

ESTABLISHMENT OF FOOD TECHNOLOGY AND NUTRITION
LABORATORIES AT THE AGRICULTURAL RESEARCH
STATION, MINISTRY OF AGRICULTURE AND FISHERIES,
SULTANATE OF OMAN

A REPORT

BY

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Introduction

1.0 Background :

A delegate of Omani Scientists headed by the Director General of Agriculture, Ministry of Agriculture and Fisheries, during their visit to the National Agricultural Research Centre, Islamabad (Pakistan) in 1984, appreciated the role of Nutrition and Food Quality laboratories in the agricultural research system, and desired to have similar facilities to be established at one of the Agricultural Research Stations in Oman. Accordingly Dr. M. Akmal Khan, Chief Scientific Officer, Nutrition and Food Quality Labs and Head of the Central Laboratories of the National Agricultural Research Centre, Islamabad, Pakistan visited Oman as consultant to accomplish this assignment on the invitation of the Ministry of Agriculture and Fisheries, Sultanate of Oman for a period of one month i.e. from 2nd April to 1st May 1986.

2.0 Terms of Reference

- i. The expert will observe and discuss the available facilities and evaluate research carried out on processing and nutritional quality of cereal grain, food legumes, fruits, vegetables at the various agricultural reserach stations.
- ii. The expert will identify areas of food commodity research at various research stations.
- iii. The expert will recommend the strengthening of the existing labs or to establish new labs with specific tests, and equipment required for quality evaluation.
- iv. The expert will suggest the methods of screening early/advanced lines of important crops for nutritional quality and consumer acceptance.
- v. The expert will suggest the priorities of research on various food commodities.
- vi. The expert will identify the fields of higher training abroad.

- vii. The expert will suggest the names of the scientific journals and periodicals relevant to the subject.

3.0 Agricultural Status

3.1 Land Use.

Oman's total land resource is 21.24 mha, of which the cultivated areas is placed to 41000 ha. The area under pasture is 1.0 mha. A considerable unused but potentially productive land (20.2 mha) is available for farming. Oman's farmland lies in widely differing agro-ecological regions, enabling production of a variety of crops.

3.2 Population.

The population of Oman has been estimated to be one and half million with an annual growth rate of 3 percent.

3.3 Role of Agriculture in National Economy.

Agriculture plays a significant role within the national economy, especially in terms of overall employment. About half the work force employed in agriculture. Oman's economy has done very well despite the downturn in the world economy and recent softening of oil prices. According to unofficial Ministry of Finance estimates, GDP grew 4-5 percent in 1983 and in 1984 to 11.1 percent. The contribution of agriculture to the national economy in terms of GDP was 37.2 million R.O. in 1980 and 53.4 million R.O. in 1983 (1 Omani Rial = 2.58 US\$).

3.4 Food Production

The following foods are commonly produced in Oman. Among fruits, dates, lime, oranges, banana, mango, coconut, papaya and others are commonly grown. The vegetables such as onion, watermelon, cucumber, tomato, potato and many others are produced. Cereals (wheat, sorghum, maize, triticale, barley, millet etc) and some legumes such as chickpea, lentils and faba beans are grown in Oman. Oman Sun Farms (Vegetables

and dairy products) and Oman Farms (Eggs) are the new large cooperative commercial farming operations in Oman. The production trends of major foods are shown in Table 1

Table 1 Estimated Production Trends in Tonnes

	1982	1983	1985
Fruits (000)	86.0	79.0	83.0
Vegetable (000)	35.0	38.0	46.0
Red Meat	N.A.	2,600.0	2,700.0
Poultry Meat	2,025.0	2,075.0	2,180.0
Eggs (millions)	N.A.	37.0	40.0
Fish	638.0	656.0	700.0
Milk	N.A.	39,500.0	40,500.0
Cereals (wheat, barley, sorghum)	1,044.0	1,110.0	1,373.0

Source: Ministry of Agriculture and Fisheries.

As per terms of reference the following foods will be discussed in detail.

