al-Khoud dam on the reservoir soil properties and the recharge rate to underlying aquifers. A number of field and laboratory experiments and both analytical and numerical modeling studies will be performed. Detailed analysis of soils inside and outside the reservoir will be conducted. Experiments in a 2-dimensional sand tank will be carried out to mimic the filtration of fine particles through the parent soil materials. The reduction of the hydraulic conductivity will be measured using a column experiment. A conceptual model will be developed to gain more insight into the kinetics of filtration and evolution of infiltration fronts in essentially heterogeneous porous media.

Understanding the behavior and patterns of the percolating soil particles and its effect on infiltration and recharge are of critical importance for better management strategies and will provide the foundation for future decision making by the Ministry of Regional Municipalities and Water Resources and other governmental agencies.

Agronomic and Economic Feasibility of Salt Tolerant Plants for Saline Lands and Water of Batinah

Ahmed Al-Busaidi, P.I.

Duration: 3 years **Budget:** 5,000

A major part of land and water resources of Al-Batinah, the principal region of Oman agriculture, has become highly saline due to seawater intrusion and secondary salinisation. This situation was created due to over pumping of water exceeding the annual recharge and has now become almost permanent. Hence, all the future agriculture will be Saline Agriculture if land resource is to be saved at all because a rapid land use change is occurring and vast valuable agricultural lands are disappearing while buildings are being constructed on such lands. Agricultural lands are scanty in the country. The farmers can only be motivated not to change the land use and sell their lands if an alternative and economically attractive use made possible and demonstrated to them. They can be convinced by presenting a solution in which they can still use their saline lands for growing of economically viable plants that can bring them fodder, food and reasonable income even using saline water for irrigation. Salicornia and Jatropha are the potential plants that can be grown in saline lands and hot moist sandy coastal belts like Al-Batinah and can also be irrigated with highly saline water. A systematic research will be conducted on these two plants continuously for three years in order to assess their salt tolerance, performance under prevailing conditions and other related aspects like oil and protein content, palatability and quality of fodder, etc.

In the first year, pot study will be conducted at Agricultural Experiment Station (AES), College of Agricultural & Marine Sciences, Sultan Qaboos University to evaluate the feasibility of tested plants irrigated by saline water to grow under Omani conditions. The results from the first year will be used to plan a large scale study at AES or Rumais station. All necessary measurements (soil, plant and yield analyses) will be done based on reliable published references. In the last year, the findings will be generalized to the public through extension channel and farm applications.

The outcome of the study will be the utilization of degraded saline water and lands and laying theoretical and experimental foundation for future to bring fodder for goat, sheep and livestock, vegetable oil, burning fuel and even bio-fuel for vehicles. Thus, employment for the rural communities be brought again and new industry can develop.

Performance Evaluation of a Solar Tunnel Dryer for Drying of Lemons in Oman

Mohammed Basunia, P.I.

Duration: 3 years **Budget:** 4,000

The use of solar tunnel dryers in drying agricultural products like vegetables and fruits has shown to be practical and economical. Solar dryers considerably reduce the drying time compared to open air natural sun drying. The small holding capacity of the solar dyer is a major limitation for commercialization. Moreover the moisture removal rate is inadequate and the required moisture removal could only be achieved with forced ventilation using fans (Basunia and Abe, 2001b, 2001c; Lutz et al, 1987). A successful solar tunnel drier was designed and developed at the Sultan Qaboos University under the project (IG/SWAE/08/01) similar with the design of University of Hohenheim, Germany, to meet the drying requirements of small farmer cooperatives to dry fishes. A solar tunnel dryer, similar with the designed by the authors under the project (IG/SWAE/08/01) for drying fishes but with different dimension and materials, will be constructed for drying ripen lemons. The performance of the dryer will be evaluated in order to find its suitability in drying lemons as these products drying using solar energy have greater potentiality in Oman.

Roof-Mounted Irrigation by Capillary Siphoning

Anvar Kacimov, P.I.

Duration: 3 years **Budget:** 200

Tomato and petunia crops will be cultivated in pots filled with three types of soil (coarse sand, recharge dam silt and soil from the SQU Agricultural Experimental Station plot). The pots will be placed in an open area of the roof of a CAMS building. Water will be diverted to the pots from plastic containers through siphons made of used T-shirts, which are rolled and filled with soil. Siphoning flow rate, moisture content in the pots, hydrological parameters and the development of the plants will be measured and monitored. Feasibility of further greening of roofs of Omani houses and their passive thermal insulation will be assessed.

Summary of Strategic Research Projects Awarded in 2010

Potential Sources of Soil-Borne Plant Pathogenic Fungi and Bacteria into Farms in Oman

Abdullah Al-Sadi, P.I.

Duration: 3 years **Budget:** 87,500

Tomatoes and cucurbits, mainly watermelon, muskmelon and cucumber, are among the most important vegetable crops in Oman, with nearly 20% of the area devoted for vegetable production. Despite an increased demand, production has been constrained by increasing disease problems. Fungal pathogens which survive in soil, also named soil borne pathogens, represent the biotic factors most limiting profitable production in soil based systems. Losses from some soil borne pathogens, e.g. *Pythium* spp. and *Fusarium* spp., exceed 90% of plants in some farms. Bacterial diseases have also been reported in some crops such as tomatoes. Soil borne pathogens pathogens can attack seeds in the soil and kill them or attack emerging seedlings and mature plants and result in wilt and subsequent death. This has resulted into an excessive use of chemicals which results in hazards to humans and the environment.

Management of soil borne diseases of tomatoes and cucurbits in Oman is limited by 3 factors: (1) the continuous introduction of new or more aggressive soil borne pathogens into Oman from abroad via unknown sources; (2) re-occurrence of soil-borne diseases in fallow soil or cultivated soil following chemical treatment; and (3) the shift of many growers towards the use of hydroponics systems for cucumber production.

The overall objectives of the proposed study are: (1) to determine the potential sources of fungal and bacterial pathogens into farms in Oman; (2) to develop adopted tools and protocols to be used by quarantine officers for assessment of sources by which plant pathogens enter Oman; and (3) to evaluate problems associated with the use of hydroponics systems for cucumber production. The emphasis in this study will be on cucurbits and tomatoes, the top two vegetable crops in terms of production in Oman.

Economical, Social and Environmental Impacts of Marine Biofouling in the Sultanate of Oman

Sergey Dobretsov, P.I.

Duration: 3 years **Budget:** 92,500

Marine biofouling (which is an undesirable growth of micro- and macro-organisms on man-made surfaces) causes enormous problems in the maintenance of ships, boats, fishing nets, cages and desalination plants worldwide. Countries worldwide are spending more than US$5 billion per year to fight biofouling using toxic compounds that kill non-target organisms and accumulate in the marine environment. Biofouling is causing serious impact on all industries in the Sultanate: biofouling is responsible for clogging pipes and membranes of desalination plants and steam-injection plants in oil industry, decreasing speed and increasing corrosion and fuel consumption in vessels, damaging fishing nets and cages and decreasing their fishing efficiency. In comparison to other regions, there is no effective strategy to deal with biofouling and its economic and environmental impact in Oman waters. We hypothesized that antifouling defence can be significantly improved by utilization of low cost and low environmental impact methods effective against biofouling organisms from Oman waters. In the proposed project we are going to: investigate economic and social impact of biofouling; analyze current antifouling methods and their environmental consequences; identify biofouling species causing major industrial problems; propose best practices to reduce the costs and environmental impact associated with antifouling protection in the Sultanate of Oman. The results of this investigation will result in an economy of resources spent for antifouling defence, reduce environmental risks and increase in efficiency of man-made installations (desalination plants, steam plants, cooling pipes, boats, nets, cages, etc.) working in the Sultanate and other Gulf countries.

Graduate Programs

Graduate Programs

Research Proposals of 2010 PhD Students

Molecular Studies on the Role of Pre-coat Protein Gene (ORF AV2) and Coat Protein Gene (ORF AV1) of *Tomato Yellow Leaf Curl Oman Virus* (TYLCOMV) in Pathogenesis

Student Name : Abdulrahman Al Matroushi
Supervisor : Dr. Akhtar Jamal Khan
Department : Crop Sciences

Tomato yellow leaf curl virus (TYLCV) is a major constraint to tomato production in Oman. It is a member of the genus *Begomovirus* of the family *Geminiviridae*. It is whitefly transmitted and infects a wide range of dicotyledonous crops. It has a circular single stranded DNA genome, encapsidated in a geminate particle. They are either bipartite (DNA-A and DNA-B) or monopartite (DNA-A). Monopartite begomoviruses has six Open Reading Frames (ORFs), among them coat protein gene (ORF-V1) and pre-coat protein gene (ORF-V2) are over-lapping in the virion sense strand. ORF-V1 is essential for encapsidation of the viral genome and protects viral ssDNA, export ssDNAs to the nucleus, mediate systemic movement in plant and needed for the transmission by whiteflies. ORF-V2 is essential for movement of the virus and affects symptom expression in some begomoviruses such as BCTV. Some members of monopartite viruses are found to be associated with ssDNA components termed as DNA-□. Tomato yellow leaf curl disease is caused by a complex of TYLCV species.

The objectives of this work are to determine the diversity of TYLCOMV and associated DNA-ß; to study the role of DNA-ß associated with tomato begomoviruses in symptom development; and to elucidate the role of TYLCOMV ORF-AV2 and ORF-AV1 in pathogenesis.

Symptomatic tomato leaves will be collected from different Welayat, total genomic DNA will be extracted. The viral DNAs will be amplified using Rolling Circle Amplification (RCA). The viral genomic components (DNA-A, DNA-ß) will be cloned using unique restriction endonucleases and sequenced and phylogenetic analysis will be done. Agroinfectious constructs of TYLCOMV DNA-A and DNA-ß will be made in a binary vector. Their infectivity will be checked individually as well as in different combination on tobacco and tomato plants. Deletion mutagenesis will be performed for ORF AV1 and AV2. The infectivity of the mutants will be tested by Agro-inoculation and symptom development will be compared.

This work will lead to determine the nature and types of tomato begomoviruses in Oman and DNA-ß associated with them, which will be used in management strategies. To understand the potential of recombination between TYLCOMV and associated DNA-ß to produce novel viruses and diseases in Oman. To understand the potential of coat protein gene (ORF-AV1) and pre-coat protein gene (ORF-AV2) in the replication. And it will contribute to the further development and refining of scientific methods in the field of biotechnology and genetic engineering.

Genetically Engineered Resistance Against Tomato Yellow Leaf Curl Disease Prevalent in Oman

Name of Student : Um E Ammara
Supervisor : Dr. Akhtar Jamal Khan
Department : Crop Sciences

Tomato yellow leaf curl disease, caused by the Tomato yellow leaf curl virus (TYLCV) has become a serious problem that affects tomato (Lycopersicum esculentum L.) worldwide. Tomato yellow leaf curl virus (TYLCV) causes a considerable losses to tomato crop every year inducing a range of symptoms such as leaf curling, stunted growth, erect or upright growth and leaves curl upward and develop crumpling and distinctive interveinal chlorosis resulting in poor yield and fruit quality (Raquel et al., 2002). More than 80% of the total arable lands of Oman are located in northern region of Oman mainly in Al- Batinah region. Khan et al., (2007) reported that TYLCV symptoms on tomato are common in all regions of Oman with disease incidence ranging from 0-100%.

The management of the disease in tomato production is difficult and expensive and has limited options. Control measurements are focused mainly on the whitefly control and are based on insecticide treatments and/or the use of physical barriers (Lapidot & Friedmann, 2002). Host resistance to TYLCV has been difficult to find and develop.

Since 1986, several research groups explored the use of pathogen-derived resistance (PDR) strategy to control RNA viruses. Indeed, the attempts to obtain PDR to geminiviruses were not as successful as those against RNA viruses, suggesting that these pathogens somehow overcome the PDR resistance mechanism. Non-pathogen-derived resistance (NPDR), on the other hand, is based on utilizing host resistance genes and other genes responsible for adaptive host processes, elicited in response to pathogen attack. The use of NPDR type of resistance, even though reported much less in the literature in comparison to PDR-based approaches, holds a better promise to achieve durable resistance.

The aim of the project is to develop resistance against TYLCV by combining PDR and NPDR strategies to confer resistance against geminiviruses. RNA silencing is a homology-dependent RNA degradation mechanism recently discovered in plants and invertebrates. It is induced by dsRNA that leads to sequence specific gene silencing at post-transcriptional level. Therefore, if a plant carries a transgene homologous to a viral sequence, then viral infection will result in virus induced gene silencing of the transgene. To avoid homology dependent RNA silencing, we avoid the nucleotide sequence homology of transgene by using synthetic genes. To accomplish this synthetic Rep, RNAi and CP providing PDR resistance and ssDNA-binding protein (G5), isolated from Escherichia coli phage M13, GroEL from B. tabaci and AZF (Artificial Zinc Finger) offering NPDR resistance will be used. In synthetic genes silent point mutations were introduced in such a way that the continuous homology between the synthetic sequence and the corresponding wild-type viral transgenic sequence was less than or equal to 5 nucleotide. The synthetic CP, RNAi and Rep will be assembled on a single transformation vector driven by independent CaMV 35ds promoters. The synthetic G5, AZF and GroEl genes will also be assembled on a single transformation vector. L. esculentum plants will be transformed with these constructs using Agrobacterium mediated tissue culture or biolistic PDS system. Transgenic model plants will be analyzed for the presence of transgene by PCR and/or Southern hybridization. Tomato plants transformed with multiple genes will be challenged with infectious construct of TYLCV and resistance will be recorded on regular interval.

Characterization and Management of Vine Decline of Muskmelon by Grafting

Name of Student : Qais Al Maawali
Supervisor : Dr. Michael Deadman
Department : Crop Sciences

The main objective of this study is to characterize and manage vine decline of muskmelon in Oman using grafting. Specific objectives include: To evaluate tolerance/resistance of different muskmelon varieties to vine decline disease; to investigate relationship between growth stages of muskmelon and fungi associated with the root system; to characterize pathogens associated with vine decline of muskmelon in Oman; to examine tolerance/resistance of more than 20 different cucurbit rootstocks for the pathogens causing vine decline of muskmelon using in vivo and field experiments; to examine the effect of these rootstocks on quality and yield of muskmelon; and to examine tolerance of these rootstocks to salinity.

Field evaluation of the tolerance/resistance of 11 commonly used varieties of muskmelon in Oman against vine decline disease commenced on

12/2/2011 at AES. A total of 64 plants of muskmelon were sown directly in the open field and distributed as randomized block design (RBD). There were four blocks for each treatment with 16 seedlings in each block. Disease incidence (%), stem diameter (cm), flowering (%), fruit number, fruit weight, fruit TSS and root dry weight were recorded. To observe the relationship between growth stages of muskmelon and fungi associated with the root system, 72 plants of (Joyce-F1) variety were sown in an open field at AES on 12/2/2011. Samples from roots and crowns of 5 randomly selected plants were collected weekly for 12 weeks continuously. Isolation and identification of fungi to the species level were achieved using morphological characteristics (e.g. van der Plaats-Niterink, 1981; Barnette and Hunter, 1998; Leslie and Summerell, 2006). A survey was also conducted in muskmelon-growing regions in Oman in order to assess the most common fungi inducing vine decline disease of muskmelon. Occurrence, symptoms, incidence and severity of this disease were assessed in most muskmelon growing regions (Batinah, Sharqiya and Buraimi). Samples from roots and crowns were collected followed by isolation of fungi associated with the disease.

Macrophomina phaseolina, Fusarium spp., Pythium spp., and *Rhizoctonia solani* were isolated from symptomatic and asymptomatic muskmelon plants. Fungi were preserved in PDA slants followed by confirmation of identity using using sequences of the internal transcribed spacer region (ITS) of the ribosomal DNA. Fungal mycelia were harvested and preserved at -80 ^{O}C for molecular identification. DNA extraction, PCR conditions as well as sequencing will be as described by Al-Sa'di *et al.* (2007). Isolations from soils, when required, will be done in selective media (Jeffers and Martin, 1986) as described by Al-Sa'di *et al.* (2008b).

Preparation for the first seminar is going on, which will be delivered by the beginning of the next semester. Collection of root stock seeds is going on and I am preparing for examining tolerance/resistance of more than 20 different cucurbit rootstocks for the pathogens causing vine decline of muskmelon using *in vivo* and field experiments.

Studies of Different Pomegranate *(Punica Granatum L.)* Skin Extracts: Physiochemical Characteristics and Protective Effects against Neurotoxicity on Human Primary Neurons

Name of Student : Amani Al Rawahi
Supervisor : Prof. Mohd Shafiur Rahman
Department : Food Science and Nutrition

The fruit of *Punica granatum* L. Punicaccae has been widely used since ancient times. In the past decade, scientists have been researching on

pomegranate fruit by analyzing its nutritional, chemical, pharmaceutical values, medical properties, or even cosmetic properties. These studies are the results of increasing awareness of the health benefits of functional fruits, such as pomegranate. Evidence from literature showed medicinal effects of different parts of pomegranate to prevent varied chronic or common illnesses. Pomegranate peels and seeds are considered as waste and are usually discarded. Scientists have started to conduct extensive research on these by-products because of their high contents of active components, such as polyphenols and vitamin C. The first part of this study will focus on the preparation of freeze-dried extracts from dried peels (air, vacuum and freeze) using different solvents. These extract will be used to explore possible beneficial effects on human neuron cells. In the second part the polyphenol contents in the skin dried will be determined by different methods, such as air, vacuum, freeze and modified atmosphere. In addition, the stability of polyphenols in the skin will be studied as a function of storage temperature. The third part will focus on thermal characteristics, such as glass transition, and solids-melting of skin. Finally, glass transition temperature will be correlated with the stability of polyphenols during storage.

Development of Microbial biofilms on Anti-fouling Coatings and their Effect on Larval Settlement

Name of Student : Annika Vaksmaa
Supervisor : Dr. Sergey Dobretsov
Department : Marine Science and Fisheries

Marine biofouling is an unwanted accumulation of micro-and macro-organisms on industrial applications. It is a large scale problem for industries (fishermen, navy, aquaculture, desalination plants, etc.) and approximately $5 billion are spent annually to combat biofouling. One of the first stages of biofouling is the formation of a biofilm consists of bacteria and diatoms. Despite of being small, microbial biofilms increase drag and fuel consumption, clog membranes, destroy polymers and promote settlement of macro-foulers. Our information about biofilms on antifouling coatings is limited and will be investigated through this study. The first part of this study will include characterization of seasonal and temporal changes of micro-fouling communities in Muscat waters. The second part will include investigation of formation of microbial biofilms on commercial and experimental coatings and their possible effect on larval settlement. In the third part we will investigate functioning of biofilms on antifouling coatings using microsensors. During this study microbial biofilms will be developed on panels and slides exposed to fouling. Microbial communities will be analyzed by direct and epifluorescent microscopy and PCR-based techniques. Differences in microbial communities will be determined by

ARISA and DGGE methods. Cultivable and uncultivable microbes in biofilms will be identified by pyrosequencing. This study will be important for development methods to prevent and minimize growth of biofilms.

Use of Numerical and Analytical Modeling in Managed Aquifer Recharge (MAR) in the Sultanate of Oman

Name of Student : Saud Al Farsi
Supervisor : Dr. Mushtaque Ahmed
Department : Soils, Water and Agricultural Engineering

Groundwater resources management is a continuous challenge in the Sultanate of Oman. This is due to rapid growing in economy and rapid development in urbanization, industrialization, agriculture, and increase in population in the last 30 years. These factors have created many stresses on groundwater resources and led to a depletion and degradation of this source. Ministry of Regional Municipalities and Water Resources (MRMWR) is augmenting groundwater resources by constructing a number of recharge dams in the main catchments in Oman. In arid regions like Oman, aquifers are the best place to store excess amount of water, because this water will be protected from any contamination and high rate of evaporation. An artificial recharge practice is expected to become increasingly necessary in Oman as the water demand is increasing for different sectors and the amount of treated wastewater is also increasing. The aim of this project is to investigate numerically and analytically the hydraulics of artificially recharged water flow in the unsaturated and saturated zone of Al Khoud and Al Ansab Catchments. In this study a recharge pond experiment will be conducted in the field. This pond will be constructed in Wadi Samail catchment (near Zulfa mosque) where four monitoring wells were installed nearly 3 km away from the coastal line. A recharge pond with dimensions of 10 m x 10 m and a depth of about 2.0 m will be constructed and filled with fresh water. All field activities, infiltration rate, water table depth data, and soil sampling will be conducted during September 2011 for modeling purposes. A general MAR hydrological conceptual model will be built up under infiltration basin method for the two selected sites (catchments). A HYDRUS package will be used to describe the effect of infiltration rate, evaporation rate, soil moisture storage and water flow rate (water flux) in the unsaturated zone in order to find out lower boundary flux. A MODFLOW package will be used to model the groundwater mound development and flow under recharge condition. In addition to that, the numerical modeling results for both zones (unsaturated/saturated) and both sites will be compared with analytical modeling results.

Thesis Abstracts of Postgraduate Students Graduated in 2010

A Comparative Study on the Chemiluminescence Responses of Polymorphonuclear Leukocytes and Mitogenic Responses of Mononuclear Leukocytes of Three Breeds of Omani Goats

Student Name : Amel Said Abdullah Alkindi (MSc)
Supervisor : Prof. Eugene Johnson
Department : Animal and Veterinary Sciences

There are three major breeds of goats in Oman, namely Jabal Akhdar (JA), Batina (BT) and Dhofari (DF). Previous studies have shown breed differences in mature body weight, carcass yield, meat quality, susceptibility to stress, susceptibility to cobalt deficiency and differences in serological responses to foot and mouth disease (FMD) vaccine. Infectious diseases are a limiting factor in goat production. This study is, therefore an attempt to compare the immunological responses of the three breeds by comparing the oxidative respiratory burst occurring during phagocytosis and the mitogenic responses of their mononuclear cells.

Five four months old goats from each breed were selected randomly for this study. These animals were kept at the Agricultural Experiments Station at Sultan Qaboos University, and were fed general ruminant concentrate and chopped Rhodesgrass hay. Blood samples for chemiluminescence (CL) and mitogenesis assays were collected monthly from the jugular vein in 7 ml heparin vacutainer tubes. Enriched preparations of polymorphonuclear and mononuclear leukocytes were prepared by density centrifugation. The oxidative respiratory burst of polymorphonuclear leukocytes (PMNs) was measured using a CL assay. Reaction mixtures contained 100 □l PMNs (5 X10^6/ ml), 100 □l opsonized zymosan, and 100 □l luminol. CL response was measured as mean relative light units (RLU), and was expressed as average counts per minute, peak CL response, and area under the curve (AUC). The mitogenic responses of mononuclear leukocytes to phytohemagglutinin (PHA) and pokeweed mitogen (PWM) mitogens were assayed using a WST-8 assay and read spectrophotometrically at 450 nm.

Although JA goats exhibited higher levels of CL in four (April, May, July and September) of the six months (April-October), these differences were not statistically different. However there was a seasonal variation in the CL response of PMNs, where the CL response was significantly higher in May, June and July (hot months) than that in April, September and October (cooler months). Moreover, there was no significant breed difference in the mitogenic response of B and T lymphocytes to PHA or PWM.

The seasonal variation in CL response may be a partial explanation why there is a higher incidence of a number of infectious diseases during the cooler months of the year.

Molecular Characterization of Local Omani Banana Cultivars Using AFLP Technique

Student Name : Abbas Al Lawati (MSc)
Supervisor : Dr. Nadiya Al-Saady
Department : Crop Sciences

Many molecular techniques have been used to supplement the classification system, which earlier was only based on morphological characterizations. The Amplified Fragment Length Polymorphism (AFLP) marker was successfully used for comparing and identifying locally grown Omani banana cultivars. AFLP technique was used successfully in eighteen Omani banana cultivars from Al Batinah, Al Dhakhilia and Dhofar regions. Eleven AFLP primer combinations were used to develop the fingerprinting of the banana cultivars. Unweighted Pair Group Method with Arithmetic mean (UPGMA) cluster using Jaccards similarity coefficient analysis showed the three distinct banana taxa. Cluster one was banana samples from Al Dakhiliah region which included Bahri, Omani, Maisori Fardh, Sokari and Zanzibar. Second cluster was banana samples from Dhofar region which included Dwarf Spotted Cavendish, Somali, Abubakar Philipino, Maisori Fardh, Milk Banana, Plantain Kenya and Sawara Red. Third cluster was banana samples from Al Batinah region which included Williams, Somali, Malindi, Red Banana, Maisori Fardh and Nagal. Results show an appreciable amount of genetic diversity among the banana cultivars. By using Numerical Taxonomy and Multivariate Analysis System (NTSYS-PC 2.2), a total of 1397 alleles were scored, of which 1322 (94.68%) appeared polymorphic. The primer combination E-ACT/M-CAC showed more percentage of polymorphism alleles about 98.15 % while, E-ACA/ M-CTG showed the highest number of alleles about 160.