Among the fruits, dates are predominant tree crop (with 50-60 % of the total cultivated land) and are the traditional food of the Omani people. The average yields of date, lime, citrus, banana, mango and coconut are 2.62, 10.19, 9.46, 15.90, 1.06 and 12.5 tonnes/ha respectively. Fruits other than dates mainly lime, banana and mango present the largest commodities in the agriculture sector, cover an area of 7,000 ha. The value of produce from these three fruit crops in 1980 was around 5.6 million Omani Rials as compared to 16.6 million R.O. from dates.

Vegetable production is highly seasonal in Oman. Total vegetable production utilizes 9 percent of cultivated land. The average yields of onion, water-melon, tomato and other vegetables have been reported to be 10.0, 12.5, 12.54 and 7.0 tonnes/ha respectively. The value of vegetables produced in Oman in 1980 was 5.3 million R.O.

Cereals (wheat, barley, sorghum) and legumes (chickpeas, lentils, faba beans) have been grown in Oman for many years.

The production of wheat in Oman during 1979 was estimated at about 750 tons based on an estimated area of 600 ha and an average of 1250 Kg/ha. Most of wheat is grown traditionally by the farmers in the interior regions of the country. The grain yields obtained by these farmers are less than 30 % of the potential yield under improved package of agronomic practices. Varieties planted on 70 % of the hectarage are mostly of local origin and much of the wheat produced is used in making Omani bread (Khubz). The yields for the local varieties normally range between 800 and 1500 kg/acre whereas Mexipak variety has given yields of 2-3.2 tons/ha but the gluten quality of wheat does not make good Khubz. Thus local varieties are generally preferred by the Omani farmer. The Ministry of Agriculture and Fishereis is planning the implementation of large commercial farms (200 ha) for wheat production under irrigation in Wadi Quriyat. Wheat and legumes and other grains will continue to be important staple in Oman and national policy indicates their importance should continue especially for reasons of food security. The production of these grains can be made more economical through the use of improved technology. The possibility of growing oilseed crop for local production of vegetable oil deserves serious consideration. There is also a need to expand storage facilities for these crops.

3.5 Food Exports and Imports.

In most developing countries there is a strong desire to expand agricultural production as quickly as possible, increase exports and reduce or to eliminate imports of food commodities. The food exports and imports for 1984 are given in Table 2 and 3.

Table 2 : Food Exports 1984		Value thousand RO
Fish and fish products		6289.5
Wheat flour		561.5
Fruits and vegetables		3184.0
Food legumes		8.4
		<hr/>
		10043.4

Source: Sultanate of Oman Statistical Year Book 1985.

Table 3 : Food Imports 1984

	Value in M. O.R.	Quantity 000, Tonnes
Meat and meat products	20.7	41.1
Dairy products and Eggs	18.6	36.0
Fish and fish products	1.1.	1.2
Cereal and cereal products	24.7	215.4
Fruits and vegetables	30.0	81.0
Edible oil and fats	4.4	13.8
Sugar	5.1	37.8
	<u>104.6</u>	<u>426.3</u>

Source: Sultanate of Oman Statistical Year Book 1985.

In order to boost the local food production, careful planning is needed to develop new agricultural production system coupled with reconsideration on the open door policy of imports.

3.6 Food Consumption.

The information on food consumption of Omani people is not available. An attempt, to calculate the average national food consumption from 1981-84 average annual imports, exports and local production adjusted to 1985 population has been made. The average consumption of different food items are illustrated in Table 4

Table 4: Average National Food Consumption

	g/head/day
Wheat	168.0
Rice	146.0
Meat (beef, mutton, poultry)	85.0
Fish	150.0
Egg	14.0
Milk and Milk products	208.0
Vegetables	125.0
Fruits	301.0
Edible Oil	19.0
Sugar	52.0

The average national diet is more than adequate to meet the daily requirements. The average energy and protein intakes are 2925 Kcal and 96 gm respectively. As these are the average figures, some population may be consuming below the average availability of food.

The consultant during his visit to Nizwa, measured the food intake of 120 students (17-19 years) residing in the hostel of Nizwa Agricultural Institute. The average daily intake of per student was 2300 Kcal and 85 gm of protein. It appears that there is no problem of food shortage in the country.