Occurrence and Molecular Characterization of *Sphaerotheca pannosa* Associated with Peach Powdery Mildew in Al Jabal Al Akhdar

Student Name : Ibtihal Juma Yaqoub Al-Raisi (MSc)
Supervisor : Dr. Michael Deadman
Department : Crop Sciences

In 2004, a severe infection by powdery mildew in peach trees occurred in different villages in Al Jabal Al Akhdar. The disease was recorded in previous seasons but in a very low incidence. This study was therefore conducted to investigate progress of the disease with time, distribution in five different villages and causal agents. The results from the first surveys in 2007 showed that first powdery mildew signs were reported in April after one month from leaf bud opening. The disease severity reached its peak in the period between May and June, followed by decline after that until they disappeared after August in all villages. Symptoms of powdery mildew started to appear on peach fruits in April, after fruit setting .Throughout the growing season, small white colonies on the fruits enlarged gradually until a large portion of the fruits was covered. Generally, fruits produced during this season have very low marketable value because most are deformed with necrotic spots that lead to surfaces cracking. Low severity of powdery mildew was found in 2008 as compared to 2007. The average twig severity from April to August was between 0.5% and 1% in all villages except in Al-Aien. The fruits produced during the growing season 2008 were in good condition with high marketable value and by the end of June all fruits were harvested. Molecular phylogenetic analysis of the nucleotide sequences of the rDNA ITS region (Internal Transcribed Spacers) of 22 isolates obtained from peach fruits and twigs indicated that all of isolates belong to one species *Sphaerotheca pannosa.* The isolates of *S. pannosa* from five different villages in Al Jabal Al Akhdar showed that all isolates have an identical sequence of ITS rDNA. Comparisons of ITS sequences of powdery mildew isolates from Oman with sequences of the ITS region deposited in GenBank (NCBI, National Center for Biotechnology Information) showed 100% similarity to published sequences of *Sphaerotheca pannosa* (e.g. AF298543, AB022348, DQ139429) in many places around the world including Australia, Japan and Belgium. A representative ITS rDNA sequence of one *S. pannosa* isolate from this study was deposited in GenBank (NCBI, National Center for Biotechnology Information) under the accession number HM189673. The pathogenicity of the fungus was proved by using detached leaf assay and representative measurements of conidia confirmed that the sporulating fungus was *Sphaerotheca pannosa*.

Chemical Composition and Amino Acid Profile of Traditional Omani Dishes and their Suitability to Meet the Dietary Requirements of Maple Syrup Urine Disease (MSUD) Pediatric Patients

Student Name : Aisha Zahran Al Riyami (MSc)
Supervisor : Dr. Amanat Ali
Department : Food Science and Nutrition

The study evaluated the nutritional quality and amino acids profile of 5 traditional Omani dishes and their suitability to meet the protein and branched-chain amino acids requirements for Maple Syrup Urine Disease (MSUD) pediatric patients. The dishes were evaluated as a whole and with visible flesh removed from the dish. The dishes were prepared according to the traditional recipes and analyzed for their proximate chemical composition, dietary fiber content and amino acids profile. The moisture, crude protein, total fat, ash, crude fiber and nitrogen free extract (NFE) contents (g/100g on as such fresh basis) of whole dishes ranged between 62.5-90.8, 2.1-9.4, 0.7-5.5, 0.2-1, 0.3-1.8 and 1.1-22.3 respectively. The gross energy content of whole dishes ranged between 55.6 and 166.3 kcal/100g. The moisture, crude protein, total fat, ash, crude fiber and nitrogen free extract contents (g/100g on as such basis) of dishes from which the visible flesh was removed ranged between 62.7-92.0, 0.6-2.8, 0.2-3.5, 0.2-1, 0.2-0.9, and 1.2-29.1 respectively. The gross energy content of these dishes (from which the visible flesh was removed) ranged between 40.5-158.7 kcal/100g. In general, the amino acid composition of these dishes differed significantly from each other and also within one dish when compared with or with visible flesh removed after preparation. Branched chains amino acids (BCAA) were significantly different within one dish (with and without visible flesh). The reduction in different dishes ranged between 41% to 93% for leucine, 45% to 93% for isoleucine and 36% to 98% for valine. The average actual nutrients intake as compared to suggested traditional Omani dishes (from which the visible flesh was removed after preparation), suggested that these traditional Omani dishes overall contributed less protein and BCAAs as compared to their average actual intake from other foods. It is therefore suggested that these dishes can be used in meal planning for MSUD Omani pediatric patients and will not only meet their nutrient requirements but will also provide them psychological satisfaction as they consume the same family dishes. This will also help in reducing the intake of BCAAs in case of unavailability of BCAA-free milk formulas. The use of these dishes in meal planning for MSUD patients will be more practicable for mothers as they don't have to cook extra special dishes for the patients. The market survey lists 60 low protein food items that may add to diet variety for MSUD patients and can further help to reduce their dependence on therapeutic milk formulas. Overall the dishes evaluated in this study with the exception of Qabouli Dijaj with removed visible chicken (QDRVC) can effectively be utilized in meal planning for MSUD Omani pediatric patients.

Modification of a Rapid Insecticide Residue Detection Technique for Post-harvest Vegetable Products in Oman

Student Name : Sumaiya Abdulhamid Al Raisi (MSc)
Supervisor : Dr. Ahmed Al Alawi
Department : Food Science and Nutrition

Organophosphorus (OP) pesticides have created a concern due to their residues on agricultural products. Although many analytical techniques have been applied to measure pesticide residues, a rapid method to detect harmful levels of pesticide residues is essential before marketing of any agricultural product. This study was performed in order to suggest a more sensitive and rapid pesticide residue detection technique for OP pesticide residues on vegetable produce in Oman for screening purposes and, also to quantify the concentration of pesticide residues up to certain levels. In this study, the rapid and highly sensitive acetylcholine esterase test i.e. rapid bioassay of pesticide residues (RBPR), that is currently used to detect OP pesticides on vegetables was modified and tested in three stages with known quantities of pesticides namely malathion and diazinon. In the first stage, pesticide determination was done in which the tested pesticide was added to a cuvette directly and no plant leaf materials were used. In the second stage, filter paper substitution was used in which the known amount of pesticide was applied on a filter paper. In the third stage, the controlled plant sample analysis was done in which a known amount of pesticide was applied on plant leaves. After applying the modified test (RBPR) on market samples, it was found that pesticide residues of the Omani vegetable market samples were over the Maximum Residue *Limits* (MRLs). The results of the current study showed that the developed RBPR technique is sensitive enough to detect positively down to 1.10 ppm concentrations of OP pesticides in plant samples, especially, by using bromine. The technique in its new version is rapid in which the test can be performed within 10 minutes. The technique will help to detect market vegetables with OP pesticide residues above the MRLs and thus the work could be used as a tool for screening vegetables for the presence of pesticide residues.

The Impact of Breastfeeding on the Development of Childhood Leukemia in the Sultanate of Oman

Student Name : Yahya Khamis Hamed Al-Mukhaini (MSc)
Supervisor : Dr. Mostafa Waly
Department : Food Science and Nutrition

Recent case-control studies on breastfeeding and childhood leukemia risk indicated that long duration (>6 months) is associated with a decrease risk of the disease. Most of these studies have been conducted in the West and the matched controls were not selected from the same family relatives of the studied cases and therefore do not consider other socioeconomic and genetic causes of leukemia. We decided to conduct a case-control study to investigate the relationship between breastfeeding and childhood leukemia risk in Oman where breastfeeding is culturally favoured for a longer period of time (up to 24 months). All of the recently diagnosed as well as registered cases (during 1999-2009) at the national registry were screened and a total number of 70 cases were recruited for this study. For each case, a matched control for age and sex was selected either from family relatives or neighbors of the cases family siblings. The ratio of cases to controls was 1:1. The data revealed that 21% of the cases and 12 % of the matched controls were breastfed for an average duration of 6-12 months. Whereas, 75% of the cases and 81% of the controls had longer periods (12-24 months) of breastfeeding. Only 4% of the cases and 7% of controls were breastfed for a period of >24 months with respect to the duration of breastfeeding and risk of leukemia, the difference between cases and controls group was statistically non-significant (χ^2= 3.816)/ P>0.05). The study indicates that duration of breastfeeding is not associated with childhood leukemia risk and other environmental and genetic factors might be responsible for the disease occurrence in Oman.

Evaluating the Governance System of Seafood Quality and Safety: A Survey-based Case Study of Seafood Industries in the Sultanate of Oman

Student Name : Salem Said Khuwaidim Qutn (MSc)
Supervisor : Dr. Ann Mothershaw
Department : Food Science and Nutrition

Concerns about seafood quality and safety standards have been at the forefront of both national and global policy debates due to the world-wide campaign of liberalization of seafood trade. Because seafood sector has been experiencing increase production, consumer demand and the growing consumers' interest in seafood quality and safety, it is important for national authorities to take proactive regulatory measures to ensure seafood quality and safety by strengthening national food control systems.

This study focuses on the regulatory governance mechanism that relates to authority, interaction, process, policies and decisions addressing fish quality and safety in Oman. The study involved two of the key stakeholders namely, the competent authority and the seafood processing companies (who hold quality control numbers) to assess the existing governance efforts to ensure seafood quality and safety in the seafood processing industry. A questionnaire survey was carried out with the two stakeholder groups.

The primary data collected from both groups through the questionnaire survey was analyzed using appropriate descriptive and inferential statistical techniques. Chi-squared (χ^2) tests were used to identify significant differences between the responses from the companies and the authority, and between the companies from Muscat and from outside the Muscat region in relation to the various aspects of the governance system.

Although specific benefits derived from the quality control regulations were being recognized by both groups a number of key constrains found from this study that have important policy implication include, amongst others; 1) the implementation and application of HACCP principles, 2) awareness of quality control regulations, 3) language and literacy of employees, and size of the companies influencing implementation of HACCP, 4) quality of fish received by the companies, 5) reactive in updating knowledge regarding seafood quality and safety standards, 6) difficulties in accessing international markets, 7) company commitment, 8) effectiveness of the inspection process, 9) adequacy of government funding, and 10) costs of HACCP implementation and difficulties in objectively identifying those costs.

Effects of Honey and Dates on Apparent Iron Absorption and Hematological Parameters in Rats Fed Diets with Fish or Camel Meat

Student Name : Eiman Abdullah Mohammed Al Hinai (MSc)
Supervisor : Dr. Majeed Al Ani
Department : Food Science and Nutrition

Iron deficiency anemia (IDA) is one of the most common diseases in the world and in the Sultanate of Oman. It is associated with alterations in many metabolic processes in the body. The manifestations of these alterations have been noted in immune function, cognitive performance, energy metabolism and exercise or work performance.

This study aims to provide scientific information that would help reduce the incidence of iron deficiency anemia or enhance apparent iron absorption, using Wister rat, as an experimental model. This study was intended to fill the gap in the literature by investigating the effects of consuming honey and dates on the total iron, heme and non-heme iron in different types of meat and cooking strategy.

Samples from fish and camel meat had significantly ($P<0.05$) higher heme iron content than those of cattle, goat and chicken. Goat meat samples had significantly ($P<0.05$) higher total iron than those of chicken. Significant ($P<0.05$) loss of total iron and heme iron during cooking increased with increasing temperature and duration. Cooking meat at 100^{o}C for 90 min exerted the highest effect mainly on heme iron in cattle, camel and fish meat samples. The highest digestibility coefficient at 120 day of age was recorded for the diets composed of fish plus honey and dates, and at 180 days of age, the diet comprised of fish plus distilled water showed the highest values. However, the digestibility coefficient of total iron did differ significantly among all experimental diets at 120 and 180 days of age. There was no significant treatment effect on performance of rats fed different experimental diets, and there were no major effects of experimental diet on the relative weight of rats' organs. Rats fed a diet deficient in iron showed higher RBC counts compared to rats fed other diets.

Fish and camel meats are richer sources of total and heme iron than other meat sources, and thus, might be considered as potential sources of dietary iron for human consumption. Moderate temperature should be used in cooking meats to conserve total and heme iron. Consumption of honey and dates could enhance iron absorption which may lead to reduced levels of IDA in a country recording high prevalence IDA such as Oman.