In order to collect data on food and nutrition situation and in particular food supply availability (national and regional) and food consumption of socio-economic groups of the population, the establishment of a nutrition unit in the planning section of the Ministry of Agriculture is recommended.

3.7 Food Processing.

The development of food processing industries in Oman began in 1972. The following factories are operating in the country.

- National Beverages Co.
- Oman Refreshment Co.
- Salalah Dairy.
- Vegetable oil processing Plant.
- Nizwa Date Factory.
- Rustaq Date Factory.
- Banana Packing Factory.
- National Biscuit Industries.
- Oman Flour Mills.

The Ministry of Agriculture and Fisheries is giving more emphasis on the development of agro-industries, to enhance and preserve the quality of agricultural produce. Such projects are useful to provide an opportunity to the farmer to increase his yield and output profitably.

In Oman, the seasonal production of fruits and vegetables causes markets to be flooded during short periods of time and deprived of the local vegetables and fruits produce for the rest of the period. High losses of tomatoes (30 %) and banana (15-30 %) during the peak season have been reported. It is therefore, recommended that small processing units should be established in the pocket areas. This would save not only the loss of food that occurs immediately after the harvest but also the preserved food can be used for the rest of the period. The quality of processed foods is controlled by the Govt Central Labs according to the local standards, under the Ministry of Commerce and Industry. The laboratories charge 33 O.R for chemical analysis of one food sample. The quality of imported wheat and its milled products is tested by the Quality Control Lab of Oman Flour Mills. These Mills are also operating under the Ministry of Commerce and Industry. Dehydration of fruits and vegetable is a comparatively cheaper process for the preservation. The dehydration is economically feasible for export and domestic use. The main advantages of dehydration over other methods of preservation being that the dehydrated products are :

- Light in weight and occupy much less space than the original, frozen or canned materials.
- Cheap to pack compared to tinned materials.
- Stable under ordinary storage conditions.

There is also a considerable scope in the processing of potatoes and it provides means of removing potatoes from the market during periods of peak production.

There is a need to conduct a survey to measure the post-harvest losses of various fruits and vegetables grown in Oman.

3.8 Agricultural Education.

At present, Oman has only one Agricultural Institute at Nizwa, under the Ministry of Education. This institute was established in 1979. The institute has comprehensive courses including food processing and human nutrition and awards diploma after three years of training. These diploma holders have good openings and work as Assistant (Agri) in the Ministry of Agriculture, Agricultural Bank

and Marketing Authority.

The college of Agriculture at Sultan Qaboos University is starting a degree course hopefully this year. Keeping in view the importance of human nutrition in agriculture, it is recommended that a course on food and nutrition should be included in the curriculum. The collaboration between the college of Agriculture and Agricultural Research Station at Rumais can play an important role in the development of agriculture in Oman.

3.9 Agricultural Research

Despite the fact that environmental factors hindering the expansion of agriculture, Oman is trying to achieve the aim of technological transformation of its farm sector, with emphasis on intensive land utilization and maximization of yield per unit of cultivation. This calls for, among other things, research on crops suitable for local conditions, cropping patterns and the principles crop rotation, will result substantial increase in production. It must however, be realised that agriculture is a very complex phenomenon. It acquires interaction of a large number of factors and has to adjust itself rapidly to the biological environments and socio-economic changes within the country and in the world at large. Modern agriculture survives only if it is backed by a well organised system of research at different levels. To handle the research work needed, a well equipped multidisciplinary and multicommodity research facility at the national level is a pre-requisite.

The stated objectives of agricultural research in Oman are : evaluating varieties, testing new crops, developing optimum input usage information (types, quantities, timings), improving cultural practices and solving agronomic problems of farmers. The following research stations are engaged to achieve the objectives mentioned above.

The Agricultural Research Station at Rumais was established in 1971 and is concentrating its research activities on various fruits, vegetables, wheat, chickpeas, cowpeas etc.

The station is trying hard to improve the quantity and quality of food crops. The research activities are backed by laboratories in the following disciplines. Soil and water, Seed lab, Entomology and Plant Pathology. The Soil lab is well equipped and providing good service to the field scientists.

The Agricultural Research Station at Wadi Quriyat is the main field crop research centre, dealing with wheat, barley, sorghum, maize, triticale, rye, cowpeas and chickpeas. The main research thrust is on wheat improvement and 50 wheat lines/ varieties were screened during 1985-86. Some improved varieties of vegetables such as tomatoes, onion, garlic, potatoes, french beans and cucumber have been released by this research station.

The research on the improvement of dates, and citrus varieties have achieved some encouraging results at Fruit Research Station located at Tanuf. The Agricultural Research Station at Salalah is conducting research on the improvement of fruits, vegetables, honey, wheat, triticale, rye and cowpeas varieties. The research is backed by the Soil, Entomology and Plant Pathology labs. No equipment is available in the Field Crop and Horticulture labs.

Some research on improving the quality of fruits at higher elevations is presently being conducted at Saiq (Jabal Akhdar) and Qairoon Hairth (Jabal Salalah).

At present the screening of food crops varieties is based on high yield/disease resistance. Although the plant scientists are fully aware of the importance of quality evaluation of their varieties but due to absence of Food Technology and Nutrition laboratories at their research stations, no work on this aspect has been done.

In order to achieve the self sufficiency in food production, agricultural research is being given top priority in the national plans. Accordingly it has been planned to strengthen the research capabilities of all the Agricultural Research Stations and to upgrade the Agricultural Research Station at Rumais to National Agricultural Research Centre. Many disciplines including Plant breeding and germplasm collection unit have been proposed for this centre.

4.0 Establishment of Food Technology and Nutrition Laboratories.

4.1 Importance

Plant breeding has been recognized as a basic means of improving crop production all over the world. Field Crop Scientists, generally under the pressure of political and economical factors, have concentrated most of their efforts on increasing yields of the most important crops., better adaptation to local environmental conditions, high production and better resistance to the major pests and diseases have been among the priority goals of genetic crop improvement. Yielding ability and stability undoubtedly deserve high priority: every effort should be made to increase availability of the staple foods. It has sometimes happened, however, that breeders have failed to pay enough attention to the need to evaluate the composition and nutritional characteristics of the food produced, and that the result has been low utilization of the crops. The Plant Scientists should be fully aware of human nutritional requirements and optimal characteristics of crop products to be utilized as food.

In the recent years the agricultural scientists of Oman have focused most of their attention on increasing the total production of the crops. However, in any major crop improvement programme, attention must not only be given to the quantitative aspect of production but also nutritional considerations (protein contents, protein yield/ha, amino acid balance, sugar contents, total soluble solids etc), processing quality and consumer acceptance (milling, banking, cooking etc) be considered in order to bridge the gap between the nutritional needs and food supply.

The areas of food technology and nutritional research in agriculture has been neglected in Oman. The laboratory facilities at all the Agricultural Research Stations are not available to test the improved lines/varieties for nutritional and technological values.

A multidisciplinary programme is thus, proposed to test the new lines/advanced lines/commercial varieties of cereals, legumes, fruits and vegetables for nutritional/processing quality and consumer acceptance. Such screening will identify food crop varieties combining superior yield potential, good nutritional/processing value and high consumer acceptance.

4.2 Proposed Location.

Keeping in view the research capabilities including lab facilities and future plans for research expansion of all the Agricultural Research Stations, the consultant strongly recommends the establishment of Food Technology and Nutrition Laboratories at the Agricultural Research Station located at Rumais.

There is also a need to provide some basic analytical facilities to the researchers, by converting the present Field Crops lab into Nutrition Lab at the Agriculture Research Station, Salalah. This lab will perform simple and basic tests and for sophisticated analysis the material will be sent to the Central Labs at Rumais.