Production and Characterization of Amylases from *Cellulosimicrobium* sp. and *Demequina* sp. Isolated from Marine Organisms

Student Name : Laila Salem Hashel Al Naamani (MSc)
Supervisor : Prof. Bassam Soussi
Department : Food Science and Nutrition

Marine sources have been known to yield novel compounds with a wide range of bioactivity with various commercial applications. In this study, the abilities of bacteria isolated from eight marine organisms to produce □-amylase were examined. All eight organisms were found to harbor amylase producing bacteria. Two bacteria isolated from the green alga *Ulva rigida* and the sponge *Mycale* sp. were further identified and their □-amylases were purified and characterized. The bacterial species isolated from the green alga *Ulva rigida* and sponge *Mycale* sp. were identified by DNA sequencing as *Cellulosimicrobium* sp. and *Demequina* sp., respectively *Cellulosimicrobium* sp. obtained maximum cell growth and amylase production at 29ºC and in the presence of lactose as a carbon source. Optimal cell growth and amylase production by *Demequina* sp. was observed at 35ºC. While lactose enhanced cell growth of *Demequina* sp., maximum amylase production was found when fructose and glycerol were the available sources of carbon. Both strains grew better in the presence of tryptone, whilst peptone stimulated amylase production. Maximal cell growth and amylase production by both of the strains was found at a medium salinity of 3% NaCl. Characteristics of the amylases extracted from the two strains (Amylase I from *Cellulosimicrobium* sp. and Amylase II from *Demequina* sp.) were assayed in the laboratory. Both amylases had the highest activity at 37ºC and pH 7. Activity of both the enzymes was reduced in the presence of detergents, such as EDTA, SDS and totally inhibited by the denaturing agent acetone. In the presence of metal ions such as Cu^{2+} and Zn^{2+}, the two amylases lost some of their activities, whereas Ca^{2+} and Fe^{2+} had stimulatory effects on both amylases. Reduction of the amylases activities by EDTA and their enhancement by Ca^{2+} indicates the calcium dependence of amylases and suggests that they are metalloenzymes. Results of this study suggest that bacteria associated with marine organisms are novel sources of □-amylases, which can be used for different commercial applications.

Traditional Artificial Reefs as Potential Tools for Enhancing Fish Production in Oman

Student Name : Salim Darwish Al Hassani (MSc)
Supervisor : Dr. Stephen Goddard
Department : Marine Science and Fisheries

In Oman, artificial reefs are exclusively constructed by the fishermen in the Al-Batinah region and A'Seeb town in Muscat governorate. The main objective of this study was to discover the potential of traditional artificial reefs found in the Al-Batinah region. The study examined the potential of the artificial reefs in the Sultanate of Oman, based on a case study in the Al-Batinah region, whether they are beneficial and efficient for the traditional fishermen or not.

The study was performed in two towns; Barka, which is from the southern section, and Shinas which is from the northern section of the region. A sample of 103 and 28 of artificial owners from Shinas and Barka respectively were selected representing 50% of total population. A survey was carried out using face-to-face interview to collect data besides the direct observations.

The artificial reefs are of great potential to fisheries of the Al-Batinah region and to fishermen. The fishermen use materials that are readily available in the construction of the artificial reefs, such as trees branches, stones, bricks, rocks and tyres. The artificial reefs require repeated and continuous addition of more materials throughout the year. The local rules and regulations that were set by the fishermen in the past played a major role in managing the fisheries sector in their villages and towns. The cutting of the anchored buoys and stealing the fish or the traps were the main problems that disturb the artificial reefs work.

The study concluded that, based on the survey conducted with the fishermen that the artificial reefs support production hypothesis rather than attraction hypothesis. Also, it was found that there is a kind on non-compliance of fishermen towards existing regulations introduced by the Ministry of Fisheries Wealth. Moreover, it was found that there are some specific characteristics in relation to the use of artificial reefs are consistent with the property rights in fisheries management. Also, it is found that the history of the artificial reefs in the Al-Batinah region goes back at least 200 years, according to the fishermen.

In order to achieve better benefit from artificial reefs, it is recommended that a strategy be developed.

A Management Plan for the Kingfish (*Scomberomorous commerson*, Lacépède, 1800) Fishery of the Sultanate of Oman

Student Name : Abdullah Hilal Al Belushi (MSc)
Supervisor : Dr. Anesh Govender
Department : Marine Science and Fisheries

Kingfish (*Scomberomorus commerson*) is a high-valued species, not only in the Sultanate of Oman but also in the neighboring Gulf Cooperation Council (GCC) countries. The latest stock status analysis indicates that the fishery is overexploited.

To ensure sustainability and economic viability, the fishermen need a management plan. In this study, the proposed management plan was developed and evaluated by its acceptance by key stakeholders. After a thorough review of the relevant literature to determine biological, ecological and socio-economic characteristics of the fishery, a pilot study was conducted involving representatives from fishermen and non-fishermen groups (fisheries managers, scientists and academics). The primary aim of the pilot study was to determine and avoid misinterpretation of questions pertaining to the proposed management plan. The draft management plan together with a brief overview of the fishery was discussed in detail with participants in the final survey. Finally, the Omani management plan was compared to international management plans for similar species with a view to drawing on international experiences.

A number of important findings have significant management implications: 1) The survey results show that both fishermen and non-fishermen agree that the kingfish fishery, at present, in the Sultanate of Oman is biologically unsustainable; 2) That the current legislative arrangements are insufficient to ensure a sustainable fishery; 3) The role of the traditional committee (Senat Al Bhar) in raising fisheries issues and changing the behavior of fishermen is diminishing; 4) Most participants believes that the proposed management plan is adequate for ensuring protection of the kingfish stock; and 5) There are regional differences in management goals and measures reflecting regional preferences and geographical characteristics.

To facilitate implementation of the kingfish management plan some key actions are recommended. By taking into consideration the shared nature of the kingfish stock a co-management approach with the relevant regional countries is essential. In this regard, a level of harmonization in legislative arrangements with relevant countries is recommended with a view to re-build this stock.

Spatial and Temporal Variation of Phytoplankton in Bandar Khyran Bay Muscat Sultanate of Oman

Student Name : Nader Mohammed Ali Al Abri (MSc)
Supervisor : Dr. Adnan Al Azri
Department : Marine Science and Fisheries

Temporal and spatial variation of phytoplankton in Bandar Al-Khyran Bay was studied in 2008 for a period of six months at three different stations (BK1, BK2, BK3). The interaction between phytoplankton, bacterial abundance and composition in relation to changes in environmental conditions was investigated. Water samples from the surface were collected on weekly basis for the entire study period.

Sea surface temperature fluctuated in Bandar Khyran Bay with maximum values during summer (32°C) and minimum values during winter (21°C). Surface dissolved oxygen concentration at the surface remained high from January to mid-March with concentrations ranging between 7 to 8.9 mg/L, followed by a decline until mid-May. On the other hand, total Chl *a* concentration showed a clear seasonal trend characterized by two peaks in February and toward the end of March. Generally, Chl *a* concentration remained below 1 □g/L throughout the sampling period.

A total of 171 net phytoplankton taxa were identified. Diatoms contributed with the highest number of species (86) followed by dinoflagellates (82) and dictyocha (1) and cyanobacteria (2). *Chaetoceros* and *Rhizosolenia* showed the largest contribution of Bacillariophyceae (diatoms) with 9 and 8 different species respectively. Dinophyceae (dinoflagellates) were dominated by *Ceratium* and *Protoperidinium sp.* with 19 and 14 different species respectively. A total number of 23 species identified in this study were considered toxic or harmful in different concentrations.

Bacterial abundance closely followed the seasonal and spatial variation of Chl *a*. Highest abundance occurred at station 2 (3.34E+05 cells/cm^3) in June while for the rest of the sampling period bacterial abundance remained at lower levels (less than 5.00E+04 cells/cm^3). A significant correlation was obtained between bacterial abundance and Chl *a* at BK1 and BK3 while BK2 showed no correlation.

Assessing the Effect of Sample Size on Estimating the Growth Parameters of Kingfish *Scomberomorus commerson* from Oman

Student Name : Badria Yousuf Al Siyabi (MSc)
Supervisor : Dr. Anesh Govender
Department : Marine Science and Fisheries

Reliable estimates of fish growth are an essential pre-requisite to understanding the dynamics of a fished stock. The design of any growth sampling scheme rests on two basic considerations: the cost of the age distribution sampling methodology and the precision of the growth estimates required. Although, age-length analyses are more precise than length-based methods, they are costly in terms of money, labor, and effort. Therefore , adopting strategies of cost-effective sampling by reducing sample sizes without compromising reliable parameter estimates is a desired requirement. For the purpose of assessing the effect of reducing sample size on the growth parameter estimates for *Scomberomorus commerson* harvested from Oman, a reference population of a sample size of 923 was re-sampled seven times with sub-samples equaling 200, 300, ..., 800. The process of re-sampling was repeated 1000 times with replacement for each sample size. Associated statistics were estimated and compared to the reference population estimates. The difference of means and their associated standard errors between the reference and the sampled data were marginal with sample size ≥ 600. The accuracy of the growth parameter estimates using both the bootstrap confidence intervals and biased corrected percentile confidence intervals narrowed as sample size increased and stabilized at a sample size of 400. Precision increases marginally after a sample size of 600 .Based on the results from our study, sample size 400-600 are considerably sufficient for a future reliable growth estimate of *Scomberomorus commerson*.

An Empirical Analysis of the Effect of the Gulf Co-operation Council (GCC) Regional Integration Process on Agriculture-Food Trade

Student Name : Jamal Nasser Salim Al Shidhani (MSc)
Supervisor : Dr. Houcine Boughanmi
Department : Natural Resource Economics

The last decade has witnessed a surge in Regional Trade Arrangements (RTA) among nations despite the increasing role of the World Trade Organization (WTO) in strengthening the multilateral trading system. This global phenomenon has also been witnessed in the Middle East and North African region (MENA) with the formation of new RTA's or the reinvigoration of the existing ones. The objective of this thesis is to assess and evaluate the trade potential of the Gulf Co-operation Council (GCC) as a Regional Trade Arrangement with countries or groups of countries with which a preferential trade agreement is signed or still in negotiation. The study used disaggregated data and estimated gravity equations for total exports, total agricultural food exports and seven agri-food commodities according to the Standard International Trade Classification (SITC), covering the period 1993-2004.

Results indicated that the GCC as a regional trade arrangement has actually promoted trade integration significantly between the member countries in total agri-food exports as opposed to total aggregate trade. Trade integration is highest in cereal and cereal-preparation products where GCC intra-trade is 10 times more than what would be predicted by the basic model, followed by sugar and fish-preparation products. The GCC intra-trade did not seem however to change significantly over the years and had probably reached its full potential during the 1993-1996 period. The newly created GCC Custom Union is therefore promising in enhancing new opportunities for trade as it goes beyond the removal of tariffs to the elimination of non tariff barriers. Except with the Mashreq countries, trade of GCC with other regional groups and sub-groups is less than expected in all commodities suggesting that there is untapped trade potential which can be enhanced by negotiating a freer trade arrangements between these groups and the GCC region.

Assessing Technical Efficiency of Small Scale Dairy Farms in Oman

Student Name : Mariam Mohammed Sulaiman Al Belushi (MSc)
Supervisor : Dr. Msafiri Mbaga
Department : Natural Resource Economics

Currently the Oman economy depends on oil. Oil being a non-renewable resource, the government understands that oil deposits will be depleted someday. As a result, the government has put together vision 2020 strategies to diversify the economy away from oil to other non-oil sectors of the economy. Agriculture is one of the non-oil sectors. Under the 2020 vision agriculture is expected to grow by 4.1% annually so as to contribute 3.1% to the GDP of Oman by 2020. However, based on the recent past five year development plans, the performance of the agricultural sector has not been according to expectations. Among the challenges identified as being behind the poor performance of the sector include, low productivity of meat and milk from the local cow breeds. Assessing the efficiency of small scale dairy farms is therefore a first step towards finding solutions to the poor performance of the agricultural sector.

This thesis therefore seeks to assess the efficiency of small scale dairy farms in Oman. Furthermore, the robustness of three popular functional forms namely, Cobb-Douglas (hereafter, CD), Translogarithmic (hereafter, TL) and Generalized Leontief (hereafter, GL) will be tested. Finally, regional efficiency differences (between the two main dairy producing regions of Salalah and Sohar) will be investigated.

Result shows that the TL functional form is robust than CD and GL. Dairy farms in Oman are on average about 85% efficient. Regional wise, Salalah and Sohar dairy farms are respectively 81% and 77% technically efficient. These results imply that with better dairy husbandry practices, it is possible to increase milk production by 19% and 23% respectively in Salalah and Sohar with the same levels of inputs currently employed.

Evaluation of Water Saving Devices in Urban Areas: A Case Study from the Sultanate of Oman

Student Name : Halima Al Farsi (MSc)
Supervisor : Dr. Hayder Abdel Rahman
Department : Soils, Water and Agricultural Engineering

Water is an essential element in everyone's daily life. The fact that the world faces a water crisis has become increasingly clear in recent years and reflects severe problems in the management of water resources.

Water Saving Technologies programs have long been recognized as the quickest and simplest way to sustain the demand for potable water and soften the impacts of such demands on water supply systems. Also they result in a very positive effect on waste water treatment and disposal systems by reducing the quantity of sewage, thereby avoiding the cost of building larger facilities and protecting the environment. Water-saving devices are widely introduced and dozens of new devices are patented each year, each claiming to be "the world's greatest water-saving device." The objective of this study is to evaluate some of these devices in the Omani context.

This study consists of three parts; a questionnaire, laboratory experiments and case studies that were done with the help of the Ministry of Regional Municipalities and Water Resources. The results of the questionnaire revealed that the pipe line system is the main method of water supply to homes for Muscat residence and it accounts for 67.7%. Also it showed that around 37.2% of the participants receive a water bill of 11-20 R.O/month (i.e. 30-60 USD/month), which indicate a total water consumption of 25000-45000 liters per household per month. The survey indicated that 88% of the participants were highly aware of the water shortage problem, and that about 92% expected benefits from using water saving devices.

Case studies for improving domestic water demand efficiency using water saving devices showed that there was no significant difference observed in household water usage before and after installation of water-saving devices due to pre-installed aerators. Toilet bags and dual flush toilets were not effective and promoted users to flush twice. However, WSDs were significantly effective in reducing water consumption in restaurants, mosques, schools, hotels and governmental buildings. Water consumption in shopping centers, hospitals, and health clubs decreased but not in a statically significant way.

The laboratory experiments examined two brands of WSDs. A set of three mixers, and three showerheads were used. Water flow was measured for each device under different pressures (1, 1.5 and 2 bars). Results indicated that one brand was more effective in saving water than the other.

Roof-Mounted Irrigation by Capillary Siphoning in Arid Zone

Student Name : Jokha Ali Saif Al Issai (MSc)
Supervisor : Prof. Anvar Kacimov
Department : Soils, Water and Agricultural Engineering

Green roofs (GR) are roof-hoisted structure to make the roof partially or completely covered with vegetation. This study was done to test the feasibility and the technical applicability of GR with a novel capillary siphoning irrigation system in Oman, to investigate whether the designed siphon-pot coolers are economically efficient at the existing electricity and water prices in Oman and to report on laboratory tests with siphoned GR modules as hydrological flood buffers. In this study, a mathematical model, was used to describe the capillary siphoning by some of the capillary rise equations.

The green roof experiments with roof-mounted siphons were conducted in January 2009 – June 2009 on the roof of the College of Agricultural and Marine Sciences (CAMS) building at Sultan Qaboos University (SQU). The pots were placed in that open area. Water was diverted to the pots from plastic containers through siphons made of used T-shirts which were rolled and filled with soil. Siphoning flow rate, moisture content in the pots, hydrological parameters and the development of the plants were measured and monitored. The results showed that siphons are feasible and technically suitable for irrigation on Omani roofs. Also, the results indicated that siphons convey water to the pots continuously at of 0.35 to 0.65 L per day per siphon per day. GR proved to have high thermal insulation efficiency. This is because the soil pots reduce the heat fluxes and improve the cooling conditions under their base. Under existing water and electricity prices the suggested GR irrigation-cooling system is economically viable. The least heat-resistant plants (e.g., tomato) planted in January developed well and perished in May. Most heat-tolerant plants (e.g., petunia) survived until the end of the experiments. The pot soil profile exhibited good buffer capacity to intercept and retain typical rain and it could utilized in urban water management measures for flood mitigation. The Washburn equation would be appropriate for the interpretation of capillary penetration rates for most systems of practical interest. The Szekely equation is applicable at any stage but gives realistic predictions at very early stages of penetration. If the pore structure characteristics of porous media are not taken into account the applicability of the Washburn or Szekely theories is limited. Temperature has a certain influence on the water, soil and siphons properties. This influence can be examined through the dependence of each particular parameter (e.g. viscosity, contact angle, density, etc) on temperature however to understand the combined effect further studies are necessary.

Physiological Responses and Postharvest Quality of Banana as Affected by Storage Conditions

Student Name : Naflaa Al Waili (MSc)
Supervisor : Dr. Manickavasagan Annamalai / Dr. Rashid Al Yahyai
Department : Soils, Water and Agricultural Engineering

Banana (*Musa* spp.) is one of the most important types of fruit grown and consumed in Oman and in the world. However, there is lack of knowledge on the postharvest technology and physiology of locally grown banana cultivars in Oman to support the development of appropriate handling and storage techniques locally. The objective of this study was to determine physiological responses and to measure the changes in postharvest quality of two banana cultivars (*Musa*, 'Malindi' and 'Milk') under three different storage conditions (refrigerator: ~ 95.5% RH and 11 - 12 ^{o}C, room: 82 – 85% RH and 20 - 22 ^{o}C and environmental chamber; 50% RH and 18 ^{o}C for 12 hours of darkness, and 28 ^{o}C for 12 hours of light).

Significant differences were observed in the fruit physicochemical properties and physiological responses in the three stages of ripening (unripe, fully-ripe and over-ripe) during the 3 experimental storage conditions. The least reduction in fruit mass and highest firmness of the fruit were found using refrigerator storage compared to room and enviromental chamber. 'Milk' bananas had significantly higher vitamin C content at all stages of ripening than 'Malindi' but 'Malindi' had higher respiration rates and ethylene production, particularly at room temperature storage. The rates of C_2H_4 and CO_2 production were low when fruits were stored under refrigeration, leading to inhibition of ripening process and maintaining green life.

The present findings confirm that refrigerated storage offered significant benefits in postharvest handling of the locally grown banana cultivars by reducing fruit weight loss (~ 5% loss *vs* 21% loss at room condition in 7 days), extending storage life (21 days *vs* 7 days at room condition), and enhancing vitamin C retention and concentration in fruit during the ripening process.

Further studies are required on the development of optimal storage techniques for other cultivars including the use of controlled atmosphere storage. The regulation of fruit ripening in these banana cultivars using ethlyene inhibitiors such as 1-Methylcyclopropene (1-MCP) also warrants investigation.

International Collaborations

International Collaborations

Table12. International collaborations in 2010.

No.	Organization	Type of Cooperation/ Contact Person	Contact Person/ Extent of Benefit
Animal and Veterinary Sciences			
1	Washington State University, USA	Collaborative research (HM project)/ Dr. Mushtaq Ahmed Memon	Prof. O.M. Gaafar/ Defining Omani goat reproduction efficiency
2	University of Porto, Portugal	Collaborative research (HM project)/ Dr. Albano Fereira	Prof. O.M. Gaafar/ Training Omanis and helping with DNA analyses
Crop Sciences			
3	Centraalbureau voor Schimmelcultures, The Netherlands	Collaborative research/ Prof Arthur de Cock	Dr. A. Al Sa'di
4	Tree Pathology Centre, The University of Queensland, Australia	Collaborative research on citrus diseases/ Prof Andre Drenth	Dr. A. Al Sa'di
5	Universidade Federal de Viçosa, Brazil	Collaborative research on WBDL/ Prof Claudine Carvalho	Dr. A. Al Sa'di
6	Universidade Federal de Viçosa, Brazil	Collaborative research on mango decline/ Prof Fabricio Rodrigues	Dr. A. Al Sa'di
7	Stellenbosch University, South Africa	Collaborative research on fruit crops	Joint supervision of postgraduate students & research work/ Dr. F. Al Said, Dr. R. Al Yahyai
8	Dept of Plant Pathology University of Georgia, Georgia, USA	Strategic research project on WBDL / Prof. C.J. Chang	Dr. R. Al Yahyai
9	Agricultural University of Faisalabad, Pakistan	Strategic research project on WBDL / Dr. Iqrar Khan	Dr. R. Al Yahyai

No.	Organization	Type of Cooperation/ Contact Person	Contact Person/ Extent of Benefit
10	Tropical Research and Education Center, Univ of Florida, USA	Mango & citrus research projects / Prof. Bruce Shaffer	Dr. R. Al Yahyai
11	Fairchild Tropical Garden, Florida, USA	Mango & citrus research projects / Dr. Richard Campbell	Dr. R. Al Yahyai
12	Univ of the Philippines at Los Baños, Laguna, Philippines	Mango and citrus research projects / Dr. Leon O. Namuco, Dr. Rachel Sotto	Dr. R. Al Yahyai
13	Miami Subtropical Horticulture Research Station, USDA, Miami, Florida USA	Mango and citrus research projects	Dr. R. Al Yahyai
14	Department of Agriculture, The Univ of Reading, UK	Capacity building for Oman/Dr. S. R. Gowen	Dr. M. Deadman/ Supervision of Omani PhD students
15	FABI, Univ of Pretoria, South Africa	Capacity building for Oman/Prof. Mike Wingfield	Dr. M. Deadman/ Supervision of Omani PhD student
16	College of Agriculture, Univ College, Dublin, Ireland	Capacity building for Oman/Prof. Jim Phelan	Dr. M. Deadman/ Supervision of Omani PhD student
17	Enviromental Studies Centre, Univ of Surrey, UK	Capacity building for Oman/Prof. Steve Morse	Dr. M. Deadman/ Supervision of Omani PhD student
18	University of Louisiana, USA	Development of a compendium of plant pathogens in Oman/ Prof. Cathie Aime	Dr. M. Deadman/ Molecular identification of plant pathogenic fungi
19	University of Arizona, USA	Scientific research/ Prof. J.K. Brown	Dr. J. Khan /Plant science/Viral genome analysis
20	University of California, Davis, USA	Scientific research/ Prof. R. Gilbertson	Dr. J. Khan/Plant pathol/Viral infectious disease

No.	Organization	Type of Cooperation/ Contact Person	Contact Dept/ Extent of Benefit
21	USDA-ARS	Scientific research/ Dr. I.M. Lee	Dr. J. Khan/ Plant pathol/ Genetic characterization of phytoplasma
22	University of Bologna, Italy	Scientific research/ Prof. A. Bertaccini	Dr. J. Khan/ Plant pathol/ Phytoplasma characterization
23	John Inn Institute	Research collaboration/ Dr. R.W. Briddon	Dr. J. Khan/ Plant Biotech/Viral satellite DNA
24	University of Malaga, Spain	Research collaboration/ Prof. J. Navas-Castillo	Dr. J. Khan/ Plant Virol/Viral genetic markers
25	University of California, Riverside	Scientific collaboration/ Dr. Marck Hoddle	Dr. A. AlWahaibi/ Biological control of Asian citrus; psyllid
26	Plant Pests and Diseases Research Institute, Iran	Scientific collaboration/ Dr. Alimorad Sarafrazi	Dr. A. AlWahaibi/ WBDL vectors
Food Science and Nutrition			
27	University of South Australia, Australia	Glass transition of spaghetti, developing a collaborative project for possible funding in Australia/ Dr. Wijitha Senadeera	Prof S. Rahman
28	Washington State University, USA	Collaborative project/ Dr. Shyam Sablani	Prof S. Rahman
29	Zagazig University, Egypt	Collaborative project/ Dr. Sabah Mounir	Prof S. Rahman
30	Diponegoro University, Indonesia	Scientific collaboration on natural preservation of fish/Dr. Tri Agustini	Prof S. Rahman

No.	Organization	Type of Cooperation/ Contact Person	Contact Dept/ Extent of Benefit
31	University of Malaya, Kuala Lumpur, Malaysia	Scientific collaboration on neural networks and fuzzy logic/Prof. Azlan Hossain	Prof S. Rahman
32	International Islamic University, Malaysia	Collaboration in the area of extraction technology and developing health functional foods	Prof S. Rahman Exchange of internship students
33	Scientist-Thermal Analysis & Quality, Canada	Collaborating in publishing a book, "Handbook of Food Process Design"/ Dr. Jasim Ahmed	Prof S. Rahman
34	La Rochelle University, France	Collaborative projects, exchanged faculty and PhD students/ Prof Karim Alaaf	Prof S. Rahman/ Joint supervision of PhD student, organizing joint international symposium at SQU
35	United Arab Emirates University (UAEU)	Characterization of camel milk protein isolates as nutraceutical and functional ingredients	Dr. A. Al-Alawi, Prof. S. Rahman, Dr. N. Guizani
36	University of New South Wales, Australia	Collaborative research/ Dr. Gilles J. Guillemin	Dr. M. Essa
37	New York State Institute for Basic Research	Collaborative research/ Dr. Abha Chauhan	Dr. M. Essa
38	Institute of Food Industry, University of Tunis II	Collaborative research (milk technology/ Dr. Salwa Bornaz	Dr. N. Guizani
39	Colorado State University, USA	Exchange of expertise in designing and implementing diabetes education programs/Prof. Pat Kendall, Extn Specialist	Dr. L. Al Subhi
40	Northeastern University, Boston, USA	Exchange of technical experience in measuring sulfur containing amino acids and oxidative stress markers in human blood samples for type 2 diabetic and autistic Omani subject	Dr. M. Waly/ Collaboration on oxidative stress markers analysis