4.3 Objectives

- i. Screening of germplasm/early lines/advanced lines/commercial varieties for nutritional quality and consumer acceptance.
- ii. Measuring the effect of production and post-harvest environments on the nutritional quality and technological value of food crops.
- iii. Developing methods for processing and preservation of fruits and vegetables and improving the quality of their processed products.
- iv. Providing analytical services to all the plant breeders, field crops, fruits and vegetable researchers working at all the Agricultural Research Stations of the country.

v. Coordinating with other Ministries, Institutions/ Sultan Qaboos University/Food Industries, that are concerned with the definition and solutions of problems in the field of food processing and nutrition.

vi. Arranging short courses for extension workers/home economists to equip them with the basic concepts of food processing and human nutrition.

4.4. Physical Facilities Required.

The following physical facilities will be required at Rumais.

1. Nutrition laboratory.
2. Cereal and legume processing laboratory
3. Fruits and vegetable processing laboratory.
4. Sensory evaluation room.
5. Test kitchen.
6. Sample cold room.

4.5 Equipment required at Rumais Centre

4.5.1 Nutrition Laboratory. This lab facility will be used for the chemical analysis of all types of foods and their products. The lab may be sub-divided into general analysis lab and analytical equipment lab.

S.No.	Component	Equipment	Quantity
1.	Moisture	Hot air oven or Rapid moisture oven	one
2.	Nitrogen/protein	Kjeltec auto analyser with accessories	one
3.	Fat	Soxtec System with all accessories	one
4.	Crude fibre	Fibertec System with accessories	one
5.	Ash	Muffle Furnace with crucibles etc.	one
6.	Starch, Nitrate/ Nitrite	Spectronic 21 Spectrophotometer	one
7.	Amino Acids	Amino acid analyser	one
8.	Sugar, vitamins antinutritional factors etc.	High performance liquid chromatography	one
9.	Screening foods for different components.	Near Infrared analyser	one

S.No	Component	Equipment	Quantity
10.	Distilled water	Water Still	one
11.	Minerals	Atomic Absorption Spectrophometer	one
12.	Energy estimation	Bomb calorimeter with accessories	one
13.	Mixing/Shaking	Ultra Shaker, Orbital Shaker	one
14.	Pesticide residues	Gas Liquid Chromatography	"
15.	Misc items: Stop watch, Centrifuge, Thermometers (Min/Max), Refrigerator/Freezer, Fume hood, Electronic analytical balance, Hot plate, Magnetic stirrers, Triple beam balance, Cork boarer, Pastle mortar, Vacuum pump, Trolley for sample transfer and Water bath		one each

4.5.2 Cereal and Legume Processing Lab

The equipment required to perform the following tests are given below :

a. Milling and Grinding Unit

S.No.	Process/Test	Equipment	Quantity
1.	Grain Sampling	Official Grain Triers	one
2.	Sample Divider	Official Boerner Divider	"
3.	Test Weight	Test Weight Balance	"
4.	Seed Cleaner	Lobofix (Brabender) and or Carter Dockage Tester	"
5.	Grain Moisture	Burrows or alternative	"
6.	Seed Weight Test	Electronic numerical seed counter	"
7.	Grain Hardness	Barley Pearler or Micro-hardness Tester	"
8.	or Particle Size (PSI)	Ro-Tap sifter with set of sieves	"
9.	Mixer/Blender	One wheat blender and one Flour mixer	" each
10.	Small sample test	Cyclotec sample mill	one
11.	Wheat milling	Qd.Junior Mill	"