No.	Organization	Type of Cooperation/ Contact Person	Contact Dept/ Extent of Benefit
41	Dept of Nutritional Sciences, Faculty of Medicine, University of Toronto, Japan	Exchange of ideas/ discussions/Prof. A.V. Rao	Dr. A. Ali/ Development of research projects
42	The University of Queensland	Research collaboration on milk flavor/ Dr. Hilton Deeth	Dr. Z. Al Attabi
UNESCO			
43	Ajman University, UAE	Collaborative research and capacity building	Prof. B. Soussi
44	H.E.J. Research Institute of Chemistry (HEJRIC), Karachi, Pakistan	Collaborative research and capacity building	Prof. B. Soussi
45	Marine Biotechnology Center, University of North Carolina, USA	Collaborative research and capacity building	Prof. B. Soussi
46	Royal Swedish Academy of Sciences/Marine Station, University of Gothenburg, Sweden	Collaborative research and capacity building	Prof. B. Soussi
47	Institut für Pharmazeutische Biologie und Biotechnologie, Düsseldorf, Germany	Collaborative research and capacity building	Prof. B. Soussi
48	UNESCO Regional Office Doha, Qatar	Collaborative research and capacity building	Prof. B. Soussi
49	UNESCO HQ, Natural Science and Higher Education Paris, France	Collaborative research and capacity building	Prof. B. Soussi
Marine Science and Fisheries			
50	International Islamic University of Malaysia (IIUM)	Joint Research	Dr. S. Goddard, Dr. S. Al Barwani
51	Oregon State University, USA (Dept of Oceanic & Atmospheric Sciences)	Scientific research on chemical compositions of dust and fine particles	Dr. A. Al Azri

No.	Organization	Type of Cooperation/ Contact Person	Contact Dept/ Extent of Benefit
52	Bigelow Lab in Maine, USA	Scientific research on Arabian sea project	Dr. A. Al Azri
53	Rosentiel School of Marine and Atmospheric Science, USA	Joint project/ Prof. Sharon Smith	Dr. A. Al Azri
54	Rhodes University	Evaluation of the Kingfish project and to run a work-shop on AD Model Builder/ Prof Tony Booth	Dr A. Govender
55	Rhodes University	Evaluation of the Kingfish project and to evaluate some aspects of aqua-culture at the MoFW and SQU/Prof Peter Britz	Dr. A. Govender
56	Florida Museum of Natural History	Continuous collaboration on sharing taxonomic information/ Dr. Gustav Paulayq	Dr. M. Claereboudt
57	Austrian Museum of Natural History	Collaborative research on biodiversity of bryozoans/ Dr. Andrei Ostrovski	Dr. M. Claereboudt
58	University of Mons, Belgium	Collaborative research on aquaculture and biology of sea cucumber/ Dr. Igor Eeckaut	Dr. M. Claereboudt
59	Dusseldorf University, Germany	Visits exchange, knowledge transfer/Prof Peter Proksch	Dr. S. Dobretsov/ Perspectives of further collaboration
60	Roskilde University, Denmark	Visits exchange, knowledge transfer/ Prof. Benni Hansen	Dr. S. Dobretsov/ Joint supervision of 2 MSc students
61	Smithsonian Marine Station, Fort Pierche, USA	Visits exchange, knowledge transfer/ Prof. Valerie J. Paul	Dr. S. Dobretsov/ Papers were published through joint collaboration
62	Institute of Biology of the Southern Seas, Ukraine	Scientific cooperation/ Dr. I. Prusova	Dr. S. Piontkovski

No.	Organization	Type of Cooperation/ Contact Person	Contact Dept/ Extent of Benefit
Natural Resource Economics			
63	SACI Waters, University of Peradeniya, Sri Lanka	Conducting training programs and authoring a book/ Prof Nimal Gunawardena	Dr. H. Kotagama
Soils, Water and Agricultural Engineering			
64	Challenge Program for Water and Food, CGIAR, C/-IWMI, Sri Lanka	Collaborative research and capacity building	Soils, Water and Agricultural Engineering (SWAE)/ Dr. S.A. Prathapar
65	Regional Center for Urban Water Manage-ment, Teheran, Iran	Collaborative research and capacity building	Dr. S.A. Prathapar
66	Wageningen Agricultural University, The Netherlands	Collaborative research and capacity building	Dr. S.A. Prathapar
67	International Rice Research Institute, Los Baños, Philippines	Collaborative research and capacity building	Dr. S.A. Prathapar
68	Australian Center for International Agricultural Research, Australia	Collaborative research and capacity building	Dr. S.A. Prathapar
69	International Atomic Energy Authority, Vienna, Austria	Collaborative research and capacity building	Dr. S.A. Prathapar

Publications in 2010

Publications in 2010

CAMS faculty published a total of 287 scientific documents among which 71 were peer-reviewed journal articles. They also contributed to 20 books and 72 articles in conference proceedings (Table 13).

Table 13. Summary of total publications in 2010.

Refereed journals	71
Conference publications (Proceedings:72; Abstracts:44; Posters:23)	139
Book	1
Chapter in books	19
Book evaluations	4
Technical reports	18
PhD dissertation	1
Articles in newspapers & other SQU publications	34
Total	**287**

Refereed Journals

1. Akhtar, M.S., B. Israr, N. Bhatty and **A. Ali**. 2010. Effect of cooking on soluble and insoluble oxalate contents in selected Pakistani vegetables and beans. International Journal of Food Properties 14: 241-249.
2. Al Khalasi, S.S., **O. Mahgoub, I.T. Kadim, W. Al-Marzooqi** and **S. Al-Rawahi**. 2010. Effects of feeding salt tolerant sorghum (*Sorghum bicolor*) forage and rhodesgrass (*Chloris gayana*) on health and performance of Omani sheep. *Small Ruminant Research*, 91:93-102.
3. Al Suleimani, Y.M., A.M. Abdulrahman, A.S. Al Mahruki, I. Alheini, **M.H. Tageldin**, M.E. Mansour and B.H. Ali. 2010. Interaction of nimesulide, a cyclooxygenas-2 inhibitor, with cisplatin in normotensive and spontaneously hypertensive rats. *Food and Chemical Toxicology,* 48:139-144.
4. Al-Asgah, N.A., E.M. Younis, A.A. Abdel-Warith, A.A. El-Khaldy and **A. Ali**. 2010. Effect of feeding olive waste on growth performance and muscle composition of Nile tilapia (*Oreochromis niloticus*). International Journal of Agriculture and Biology 13: 239-244.
5. **Al-Azri A.R, S.A. Piontkovski, K. Al-Hashmi,** J. Goes, and H. del Rosario-Gomes 2010. Chlorophyll *a* as a measure of seasonal coupling between phytoplankton and the monsoon periods in the Gulf of Oman. *Aquatic Ecology* 44:449-461.
6. **Al-Bulushi, I**., S. Poole, R. Barlow, H. Deeth and G. Dykes. 2010. Speciation of gram-positive bacteria in fresh and ambient-stored

sub-tropical marine fish. *International Journal of Food Microbiology,* 138:32-38.

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Conference Publications

a. Proceedings

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23. **Waly, M.,** Y. Al-Farsi, **A. Ali**, M. Al-Shafaee and M. Al-Sharbati. 2010. The measurement of reduced and oxidized glutathione levels in the sera of autistic children in Oman. *Proceedings of the 9th International Meeting for Autism Research* (IMFAR). Philadelphia, USA, 20-22 May 2010.

Book

Ahmed, M., S.A. Al-Rawahy and N. Hussain (Editors). 2010. *A Monograph on Management of Salt-affected Soils and Water for Sustainable Agriculture*. 117 pp. Sultan Qaboos University, Muscat, Oman. 11-14 January 2010.

Chapter in Books

1. **Ahmed, M., S.A. Al Rawahy**, N. Hussain, **H. Esechie,** A. Al-Lawati, **H. Abdel Rahman**, S.A. Shahid, S. Al Habsi and S. Al-Rasbi. 2010. Biosaline agriculture in Oman: A critical review. In: *A Monograph on Management of Salt-affected Soils and Water for Sustainable Agriculture*. M. Ahmed, S.A. Al-Rawahy and N. Hussain (Editors), pp. 9-16. Sultan Qaboos University, Muscat, Oman. 11-14 January 2010.
2. **Al-Azri A.R., S. Piontkovski, K. Al-Hashmi**, J. Goes and H. Gomes. 2010. Recent outbreaks of Harmful Algal Blooms along the coast of Oman: Possible response to climate change. In: *Indian Ocean Tropical Cyclone and Climate Change*. Y. Charabi (Editor) pp.347-356. Springer.
3. **Al-Busaidi, A.,** J. Rabeea, **S. Al-Rawahy** and **M. Ahmed**. 2010. Estimating leaching requirements for barley growth under saline irrigation. In: *A Monograph on Management of Salt-affected Soils and Water for Sustainable Agriculture*. M. Ahmed, S.A. Al-Rawahy and N. Hussain (Editors), pp. 35-39. Sultan Qaboos University, Muscat, Oman. 11-14 January 2010.
4. **Al-Busaidi, A., S.A. Al-Rawahy** and **M. Ahmed**. 2010. Growing tomato in salty soil: Screening response of different tomato cultivars to saline irrigation. In: *A Monograph on Management of Salt-affected Soils and Water for Sustainable Agriculture*. M. Ahmed, S.A. Al-Rawahy and N. Hussain (Editors), pp. 25-33. Sultan Qaboos University, Muscat, Oman. 11-14 January 2010.
5. **Al-Dhuhli, H., S.A. Al-Rawahy** and **S. Prathapar**. 2010. Effectiveness of mulches to control soil salinity in sorghum fields irrigated with saline water. In: *A Monograph on Management of Salt-affected Soils and Water for Sustainable Agriculture*. M. Ahmed, S.A. Al-Rawahy and N. Hussain (Editors), pp. 41-46. Sultan Qaboos University, Muscat, Oman. 11-14 January 2010.
6. Al-Khalasi, S.S., **O. Mahgoub, I.T. Kadim, W. Al-Marzooqi** and **S.A. Al-Rawahi**. Salt tolerant fodder for Omani sheep (Effects of salt tolerant sorghum on performatnce, carcass, meat quality and health of Omani sheep). In: *A Monograph on Management of Salt-affected Soils and Water for Sustainable Agriculture*. M. Ahmed, S.A. Al-Rawahy and N. Hussain (Editors), pp. 67-81. Sultan Qaboos University, Muscat, Oman. 11-14 January 2010.

7. Al-Lawati, A., H. Al-Wahaibi, **S.A. Al-Rawahy, H. Al-Dhuhli,** M. Al-Rashdi and S.S. Al-Habsi. 2010. Production and water-use efficiency of alfalfa under different water quantity and quality levels. In: *A Monograph on Management of Salt-affected Soils and Water for Sustainable Agriculture*. M. Ahmed, S.A. Al-Rawahy and N. Hussain (Editors), pp. 61-65. Sultan Qaboos University, Muscat, Oman. 11-14 January 2010.
8. **Al-Mulla, Y.A.** 2010. Salinity mapping in Oman using remote sensing tools: Status and trends. In: *A Monograph on Management of Salt-affected Soils and Water for Sustainable Agriculture*. M. Ahmed, S.A. Al-Rawahy and N. Hussain (Editors), pp. 17-24. Sultan Qaboos University, Muscat, Oman. 11-14 January 2010.
9. **Al-Rawahy, S.A., M. Ahmed** and N. Hussain. 2010. Management of salt-affected soils and water for sustainable agriculture: The project. In: *A Monograph on Management of Salt-affected Soils and Water for Sustainable Agriculture*. M. Ahmed, S.A. Al-Rawahy and N. Hussain (Editors), pp. 1-8. Sultan Qaboos University, Muscat, Oman. 11-14 January 2010.
10. **Al-Sadi A.M,** N. Al-Habsi, K.S. Al-Kiyumi, **F.A. Al-Said, S.A. Al-Rawahy, M. Ahmed** and **M.L. Deadman** 2010. Effect of salinity on growth, reproduction and pectolytic enzyme production by *Pythium aphanidermatum*: a serious soil borne pathogen of vegetable crops in Oman. In: *A Monograph on Management of Salt-affected Soils and Water for Sustainable Agriculture*. M. Ahmed, S.A. Al-Rawahy and N. Hussain (Editors), pp. 95-98. Sultan Qaboos University, Muscat, Oman. 11-14 January 2010.
11. **Al-Yahyai, R., S. Al-Ismaily** and **S.A. Al-Rawahy**. 2010. Growing tomatoes under saline field conditions and the role of farmers. In: *A Monograph on Management of Salt-affected Soils and Water for Sustainable Agriculture*. M. Ahmed, S.A. Al-Rawahy and N. Hussain (Editors), pp. 83-88. Sultan Qaboos University, Muscat, Oman. 11-14 January 2010.
12. Deth, R.C., **M. Waly**, C. Muratore and N. Hodgson. 2010. Redox imbalance and the metabolic pathology of autism. In: *Developmental Neurotoxicology Research: Principles, Models, Techniques, Strategies and Mechanisms.* Section V: Autism Spectrum Disorders Section. Isaac Pessah (Editor), John Wiley and Sons, Hoboken.
13. **Dobretsov, S.** 2010. Marine Biofilms. In: *Biofouling*, S. Dürr, J.C.Thomason (Editors), pp. 123-136. Wiley-Blackwell Oxford, UK.
14. **Dobretsov, S.** Romani A.M., Spratt D.A., Ready D., Pratten J. 2010. Introduction to microbial fouling. In: *Biofouling*, S. Dürr, J.C.Thomason (Editors), pp. 121-136. Wiley-Blackwell Oxford, UK.
15. **Goddard, S., A.S. Al-Busaidi** and U.K.H.S. Al-Kendi. 2010. Fish culture and hydroponics at low salinities. In: *A Monograph on Management of Salt-affected Soils and Water for Sustainable Agriculture*. M. Ahmed, S.A. Al-Rawahy and N. Hussain (Editors), pp. 89-94. Sultan Qaboos University, Muscat, Oman. 11-14 January 2010.

16. **Guizani, N**. 2010. Vegetable fermentation and pickling. In: *Handbook of Vegetables and Vegetable Processing*. N.K. Sinha, Y.H. Hui, E. Özgül Evranuz, M. Siddiq and J. Ahmed (Editors), Chapter 17, pp. 351-367. Wiley – Blackwell.
17. Hussain, N., **S.A. Al-Rawahy**, **M. Ahmed**, S.A. Shahid and **S. Zekri**. 2010. Living with salinity: Policy issues, recommendations, future research and guidelines for extension workers and Omani farmers. In: *A Monograph on Management of Salt-affected Soils and Water for Sustainable Agriculture*. M. Ahmed, S.A. Al-Rawahy and N. Hussain (Editors), pp. 115-117. Sultan Qaboos University, Muscat, Oman. 11-14 January 2010.
18. **Piontkovski, S.A**. and **A. Al-Azri**. 2010. Influence of a tropical cyclone GONU on phytoplankton biomass (chlorophyll a) in the Arabian Sea. *Indian Ocean Tropical Cyclone and Climate Change*. Y. Charabi (Editor) pp. 339-349. Springer, 285pp.
19. **Zekri, S., S.A. Al-Rawahy** and A. Naifer. 2010. Socio-economic considerations of salinity: Descriptive statistics of the Batinah Sampled Farms. In: *A Monograph on Management of Salt-affected Soils and Water for Sustainable Agriculture*. M. Ahmed, S.A. Al-Rawahy and N. Hussain (Editors), pp. 99-113. Sultan Qaboos University, Muscat, Oman. 11-14 January 2010.

Book Evaluations

1. **Al-Azri, A.** 2010. Reviewer 2nd edition of the book, *Marine Microbiology* by C. Munn.
2. **Mostafa Waly**. Regular reviewer of International Journal of Nutrition, Pharmacology and Neurodegenerative diseases.
3. **Mostafa Waly**. Regular reviewer of International Journal of Food Science and Nutrition.
4. **Sergey, D.** 2010. Reviewer 2nd edition of the book, *Marine Microbiology* by C. Munn.

Technical Reports

1. **Ahmed, M., S.A. Prathapar** and **H. Kotagama**. 2010. Gaza water resources: Immediate Plan of Actions. *Report prepared for UNEP*, Geneva.
2. **Al-Alawi, A.** 2010. Chemical and physical characterization of date pectin and its effect on date syrup quality. *Final Research Report*. (IG/AGR/FOOD/08/01).
3. **Al-Ani, M.** 2010. Antiatherogenic characteristics of consumption of fruit and vegetables grown in Oman. *Final Research Report*. (IG/AGR/FOOD/08/02).

4. **Al-Rasasi, B.** 2010. Nausea and vomiting in pregnancy, maternal nutrition and pregnancy. *Final Research Report.* (IG/AGR/FOOD/05/01).
5. **Al-Rawahy, S.A.** *et al.* 2010. Management of salt-affected soils and water for sustainable agriculture. *Final Research Report.* (SR/AGR/SWAE/06/01).
6. **Boughanmi, H.** 2010. Wheat cultivation in the Sultanate of Oman: Situation, challenges and prospects. *Report prepared with the Technical Group for the Wheat Cultivation Project in Oman and submitted to the National Committee.* (*In Arabic*).
7. **Boughanmi, H., H. Kotagama** and **S.A. Prathapar**. 2010. Farming systems analysis on potential to cultivate wheat in Oman. *Report submitted to Technical Committee on Securing Food Security in Oman through Wheat Cultivation* under the Chairmanship of H.E. Vice Chancellor, SQU.
8. **Esechie, H.A.**, *et al.* 2010. Chlorophyll metering: An innovative approach to nitrogen management in forage corn. Final Research Report. (IG/AGR/PLNT/00/02).
9. **Esechie, H.A.,** *et al.* 2010. Response of chickpea (*Cicer arietinum*) to salinity stress. *Final Research Report.* (IG/AGR/PLNT/03/02).
10. **Kacimov, A.** 2010. Roof-mounted irrigation by capillary siphoning. *Final Research Report.* (IG/AGR/SWAE/10/05).
11. **Kadim, I.T.** 2010. Effects of cooking on iron bioavailability in various meat types. Department of Animal and Veterinary Sciences, College of Agricultural and Marine Sciences, Sultan Qaboos University, Sultanate of Oman. *Published on Feeding for News Service.*
12. **Kadim, I.T.** 2010. Establishing meat and milk processing plants in the Sultanate of Oman. Department of Animal and Veterinary Sciences, College of Agricultural and Marine Sciences, Sultan Qaboos University, Sultanate of Oman. (*In Arabic*).
13. **Kadim, I.T.** 2010. Meat and milk production in the Sultanate of Oman. Department of Animal and Veterinary Sciences, College of Agricultural and Marine Sciences, Sultan Qaboos University. (*In Arabic*).
14. **Khan, A.J.** 2010. Molecular characterization of phytoplasma associated with witches' broom, phyllody virescence diseases of sesame (*Sesamum indicum)* in Oman. *Final Research Report.* (IG/AGR/CROP/07/01).
15. **Kotagama, H.** 2010. Economic and institutional aspects of Kingfish management. *Final Research Report.* (IG/AGR/ECON/05/03).
16. **Mbaga, M.** 2010. The effect of Omanization policy on the efficiency of dairy and date farms in Oman. *Final Research Report.* (IG/AGR/ECON/07/01).
17. **Mbaga, M**. and **H. Kotagama**. 2010. Food demand survey: Indicative demographic trends. *A Consultancy Report submitted to GRM International.* 15 May 2010.
18. **Waly, M.** 2010. Malnutrition among children, under development. *Technical Report* submitted to UNICEF, Regional Office, Muscat.

PhD Dissertation

Al-Attabi, Zahir Humaid Rashid. 2010. Volatile sulphur compounds in UHT milk. *PhD thesis,* University of Queensland, Australia.

Articles in Newspapers & Other SQU Publications

Newspapers

1. **Al-Mulla, Y.A.** A study on building greenhouses. *Oman Observer Newspaper,* Vol. 29, No. 246. 18 July 2010.
2. **Al-Mulla, Y.A**. A study on constructing greenhouses for arid Regions *(in Arabic). Al Watan Newspaper.* Vol. 40, No. 9846, 17 July 2010.
3. **Al-Sadi, A.M.** SQU experts isolate new fungi. *Oman Tribune*, 6 December 2010**.**
4. **Deadman, M.** Deadman is visiting professor at UK university. *Oman Tribune,* 11 January 2010.
5. **Deadman, M.** Oman's agriculture sector has massive export potential. *Muscat Daily,* 11 January 2010.
6. **Deadman, M**. SQU academic appointed as visiting professor at UK University. *Oman Daily Observer*, 11 January 2010.
7. **Essa, M.M**. Alzheimer's aware. *The Week,* 10 July 2010.
8. **Essa, M.M**. Childhood obesity on the rise. *The Week,* 14 April 2010.
9. **Essa, M.M.** Walnuts and Alzheimer's disease. *Oman Observer*, 21 January 2010.
10. **Kotagama, H., H. Boughanmi** and **S.A. Prathapar**. Food security in Oman: Position and prospects, insight. *Horizon*, 30 January 2010.
11. **Mbaga, M**. and B.M. Al-Harthy. 2010. An investigation on the level of awareness of Oman's public regarding the origin and effects of the global financial crisis. *Oman Economic Review,* September 2010 issue. Available at: *http://www.oeronline.com/php/2010_aug/byinvitation.php*
12. **Soussi, B.** Changing Perceptions: The growth of Oman's research culture. *Scientific American Special issue, Global Biotechnology Perspective*, 11 May 2010.
13. **Soussi, B.** Establishment of Centre of Excellence in Marine Biotechnology and Research and Innovation Complex. *Oman*, 14 June 2010. *(In Arabic).*
14. **Soussi, B.** Omega-3 fatty acids keep you healthy. *Observer*, 30 January 2010.
15. **Soussi, B.** Importance of seaweeds in Oman. *Observer,* 26 May 2010.

16. **Soussi, B.** TRC considers setting up Marine Bio-technology Excellence Centre. *Observer,* 14 June 2010.
17. **Waly, M**. Childhood obesity on the rise. *Oman Times*, 14 April 2010. p. 2.
18. **Waly, M.** More child psychiatry units needed to treat autism cases. *Muscat Daily,* 4 May 2010. p. 2.
19. **Waly, M.** Non-communicable diseases become more prevalent in Oman. *Muscat Daily, 29* March 2010. p. 3.

SQU Publications

1. **Al-Ani, M.** Challenges of food security/a series of articles. *The Researcher, SQU,* Issues of April and May, 2010.
2. **Al-Ani, M.** Healthy eating in Ramadhan. *Horizon,* Issue 196, 30 July 2010.
3. **Al-Bulushi, I.** Microbial food poisoning: Principles and control. *Massar,* 2010.
4. **Ali, A.** Nutrition and cancer risk in Oman. *Horizon,* Issue 188, March 2010.
5. **Al-Mulla, Y.A.** A study on designing and constructing greenhouses for arid regions (*in Arabic*). *Scientific Bulletin,* Academic Publication and Outreach Dept, Deanship of Scientific Research, SQU. September issue.
6. **Claereboudt, M.** Coral larvae do not move very far from home. *Horizon,* 10 February 2010.
7. **Claereboudt, M.** The dispersal pattern of coral larvae. *Horizon,* 20 February 2010.
8. **Essa, M.M.** Walnuts in Alzheimer's disease. *Horizon,* 28 April 2010. p.5
9. **Rahman, M.S.** Postharvest technologies reduce losses and improve quality and supply of fresh produce in Oman. *Al Hasaad*, May 2010. pp 5-6.
10. **Soussi, B**. Omega-3 fatty ccids and human health. *Horizon*, 20 January 2010.
11. **Soussi, B.** Omega-3 enhanced fish. *Al Hasaad,* May 2010.
12. **Soussi, B.** SQU Inks MoU. *Horizon,* 30 June 2010.
13. **Soussi, B.** Seaweeds in Oman. *Horizon,* 30 September 2010.
14. **Soussi, B.** Nutritional and medicinal values of seaweeds. *Horizon,* 10 October 2010.
15. **Waly, M.** Nutrition and physical activity. *Al-Hasaad*, March 2010 Edition.