S.No.	Process/Test	Equipment	Quantity
12.	Wheat milling	Buhler Mill	one
13.	Weighing	Top Loading Balance	"
14.	Humidity Control	Room Humidifier (Automatic)	"
b. Physical Dough Testing Section			
1.	Viscosity	Any suitable Viscometer	"
2.	Amylase activity	Falling Number Apparatus	"
3.	Dough tests	Farinograph, Extensograph, Oven Rise Recorder, Simon Moisture Meter, Mixograph, 10g"	each
4.	Gluten test	Theby Gluten Washer or Glutamatic	one
5.	Water Activity	Water activity testing apparatus	"
6.	Area measurement of curves	Planimeter	"
c. Test bakery			
1.	Food Extrusion	Extruder Unit (Lab. Scale)	"
2.	Small scale baking test	Dough Mixer with hook, whip, paddle attachments, moulder, proofer, bakery oven with steam injection	one each
3.	Bread, Cake and other bakery items	Bread, Cake and pastry pans	six each
4.	Volume measurement	Volumeter with rape seed displacement	one
5.	Temp. test	Pyrometer	"
6.	Sample holding & transfer	Trollies	"
d. Cooking time/Quality of Legumes			
1.	Cooking time	Reflux condenser unit set with heater assembly and other glassware	"
4.5.3 Fruit and Vegetable Processing Lab			
1.	Dehydration of samples	Small Scale Lab. Hot Air Food Dehydration Unit	"
2.	Sample preparation	Fruit Washer, Abrasive Peeler	"
3.	Juice Extraction	Juice Extractor (Citrus etc)"	"
4.	Processing	Coarse Pulper, Food Processor (optional)	"

S.No.	Process/Test	Equipment	Quantity
5.	Blanching	Steam Blancher	One
6.	Mixing of Liquids	Stainless Steel Tanks with stirring/mixing arrangements for juice	"
7.	Extraction, Deaeration, Filling	For Grapes etc Basket Press Type Juice Extactor, Deaerator, Capping Machine	"
8.	Freeze Drying	Freeze Dryer and Accessories	"
9.	Sugar % test	Reflectometer	"
10.	Sugars and other optically active liquids	Polarimeter	"
11.	Pectin test	Jelmeter	"
12.	Texture	Precision Universal Pentrometer, Fruit Pressure Tester	one each
13.	Salt in Canned Fruits	Salt Analyser	one
14.	Canned Products Examination	Stepped Headspace Gauge or Campden Head Space Gauge	"
15.	Canning of Samples	Lab. Scale Canning Machine Units, e.g. Tin plate cutter, Seamer (Double seam maker) etc.	"
16.	Seam checking	Seam Micrometer, Seam Checking Gauge	"

4.6 Equipment Required for Nutrition Lab at Salalah.

This lab will perform simple routine analyses and for other tests the material will be sent to Rumais.

The following equipments are recommended :

1.	Hot air Oven	one
2.	Kjeltec auto analyser	"
3.	Soxtec System	"
4.	Fibertec System	"
5.	Muffle Furnance	"
6.	Spectronic 21 Spectrophotometer	"
7.	Water Still	"
8.	Centrifuge	"
9.	Refrigrator	"
10.	Analytical balance	"
11.	Water bath	"
12.	Ud Cyclone grinder	"

4.7 Screening Tests for Breeding Bread Wheat and Triticale

The following lists of tests and equipment will provide a comprehensive test schedule for breeding programmes in bread wheat and triticale at Rumais.

a. Bread Wheat

F 4 to advanced and parental material

- | | |
|--|-------------------------------------|
| 1. Test weight | Hectolitre weight |
| 2. Hardness | PSI |
| 3. Protein content | Kjeltec or NIR. |
| 4. Protein strength | SDS Sedimentation test |
| 5. Protein strength | 10 gm Mixograph |
| 6. Flour milling | Brabender junior mill |
| 7. Protein strength and Water absorption | Farinograph (50 gm bowl) |
| 8. Baking | i) Omani bread
ii) Raised breads |
| 9. Alpha amylase | Falling number test |

b. Triticale

1. All tests from 2 to 8 for bread wheat. Do not include baking raised bread.
2. Colour and appearance. Visual: Triticales which are not close to amber in colour, and with smooth kernel surface will not be suitable as food, but may still be useful as feed.

4.8 Research Priorities

4.8.1 Cereal and Legume Grains

Short Term

- a. Analysis of germplasm for screening purposes.
- b. Chemical and physical analysis of advanced lines/commercial varieties of cereals and legumes.
- c. Cooking and consumer acceptability studies on improved varieties of legumes.

Long Term

- a. Effect of milling on the nutritive value of flour from cereal grains.
- b. To study the role of antinutritional factors in cereals and legumes.

- c. To investigate the effect of germination on the nutritive changes in cereal and legume grains.
- d. Influence of storage on the technological and nutritive value of cereals and legumes.
- e. A study on the nutritive value and storage life improvement of local and other flat breads.
- f. Development and nutritional evaluation of cereal food products from cereal and legume grains.
- g. Effect of production environment (fertilizer, irrigation, stage of maturity etc) on the nutritional quality and technological value of cereals and legumes.

4.8.2 Fruits and Vegetables

Short Term

- a. Analysis of local fruits and vegetables for evaluation of nutritional quality.
- b. Quality and consumer acceptance of processed products (juice, jam, drinks etc) from local fruits.
- c. Sensory and nutritional quality characteristics of some popular pickled vegetables in Oman.
- d. A survey of storage stability of local fruits and vegetables.

Long Term

- a. Changes in Nutrient Contents of fruits and vegetables during transportation available in the Local Market.
- b. Effect of freezing and thawing of vegetables available in Oman.
- c. Production of Dehydrated Vegetables and study of their storage stability.
- d. Production, analysis, preservation and utilization of Date Palm Syrup.
- e. Development of Long-Life Fruit and vegetable juices by Dehydration.
- f. Functional properties of Cell Wall in Tomato Juice and its impact on storage stability.
- g. A study on Postharvest Losses of selected fruits in Oman.
- h. Determination of pesticides residue on fruits and vegetables available in the market.

4.8.3 Studies on the Nutritive Value of Diets.

- a. Nutritive value of Omani diets consumed in different agro-ecological regions.
- b. Nutritional evaluation of home made and commercial baby foods.

4.8.4 Food Policy and Planning

- a. Studying the impact of agricultural and food supply policies on nutrition and health status of the population.
- b. Advising those responsible for planning and implementing agriculture programmes on nutrition.

4.9 Personnels and Training

The following staff will be required to run the laboratories :

4.9.1 Rumais

1. Cereal technologist	- 1	Ph.D in cereal science
2. Food technologist	- 1	Ph.D in fruits/vegetable processing
3. Nutritionist/ Biochemist	- 1	Ph.D in Nutrition/ Biochemistry
4. Lab technicians	- 4	B.Sc (Agri.Chem)
5. Lab attendants	- 3	Secondary School Certificate

4.9.2 Salalah

1. Nutritionist/ Biochemist	- 1	M.Sc in Nutrition or Biochemistry
2. Lab technician	- 1	B.Sc (Agri-Chem)
3. Lab attendant	- 1	Secondary School Certificate.

Training: The local staff having B.Sc (Agri.Chem) should be sent abroad for higher studies in the above mentioned areas.

Two technicians one from each station may be trained for routine quality analyses for 2-3 months at the National Agricultural Research Centre, Islamabad, Pakistan.

5.0 Immediate Actions Needed.

5.1 It may take some time to implement the recommendations of the Consultant in establishing Food Technology and Nutrition Labs at Rumais. In the mean time the following equipments may be provided to the Chemistry Section of Soil and Water labs to test food varieties for nutritional quality.

- | | |
|---------------------------|-----|
| 1. Kjelttec Auto Analyser | one |
| 2. Soxtec System | one |
| 3. Test weight balance | one |

The following equipments presently not being used in Seed lab should also be transferred to the Chemistry Lab to be utilized properly for quality evaluation.

1. Seed Divider
2. Seed Counter
3. Moisture Tester.

Such temporary arrangements would help the plant scientists to evaluate their food varieties for nutritional quality.

5.2 A technician having B.Sc (Agri-Chem) may be sent for short training (2-3 months) in nutritional evaluation of food varieties to the National Agricultural Research Centre, Islamabad.

5.3 The present arrangements of sending wheat varieties for some quality tests at the Quality Control Lab of the Oman Flour Mills may not be feasible as the management is planning to charge some money for providing this facility.

5.4 The Nutrition and Food Quality Laboratories of the National Agricultural Research Centre, Islamabad may extend all facilities for testing cereal and legume varieties evolved at the Agricultural Research Stations in Oman for nutritional quality and technological value.