Conferences/Workshops/ Seminars Attended by Faculty and Staff in 2010

Conferences Attended by Faculty & Staff

a. International

1. **Claereboudt, M.R.** Coral larval connectivity in the Northwestern Arabian Sea: Consequences for conservation policies. *Invited speaker at the Marine Conservation Forum 2010.* Abu Dhabi, UAE, 14-16 December 2010.
2. **Guizani, N.** Fifth CIGR International Technical Symposium on Food Processing, Monitoring Technology in Bioprocesses and Food Quality Management. ATB. Agratechnic Bornim. Germany, 31 September to 02 October 2010.
3. **Guizani, N.** Seventeenth World Congress of CIGR. Quebec City, Canada, 3-17 June 2010.
4. **Prathapar, S.A.** Agricultural water productivity in South Asia: challenges and options. *Invited guest speaker and contributing speaker at the Sustainable Water Management Conference*. Mehran University, Hyderabad, Pakistan, 15-18 September 2010.
5. **Prathapar, S.A.** Minimizing disposal and storage needs of treated effluent in Muscat, Oman. *Invited guest speaker and contributing speaker at the Sustainable Water Management Conference*, Mehran University, Hyderabad, Pakistan. 15-18 September 2010.
6. **Rahman, M.S.** Food stability determination: Challenges beyond water activity and glass transition. *Sixth Conference on Water in Food (Euro Food Water 2010).* Reims, France, 21-23 March 2010. (Plenary Lecture).
7. **Waly, M.** The 3rd International Arab's Meeting for Obesity and Physical Activity, Manama, Bahrain, 19-21 January 2010.

b. Local

1. **Al-Ani, M.** National Nutrition Conference, Ibra, Northern Al-Sharqiya Region, Oman, March 23-24, 2010.
2. **Al-Ani, M.** The First Omani Conference of Nutrition and Dietetics. Muscat, Oman, 5-6 October 2010.
3. **Al-Ani, M.R.** The dilemma of sunshine and vitamin D availability in Oman. *The 1st Omani Conference of Nutrition and Dietetics*. Muscat, Oman,5-6 October 2010. (Keynote Speaker)
4. **Al-Mulla, Y.** *Attended Third Geographical Information System Forum*, SQU, Oman. 10-11 May 2010.
5. **Al-Yahyai, R.** Date palm preservation and development. *Date Palm Symposium.* Oman Chamber of Commerce and Industry, University of Nizwa, Oman, 20 Sept 2010. (Invited lecture).
6. **Piontkovski, S.A., M. Claereboudt, A. Al-Azri** and **K. Al-Hashmi**. Eddies and phytoplankton blooms along the Batinah coast of Oman.

Presented at the Inauguration of the Cultural Center, Sultan Qaboos University. November 2010.

7. **Waly, M.** Annual National Nutrition and Health Conference in Oman, Ministry of Health, North-Sharqia Region, 23-24 March 2010. (Speaker).

Workshops Attended by Faculty & Staff

a. International

1. **Al-Azri, A.** International Workshop on the Law of the Sea. Dublin, Ireland, 20 April 2010.
2. **Al-Azri, A.R., S. Piontkovski** and **K. Al-Hashmi**. Harmful algal blooms in Omani water: Possible causes, impact and monitoring approach. *Invited as keynote speaker in a Workshop on Harmful Algal Blooms Mitigation.* Tehran, Iran, 21-23 February 2010.
3. **Claereboudt, M.** Connectivity pattern in Arabian Sea, Sea of Oman coral communities. *Invited paper presented at the Regional Workshop on Impacts of Climate Change in Corals, Heat-Resistant Corals and Artificial Reefs.* Teheran, 20-23 June 2010.
4. **Zekri, S.** Socio-economic drivers of groundwater demand and aquifer services. *Invited guest speaker at the Water Governance Workshop.* Amman, Jordan, 27-28 June 2010.

b. *Local*

1. **Al-Ani, M.** The Oman-South Africa Joint Workshop (Integrated Approaches to Fruit Production and Postharvest Management in Arid Climates), Sultan Qaboos University, 29-31 May 2010.
2. **Al-Ani, M.R.** 2010. Fish Consumption: The risks and the benefits. Workshop on Food, Nutrition in Health and Disease. CAMS, SQU, 10 May 2010.
3. **Al-Attabi, Z.** Sanitary practice in dairy processing. *Presented in a Workshop on Food Safety and Consumer Health* organized by Muscat Municipality, 21-22 March, 2010.
4. **Ali, A.** Diet and cancer. *Presented in a Workshop on Current Challenges of Nutritional Related Health Problems in Oman.* Sultan Qaboos University, Muscat, 21 March 2010.
5. **Al-Jabri, O.** *Participated in the Sustainable Development of the Agricultural Sector Workshop* organized by the Ministry of Agriculture, Sih Al Massarat, Wilayat Abri, Oman. 1-3 November 2010.
6. **Al-Masroori, H.** *Participated in a Workshop on Becoming an Effective Supervisor, for Postgraduate Research Supervisors,* organized by the Office of the Deanship of Postgraduate Studies, SQU. 23-24 January 2010.

7. **Al-Masroori, H.** *Participated in a Workshop on Developing a Five-Year Plan for Fisheries Extension in Sultanate of Oman.* Ministry of Fisheries Wealth, 29-30 May 2010.
8. **Al-Rawahy, S.A.** 2010. Results of the Strategic Project "Management of Salt-Affected Soil and Water for Sustainable Agriculture." *Presented in simplified way to farmers with 60 salt-affected farms of wilayats of South Batinah.* Workshop held at Sawadi Beach Resort, Barka, 28 March 2010.
9. **Al-Rawahy, S.A.** Results of the Strategic Project "Management of Salt-Affected Soil and Water for Sustainable Agriculture." *Presented in simplified way to farmers with 60 salt-affected farms of wilayats of North Batinah.* Workshop held at Crown Plaza Hotel in Sohar, 20 March 2010.
10. **Al-Saady, N.** Applications of biotechnology in fruit production. *Workshop organized under Oman-South Africa Scientific and Technical Bilateral Cooperation Programmed and the Strategic Research Project: Rejuvenating Lime Production in Oman: Resolving Current Challenges.* 29-31 May 2010.
11. **Al-Sadi, A.** and **M. Deadman**. 2010. Plant Pathology Research Laboratory: Accomplishments, current projects and future plans. *Workshop organized under Oman-South Africa Scientific and Technical Bilateral Cooperation Programmes and the Strategic Research Project: Rejuvenating Lime Production in Oman: Resolving Current Challenges.* 29-31 May 2010.
12. **Al-Subhi, L.** Workshop on Government Statistics. Spring 2010.
13. **Al-Wahaibi, A.K.** Coconut Mite Research Project Third Workshop. Organized by the Ministry of Agriculture held in Salalah, 25-26 January 2010.
14. **Al-Wahaibi, A.K.** Insect vectors of phytoplasmas: The case of WBDL in Oman. *Workshop organized under Oman-South Africa Scientific and Technical Bilateral Cooperation Programmes and the Strategic Research Project: Rejuvenating Lime Production in Oman: Resolving Current Challenges.* 29-31 May 2010.
15. **Al-Wahaibi, A.K.** Integrated Approaches to Fruit Production and Postharvest Management in Arid Climates. Workshop held in College of Agricultural and Marine Sciences, SQU, 29-31 May 2010.
16. **Al-Yahyai, R.** and **F. Al-Said**. Physiological approach to fruit production. *Workshop organized under Oman-South Africa Scientific and Technical Bilateral Cooperation Programmes and the Strategic Research Project: Rejuvenating Lime Production in Oman: Resolving Current Challenges.* 29-31 May 2010.
17. **Al-Yahyai, R.** Fruit production in the Sultanate of Oman. *Workshop organized under Oman-South Africa Scientific and Technical Bilateral Cooperation Programmes and the Strategic Research Project: Rejuvenating Lime Production in Oman: Resolving Current Challenges.* 29-31 May 2010.

18. **Boughanmi, H.** and **H. Kotagama**. Food security in Oman: Situation and prospects. *Poster presented at the Sustainable Development of the Agricultural Sector Workshop* organized by the Ministry of Agriculture, Sih Al Massarat, Wilayat Abri, Oman. 1-3 November 2010.
19. **Claereboudt, M.R.** and A. McLachlan. *Presentation in a Workshop on "Writing Scientific Papers"* organized by the Office of the Deanship of Postgraduate Studies, SQU.
20. **Essa, M.** Walnuts improve memory deficits in AD mouse models. *Presented in a Workshop on Food, Nutrition in Health and Diseases.* CAMS, Sultan Qaboos University, Muscat, 10 May 2010.
21. **Jayasuriya, H.** Aerial imaging for on-farm applications. *Presented in a Workshop entitled, "Image Applications in Biological and Agricultural Sciences,"* SQU. 28 April 2010.
22. **Jayasuriya, H.** Introduction to tillage implements, hitching of implements and stability. *Presented lecture and field demonstrations in a Workshop entitled, "Familiarization with Tractors and Implement Operations,"* AES, CAMS, SQU. 16-18 May 2010.
23. **Jayasuriya, H.** Introduction to tractor and its power transmissions for implement operations, safety measures. *Presented lecture and field demonstrations in a Workshop entitled, "Familiarization with Tractors and Implement Operations,"* AES, CAMS, SQU. 16-18 May 2010.
24. **Jayasuriya, H.** Introduction to tractor attachments; seeders, planters, chemical and manure applicators, hey harvesting and processing. *Presented lecture and field demonstrations in a Workshop entitled, "Familiarization with Tractors and Implement Operations,"* AES, CAMS, SQU. 16-18 May 2010.
25. **Mothershaw, A.** Food Safety Workshop. Organized by Muscat Municipality, Hyatt, Sultanate of Oman. 2010.

Seminars Attended by Faculty and Staff

a. International

1. **Piontkovski, S.** The Lighthouse Co. Research. *Joint seminar between Ministry of Fisheries Wealth and Texas University Lighthouse Co..* Intercontinental Hotel, Muscat, 18 October 2010.

b. Local

1. **Al-Ani, M.** Food Safety and Consumer Health. Muscat Municipality, Holiday Inn. Muscat, Oman, 21-22 March 2010.
2. **Al-Ani, M.** Nutrition and Dietetic Seminar. Al-Nahdha Hospital, Ministry of Health, Oman, 27 March 2010.

3. **Al-Ani, M.R.** Omega-3 fatty acids and fish consumption health benefits. *Nutrition and Dietetic Seminar*. Al-Nahdha Hospital, Ministry of Health, Oman, March 27, 2010 (Keynote speaker).
4. **Al-Bulushi, I.** Food Safety. Ministry of Commerce and Industry and Omani Euro Food Industry, Oman.
5. **Al-Bulushi, I.** Microbiologically-safe handling of foods in restaurants. Barka Municipality, Oman.
6. **Ali, A.** Effect of Arabian coffee on the glycemic response and glycemic index of foods "Diet and Cancer."
7. **Al-Mulla, Y.** Attended seminar on Water and Sustainable Agricultural Development: Global Trends, State Council, Oman, 23 May 2010.
8. **Al-Rawahy, S.A.** Results of the Strategic Project "Management of Salt-Affected Soil and Water for Sustainable Agriculture" and Recommendations of the International Conference on Management of Soil and Groundwater Contamination in Arid Regions. *Presented at the CAMS Advisory Board*, Chamber of Commerce and Industry, Muscat, 29 March 2010.
9. **Al-Rawahy, S.A.** Results of the Strategic Project "Management of Salt-Affected Soil and Water for Sustainable Agriculture" and Recommendations of the International Conference on Management of Soil and Groundwater Contamination in Arid Regions. *Presented at the weekly seminar organized by CAMS on the theme, Sustainable Agricultural and Marine Environments* (SAME). CAMS, SQU, 5 April 2010.
10. **Al-Yahyai, R.** The date palm. *Date Palm Day,* Hail Al-Awamer High School (Grade 11-12) Ministry of Education, Muscat, Oman. 2 February 2010. (Invited lecture).
11. **Boughanmi, H.** Highlights on the Food Security Conference and recommendations. *Presented at the CAMS Advisory Board*. Chamber of Commerce, Muscat, 29 March 2010.
12. **Claereboudt, M.R.** and K.M. Al-Rashdi. 2010. Diversity, stocks and feasibility of sea cucumber aquaculture in Oman. *Presentation in Research Seminars of Collaborative Projects between SQU and MFW*. Sultan Qaboos University, 28 February 2010.
13. **Dobretsov, S.** Antimicrobial compounds from marine organisms. *Presentation at the College of Medicine, SQU*. 14 March 2010.
14. **Piontkovski, S.** Coastal hypoxia on the northern gulf of Mexico: Physics and Phytoplankton. *Joint seminar between SQU, Ministry of Fisheries Wealth and Texas University Lighthouse Co.* held at Sultan Qaboos University, 20 October 2010.
15. **Waly, M.** Non-communicable diseases prevalence in Oman, Ministry of Health, Al-Dhalia Region, 16-17 February 2010. (Speaker).

Others

2010 University Day Presentations

Oral

1. **Al-Rawahy, S.A. et al**. Management of salt-affected soils and water for sustainable agriculture.
2. **Al-Yahyai, R. et al.** Rejuvenating lime production in Oman: Resolving current challenges.
3. **Kadim, I.T.** Effect of low voltage electrical stimulation and splitting carcasses on meat quality of Omani camel.
4. **Mbaga, M.** The effect of Omanization policy on the efficiency of dairy farms in Oman.
5. **Rahman, M.S.** Thermal characteristics of gelatin extracted from Shaari: Effects of extraction conditions.
6. **Sarma, Y.V.B.** The influence of the sea surface temperature on tropical cyclone track –A case study.

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Appendix - CAMS Research Profile, 2010

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