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Appendix 1 List of Periodicals and Scientific Journals

The following journals are recommended for the Library.

1. Journal of Food Science (USA)
2. Food Technology (USA)
3. J. Sci. Food and Agriculture (UK)
4. Cereals Food World (USA)
5. Cereal Chemistry (USA)
6. Journal of Cereal Science (UK)
7. Journal of Food Science & Technology (Mysore-India)
8. Journal of Food Technology (UK)
9. Journal of Food Quality (USA)
10. British J. of Nutrition (UK)
11. Nut. Abst. and Rev (UK)
12. Food Research (USA)
13. Baker's Digest (USA)
14. Milling (USA)
15. J. Agric. Food Chemistry (USA)
16. Food Processing (USA)

Ministry of Agriculture and Fisheries

1. Mr. Mohammad Redha Bin Hassan Bin Salman
Director General (Agriculture)
2. Mr. Yahyai Ahmed, Director, Fisheries Resources
3. Mr. Ali Bin Saif Alabri, Director Research/Director
Agricultural Research Station, Rumais.
4. Mr. Hassen Shehata Hassan, Economic Expert,
Planning Unit.
5. Mr. Wazir Hasan, Agriculture Expert, Planning Unit.
6. Mr. Hafeez Ahmed Salim, Director Agricultural Statistic
7. Mr. Ali Alamri, Director, Agricultural Affairs.
8. Mr. Abdul Satter, Agricultural Expert on Agri Affairs.
9. Dr Dutton, Director, Khaborah Project.
10. Mr. Saeed Ahmed Mohammad, Director, Agricultural
Station, Sohar.
11. Mr. Hamood Hamdom, Manager, Oman Sun Farms, Sohar.
12. Mr. M.A. Qureshi, Agronomist, Oman Sun Farms, Sohar.
13. Mr. Amar Hamed Al-Jabry, Manager, Date Processing
Factory, Rustaq.
14. Mr. Adil Mahmood, Deputy Manager, Date Processing
Factory, Rustaq.
15. Mr. M.A. Kerr, Consultant on Date Industry.
16. Mr. Saeed Suleman, Incharge Honeybee Research
Sub-Station, Rustaq.
17. Dr Harib, Deputy Director, Central Veterinary
Investigation Laboratories, Rumais.
18. Mr. Ali Saleem, Director, Department of Agriculture,
Nizwa.
19. Mr. Suleman Abdullah, Manager, Date Processing
Factory, Nizwa.
20. Mr. Jacob Chacko, Incharge Fruit Research Station
Jabal Al-Akhdar, Nizwa.

21. Mr. Akhtar Ali, Agronomist, Fruit Research Station, Tanuf.
22. Mr. Mohammad Ahmed Jadalla, Field Crop Researcher, Agricultural Research Station, Wadi Quriyat.
23. Mr. Zehran Saud, Director Agricultural Department, Ibri.
24. Mr. Fouad Yehia, Expert Dates Marketing and Packing, Agro-industries Dept.
25. Mr. Selim Saeed Alshanfari, Director, Agricultural Research Station, Salalah.
26. Mr. Ali Hasan Saad, Incharge, Fruit Research Station, Quaroon Hairth, Salalah.

Ministry of Commerce and Industry.

27. Mr. Mohammad Al Battashi, General Manager, Oman Flour Mills, Muscat.
28. Mr. A.M. Abu Warda, Manager, Quality Control Lab, Oman Flour Mills, Muscat.
29. Mrs Aida Riyaami, Director, Central Laboratories, Directorate of Specification and Measurements Muscat.
30. Mr. A.B. Tidman, General Manager, Rusayl Industrial Estate Authority.
31. Mr. Ahmed Hussain Abdulla Babut, Manager, Banana Packing Plant, Salalah.

Ministry of Education and Youth Affairs.

32. Mr. Ahmed Salim Algaithy, Principal, Nizwa Agricultural Institute, Nizwa.
33. Professor Carrol V. Hess, Dean, College of Agriculture and Fisheries, Sultan Qaboos University, Muscat.